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# 4<sup>th</sup>



## INTERNATIONAL CONFERENCE ON EMERGING TRENDS IN ENGINEERING, MANAGEMENT & SCIENCES (ICETEMS-2021)

BRIDGING GAPS THROUGH MULTI-DISCIPLINARY RESEARCH  
AND INNOVATION FOR SUSTAINABLE DEVELOPMENT



## PROCEEDING BOOK

OCTOBER 13 - 14, 2021

ORGANIZED BY

CITY UNIVERSITY OF SCIENCE & INFORMATION  
TECHNOLOGY (CUSIT), PESHAWAR - PAKISTAN

COLLABORATING PARTNERS



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**4<sup>th</sup> International Conference on Emerging Trends in  
Engineering, Management and Sciences  
(ICETEMS-2021)**

*“Bridging Gaps through Multidisciplinary Research and Innovation for  
Sustainable Development”*

**October 13-14, 2021**

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# **4<sup>th</sup> International Conference on Emerging Trends in Engineering, Management and Sciences (ICETEMS-2021)**

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## Foreword

Today, the developing world is faced with a multitude of challenges, which include modernizing infrastructures, enhancing technological resources, and developing human assets to attract more Direct Foreign Investment (DFI). Though the Governments are investing a lot of resources to cater with their problems, yet sustainable and cost-effective solutions are still not explored. This certainly requires collaborative and integrated efforts. City University of Science and IT initiated a Conference series under “International Conference on Emerging Trends in Engineering, Management and Sciences (ICETEMS) in 2014. The first conference of the series (ICETEMS-2014) was held on Dec 28-30, 2014 at Pak-China Friendship Centre Islamabad while the second and third ICETEMS were held in Dec 2016 and Oct 2018 respectively at City University of Science and Information Technology, Peshawar, Pakistan with participants from across the globe.

It is a matter of great pleasure for the organizing committee of ICETEMS-2021 has been held successfully at at City University of Science and Information Technology, Peshawar, Pakistan. ICETEMS, is an endeavour to bring together all major stakeholders of the society for exchange of thoughts and experiences regarding the concepts, trends and practices pertaining to the major areas of Engineering, Management and Sciences. ICETEMS is our flagship event, and will provide an international forum for the discussion on important topics and emerging trends to develop new knowledge in engineering, management and sciences. The focus of the conference is to promote cutting edge interdisciplinary research in these core areas, so that efficient and cost-effective solutions are explored for the contemporary problems and issues. We are expecting a well-informed gathering, with the hope that scientists and researchers from industry and academia, public health professionals, clinicians, business delegates, manufacturers, and engineers will exchange ideas and collaborate for the sustainable development of Pakistan. This is also reflected in the theme of the conference “*Bridging Gaps through Multidisciplinary Research and Innovation for sustainable development*”.

We sincerely hope that you will continue to support our efforts.

Thanks, and best regards

**Mr. Mohammad Sabur Sethi**

President, CUSIT, Peshawar, Pakistan

## **Message from Conference Chair**

***Prof. Dr. Syed Minhaj ul Hassan***

Vice Chancellor

City University of Science and Information Technology, Peshawar

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On behalf of the 4<sup>th</sup> International Conference on Emerging Trends in Engineering, Management, Sciences and Social Sciences (ICETEMS 2021), jointly organized by City University of Science and Information Technology Peshawar, and Karakoram International University, Gilgit. It's a pleasure to welcome the anticipating participants. It is a great honor and privilege for me to serve as the Co-Chair of this International conference. ICETEMS has really brought together a tremendous and rich diversity of authors and speakers from universities, government and industry around the world to share ideas and new perspectives on a wide range of topics that includes communications, engineering and computing research, technologies and last but not the least social and political issues, addressing new technical and business issues essential to advancing today's engineering and technological environments.

The popularity of ICETEMS as the premier forum for communications, engineering, business and computing research has started to grow. The ICETEMS has already become a prominent forum, where researchers and practitioners openly exchange ideas and report progress in the exciting area of communications and networking. This year we have also included Social Scientists among our distinguished guests thus ICETEMS will deliver a stimulating, informative and delightful program. We greatly value the participations and look forward to the insightful vision and thoughts of the invited speakers. Thanks also go to the distinguished professors, invited talks and participants. I would like to extend my most sincere congratulations to the authors and speakers for their contributions. It is their efforts and vision which provided the impetus to put together this outstanding technical program. The excellence and success of ICETEMS would not have been possible without the support of our sponsors. We greatly appreciate all our sponsors and well-wishers. It is my great honor and pleasure to accept the responsibilities and challenges of Conference Chair. I hope that the conference will be stimulating, informative and enjoyable to all who attend it.

## **Message from Conference Co-Chair**

***Engr. Prof. Dr. Atta Ullah Shah***

Vice Chancellor

Karakoram International University, Gilgit

---

It is a matter of pleasure and honor for me to be part of the organizing committee a Co-Chair of 4th International Conference on Emerging Trends in Engineering Management and Sciences (ICETEMS-4), being organized by City University of Science and Information Technology (CUSIT) on Oct 13-14, 2021 in partnership with Karakoram International University Gilgit Baltistan besides other national and international partners.

The conference series was started in Dec 2014, at Pak China Friendship Centre Islamabad, which was followed by second conference in 2016 at CUSIT Peshawar. The third conference was jointly held at CUSIT and KIU in Oct/Nov 2018. ICETEMS-4 was though planned in 2020, but due to stringent restrictions on travelling and physical meetings, it was delayed to Oct 2021. I appreciate the efforts of the organizing committee and Chair of the Conference, which the conference has been arranged despite of all odds. Cumulatively in the last three conferences about 400 research abstracts were presented and this time, we expect about 150 plus abstracts, to be published in the conference proceedings and presented in the hybrid modes.

We are also working with some of the renowned publishers for publishing the Conference Proceedings. At the same time, outstanding research papers will be referred for publishing in the HEC approved Y Category Journals i.e. City University Research Journal (CURJ), City University Research Journal of Literature and Linguistics, Journal of Mountain Areas Research (JMAR) of KIU, after peer reviewed process, as per HEC & Journal requirements.

ICETEMS series of Conference has attracted good number of quality research papers since 2014 in the diverse fields of Engineering Sciences, Natural Sciences, Social Sciences and Arts & Humanities etc. The increasing number of the abstracts submissions in the conference also reflects the commitment of President, Vice Chancellor and organizing committees of CUSIT, and hard work of the editorial and technical review teams. As envisioned in the first conference in 2014, the mission of the ICETEMS conferences is to facilitate communication between multidisciplinary teams, especially those involved in engineering, management and Sciences to share their research on the emerging trends in these areas with special reference to Pakistan.

On behalf of Karakoram International University as Co-Chair and Co-host with City University of Science and IT Peshawar, I take the honor to welcome the delegates to this conference and expect that these deliberations in this cross disciplinary platform will create venues for more collaboration amongst the Higher Education Institutes and Faculty across the country, KP and entire world. The next part of the conference has been planned in Spring 2022 at Karakoram International University and the details will be shared with you all in due course of time.

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# ARTIFICIAL INTELLIGENCE

# A Novel Machine Vision-based X-ray Investigation for Various Chest Disease Detection

(Ref No. ICETEMS-21-015)

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## Abstract

Chest diseases such as lung cancer, pneumonia, COVID-19, and tuberculosis are the main causes of disability and ultimately lead to mortality; consequently, Millions of people suffer globally from various chest diseases. Therefore, this study proposes a non-invasive, contactless machine vision-based chest disease early detection system. The developed method incorporate Machine and Deep Learning-based artificial intelligent system. The method includes, data acquisition initially followed by preprocessing step for the selection of region of interest. Chest X-ray (CXR's) images were acquired from well publicly available medical databases for experimentation. Various feature extraction techniques, such as Local Binary Pattern (LBP), an improved version of Grey Level Co-occurrence Matrix (GLCM), and Histogram of Oriented Gradients (HOG), were employed for extraction. Furthermore, statistical features, for instance, mean, mode, median, skewness, and kurtosis were employed to develop a multi-class ensemble classification model. The developed method was compared with other methods, and result exhibits a superiority of 95% accuracy in terms of investigation of various chest diseases at early stages.

## Keywords

Deep Learning, Artificial Intelligence, Biomedical Engineering, Clinical Image Processing

## Introduction

Lung diseases are lethal and dangerous. Therefore millions of people suffer from various chest diseases every year worldwide (H. Wang et al., 2016). Life-threatening lung diseases are commonly known as respiratory diseases, such as tuberculosis, pneumonia, COVID-19, and lung cancer. Tuberculosis (TB) is an infectious disease that transmit, easily from one person to another. It is known to have a high fatality rate among the major chest diseases. Common symptoms include persistent cough for two weeks, chest pain, blood inside cough, fever, loss of appetite, feeling of cold, tiredness, and the loss of weight. TB is transmitted via air, similar to flu or a common cold. The proper medication course for TB takes at least 25 to 40 weeks (World Health Organization 2020). Pneumonia is a contagious disease that spread from one person to another via air, through coughing, or while sneezing. Its common symptoms are fever, chest pain while coughing, trouble while breathing in a condition of rest, or performing some activity. Other indicators of pneumonia are loss of appetite, feeling of tiredness, nausea or vomiting, headaches, and cough with phlegm (World Health Organization 2020). Pneumonia is a bilateral infection and is caused by swelling in the alveoli of the lungs. When the alveoli are filled up from the purulent material, it gets harder and harder to breathe. In December of 2019, the first positive case of COVID-19 originated in Wuhan City, China. It is a contagious disease that spread rapidly from China to all over the world (Tao, Tian, and Pei, n.d, 2020). Till date, the total number of positive cases worldwide is 114 million, and 2.5 million fatalities have occurred since its origin (World Health Organization 2020). COVID-19 is a broad family of viruses that leads to more serious diseases like MERS-CoV and SARS-CoV (Wang et al. 2020). This pandemic has catastrophic effects on everyone throughout the world. The most common symptoms are fever, tiredness, headache, sneezing, nasal congestion, and dry cough. As per the Forum of International Respiratory Societies (FIRS) (Forum of International Respiratory Societies. 2017), every year tuberculosis kills more than 1.5 million people. Millions are dying every

year from pneumonia, and about 16 million die from lung cancer yearly. X-ray imaging is commonly introduced to diagnose sensitive human body parts such as Chest, bones, teeth, skull, etc. This technique has been employed by radiologists from many decades to explore the abnormalities in the body (Er, Yumusak, and Temurtas, 2010). CXR's is a cost-effective and convenient medical imaging and diagnostic technique which plays a key role in the diagnosis of various diseases. CXR's includes a significant amount of details concerning a patient's health condition. However, correct interpretation of the data is a constant challenge for medical experts. Lung diseases are usually detected through sputum sample tests, blood tests, skin tests, (Standards, 2000). Computed tomography and CXR's examination (Setio et al., 2017). CXR's imaging became commonly accepted standard for its noninvasive nature and timely detection and diagnosis of pulmonary abnormalities (Hooda, Mittal, and Sofat., 2018). There is a high chance of misclassification error if a clinician examines the images with naked eye, and therefore the doctor cannot get the correct details of the patient. Consequently, the patient condition worsens. To address this problem, there is a need to develop such a model that would timely investigate and detect various chest diseases. Automatic diagnostic medical image processing is one relevant activity to boost the health sector. The proposed study is carried out to develop a Machine Learning (ML) and Deep Learning (DL) based model that would automatically investigate and detect various chest diseases. Detection of these diseases in preliminary stages could increase the odds of successful treatment

The remaining of this paper is organized as following section II presents literature, section III explaining Methodology, experimentation are presented in section IV, section V describe results and followed by conclusion.

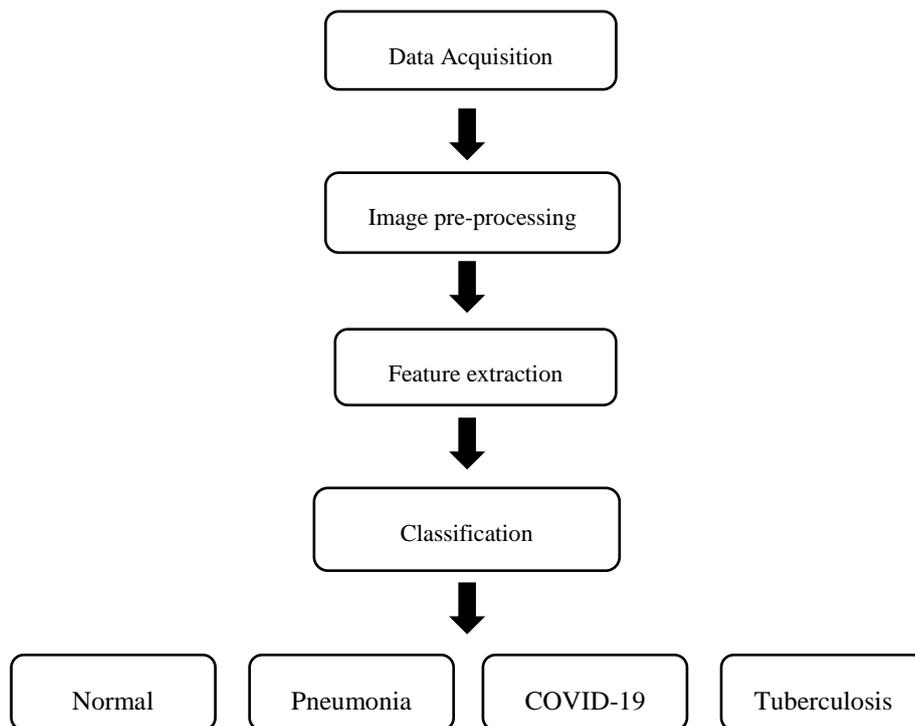
## Literature Review

Over the past decade, many techniques have been utilized to detect medical abnormalities in chests (Zhao et al., 2001), employed CXR's images. Various methods have been proposed in the literature to investigate various chests diseases. CXR's images contain more valuable information of human organs that facilitates the medical experts in diagnosing various kinds of diseases. The manual examination technique of handling and interpreting large amount of imaging data is not suitable. Therefore, several research groups have worked on Computer-Aided Design (CAD) systems for automatic investigation of CXR's images (Filho et al. 2019). In 1960s, the first CAD system was established for chest disease detection (Lodwick et al., 1963). The automatic detection and classification of various pathologies remain unresolved due to the complexity of CXR's. The aim of the existing model of CAD systems is only to detect lung cancer at the early stage. Only a handful number of work are attributed towards the automatic detection and classification of other types of diseases (Sherrier and Johnson, 1987). X-rays play an important role in the diagnoses process. The X-ray image is employed to generate a two-dimensional shadow which is raw data with no meaningful information detailing. The shadow, which is created by the rays passing through soft tissue, may generate an incomplete picture. This may result in providing small details regarding the irregularities present in the lungs. The segmentation of lungs region is an important procedure for medical imaging analysis and classification, especially for radiological evaluation and computer-aided diagnosis. Currently, a lot of research is carried out in the field of medical imaging. A number of computer vision algorithms are employed to enhance the quality of medical images. Therefore, various techniques have been introduced for the segmentation of lungs (Comaniciu, Ramesh, and Meer, 2000), to facilitate the clinicians in the process of diagnosing and screening (Liu *et al.* 2018). Segmentation methods (annangi, *et al.*, 2010), contain sequences of steps and rules such as thresholding or morphological operations. During the process of image segmentation, the image is divided into a group of pixels, each sharing similar characteristics, features, or some properties. In other words, the image segmentation technique segments the regions of similar features together (Shiraishi et al., 2000). The author in (Rohmah *et al.*, 2013), has proposed an approach to investigate and detect tuberculosis. The research aim was to reduce the waiting period for diagnosis. Initially, the region of interest is established and is following by extracting statistical features like mean, skewness, standard deviation, entropy, and kurtosis. Afterward, these features were reduced to develop principal component analysis (PCA) (Rohmah et al., 2013). In (Rajpurkar *et al.*, 2017), a Chex Net algorithm was applied on a publicly available dataset. The system detected pneumonia, and the performance was satisfactory when compared to an expert radiologist. (Wang *et al.*, 2021) developed a DL framework that extracts features of a novel coronavirus from CT images, and a DL method has

been employed for multi-class classification, of Miliary TB, Cavitary TB, and healthy lung (Naeem *et al.*, 2020). The author in (Maurya *et al.*, 2014) employed GLCM feature and multiclass Support Vector Machine (SVM) to classify automatic skin cancer. The said method achieved better performance on the basis of statistical methods for texture analysis. A supervised ML algorithm K-nearest neighbor (KNN) that has been implemented in medical imaging (Humeau-Heurtier, 2019). It is employed to cluster an unknown dataset into a class of its KNN. This method is generally employed for pattern recognition where in order to compute its nearest neighbor, Euclidean distance is calculated between two points. The method has shown effectiveness with large dataset (Khatun *et al.*, 2020). In (Karargyris *et al.*, 2016), the authors proposed a DL technique to extract features, and resnet50 and SVM together attain higher accuracy. The shape and texture features have a significant contribution to the comprehensive examination of medical images. Artificial intelligence techniques especially deep learning provides a substitute in processing, extraction of different features, and classify various diseases using CAD systems. These techniques were broadly employed for image segmentation of CXR's.

## Methodology

The steps adapted to develop a machine vision-based technique to automatically detect various chest diseases Shown in Figure 1. Different imaging modalities have various features for every disease. In order to identify these complications in traditional machine learning approach, a classifier is employed to identify four different classes of images i.e., tuberculosis, pneumonia, COVID-19, and normal CXR's.



**Figure 1: overall methodology**

### Data Acquisition

In the proposed study, the data was acquired from publicly available datasets for the purpose of experimentation ("GitHub - Ieee8023/Covid-Chestxray-Dataset")("Mendeley Data "). images of CXRs were collected. Each class contains 3061 CXR's images of COVID-19, normal, pneumonia, and tuberculosis respectively. The next step is data augmentation, for deep learning, the training accuracy could be improved by increasing the volume of data. Previous research shows that a weak algorithm

performs more accurately with a large dataset when compared to a strong algorithm with a limited dataset (Pedro, 2012). To increase the number of images, augmentation technique is employed without the need of acquiring new data. Numerous augmentation techniques were applied to increase the data in each class (i.e., tuberculosis, pneumonia, normal, and COVID-19). In this study, flipping, rotation, translations, mean filter, median filter, color shifting, and Gaussian filter were applied, and the number of CXR's images increased to 3061 images in each class. Next all images were preprocessed. In the first step, all images were resized at  $512 \times 512$  pixels. Images were then enhanced using different enhancement methods such as contrast enhancement, de-noising technique for noise removal, edge sharpening, filtering, histogram equalization, and intensity adjustment. After image enhancement, the region of interest (ROI) is achieved for segmentation of lungs region from CXR's. An important step is feature extraction each input image has various features. For recognition, it is significant to extract some useful features from the input CXR's images. Feature extraction is applied to reduce complexity and to remove redundancy from data. However, to acutely examine the CXR's, it could be seen that the images have minute contrast in shapes, edges, and textures. Therefore, these features would employed as follow. Initially, a comprehensive textural analysis of CXR's images is carried out by optimizing the GLCM parameters including quantization level, displacement direction, displacement magnitudes, and GLCM features. A supervised feature selection method is employed for evaluating the efficiency and relevance for the four mentioned parameters were commonly employed GLCM features were utilized to assess the texturals feature of CXRs images. Subsequently in LBP the features of an image were extracted in the form of numerical values for the purpose of classification. In CXR's images, the texture is due to the repetitive pattern that shows the absorption of various spectrums of tissue density. For features extraction, the image is segregated into  $3 \times 3$  pixels in the form of cells. It is then compared to its neighboring cell. The center pixel is replaced with value 1, and the neighboring cells value is replaced with 0. Lastly, the histogram of each cell is calculated as per Equation (1).

$$LBP_{R,T}(t,q) = \sum_{t=0}^{T-1} s(g_t - g_c) 2^t, s(t) = \begin{cases} 1, & t > 0 \\ 0, & otherwise \end{cases} \quad (1)$$

The Equation (1) is employed to differentiate the neighborhood pixels as T-bit binary number. These leads to distinctive values of binary patterns. This equation mentions the gray level of local neighborhood center pixel. It also points out equally spaced pixels where R and S represent Radius, and sample images respectively. Further HOG features extracts a selective number of histogram bins. The proposed study uses a higher number of histogram bins on dissimilar sections of the images. The input images were scaled to  $64 \times 128$  pixels. They were then transformed into a grayscale image. The gradient for each pixel is computed using Equations (2) and (3).

$$dx = P(x + 1, y) - p(x, y) \quad (2)$$

$$dy = p(x, y + 1) - p(x, y) \quad (3)$$

Where  $dx$  and  $dy$  are the horizontal and vertical gradient respectively, and  $p(x, y)$  is the pixel value at  $(x, y)$  position. The gradient orientation is calculated using Equation (4).

$$\theta(x, y) = \tan^{-1} \frac{dy}{dx} \quad (4)$$

### **Classification**

In the final step, classification was be performed. Classification is employed for categorizing the pixels in a digital image into various sets of classes. If more than one classifier is merged for prediction purpose, it is called ensemble classification ( Thomas G.. and Dietterich, 1996). Ensemble increases the conformity of predictions which results in higher accuracy compared to an individual model. This method uses majority voting, in which each model predicts for each test instance. The final prediction is the one that receives the higher number of votes. According to the features selection, different machine learning algorithm for classification is employed in this study. These are KNN, SVM, Decision Tree, and Random Forest.

KNN algorithm identifies the nearest neighbor of an unknown data point. This algorithm function depends on the value of 'k'. If the value of k equals 'n', the near neighbor would be predicted. In this research work, two classes are present namely, normal class and abnormal class. Decision Tree model is developed that aimed to compute the value of a various input value of required variables. The Random Forest model includes numerous decision trees. The training data is randomly sampled in each decision tree. The splitting nodes were then selected with subsets of features. Random Forest overcomes the limitations of Decision Tree as it has larger variance when fitting data. A supervised ML algorithm KNN employed for classification as well as for regression purposes. However, it is most frequently employed in different classification problems. In SVM, the model plotted each data individually in n-dimensional space, where 'n' is the number of features. Classification is carried out to find out the hyper-plane that classifies each class. These algorithms are widely employed to classifying pulmonary diseases using CXR's for their faster response

### Experimentation

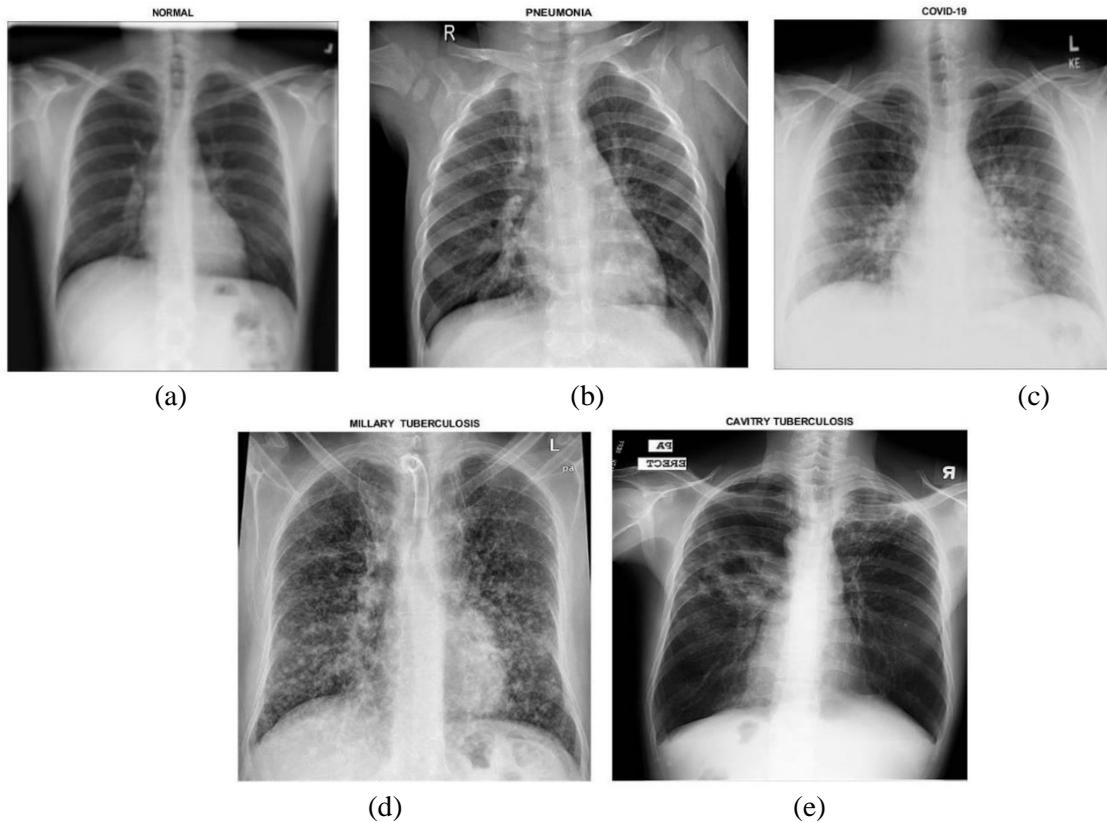
In the experimentation stage, a CXR's image was fed as input to the system. In the next step, pre-processing techniques were employed to remove the unnecessary data from the input image. The images were then each resized to 512x512. After pre-processing, ROI is extracted. In further processing, various features from the images were extracted using GLCM, HOG, and LBP methods. Furthermore, statistical features, for instance, mean, mode, median, skewness, and kurtosis were employed with GLCM, HOG, and LBP features. A multi-class Ensemble Classifier model is developed that could classify each of the classes i.e., normal, tuberculosis, pneumonia, and COVID-19. The model is trained using 3061 CXR's images of each class. The Ensemble Classifiers would then train the dataset to detect and distinguish between various chest diseases i.e., tuberculosis, pneumonia, and COVID-19. The four machine learning classifiers (KNN, SVM, Random Forest, and Decision Tree) were combined to make a prediction. The algorithm is trained on CXR's images. During training, 70% dataset was allocated, and the remaining 30% was kept for testing. The developed algorithm then classify each image as normal, tuberculosis, pneumonia, and COVID-19.

### Results and Discussion

The proposed model is developed to investigate and identify the subtle abnormalities within the CXR's images of tuberculosis, pneumonia, and COVID-19. It utilizes both image processing and machine learning-based algorithms. The model is trained to classify the CXR's images on the basis GLCM, HOG, and LBP features. The algorithm modeling for the developed method is represented in the form of pseudo-code as mentioned in Table 1:

Table 1. Pseudocode for the developed method	
Data acquisition	
Image preprocessing	
1.	lab = imdsTrain.Labels;
2.	lab_test = imdsValidation.Labels;
3.	for i=input image
	if cc ==3
	a = rgb2gray(a);
	end
4.	Extract each image feature
	features = [amean astd amod amed aiqr arag avar ask akur];
	features1 = reshape(extractLBPFeatures(a),1,[]);
	features2 = reshape(extractHOGFeatures(a),1,[]);
	features3 = reshape(graycomatrix(a),1,[]);
5.	Train_X(i,:)
6.	Test_X(i,:)
	for i=1:numel(Test_X(:,1))
	a= Test_X(i,:);
7.	for i=1:numel(Test_X(:,1))
	a= Test_X(i,:);
	all= [predict1 predict2 predict3 predict4];
	for i=1:numel(Test_X(:,1))
	new_lab2(i,1) = mode(all(i,1:4))
	end

Subsequent to training, the model was tested on unseen data (not involved in training and testing). The results for traditional machine learning classifiers are shown in Figure. 2.



**Figure. 2 CXR'S based lung disease detection**

(a) Normal CXR, (b) Pneumonia CXR, (c) covid-19 CXR (d) Millary TB CXR (e) Cavity TB CXR

Several performance metrics have been employed to figure out the results of the Machine Learning algorithms executed in this study. Four performance metrics were generated for evaluation. The Comparison of performance of the different technique is shown in Figure. 3 is described as the main metric employed to test the performance of both the classification and detection module

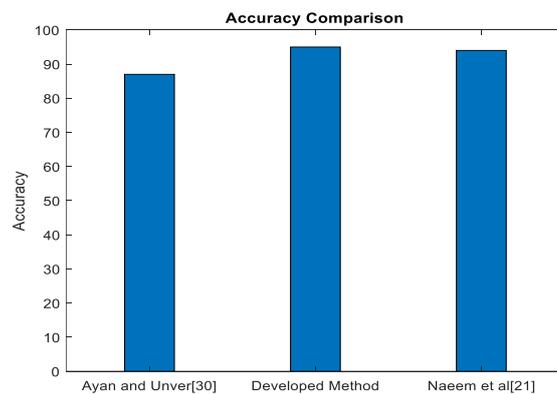


Figure. 3. Comparison of performance

These parameters are precision, recall, F1 score, and accuracy as discussed in Table 2.

**Table 2. Statistical test**

Classes	Precision	Recall	F1 Score	Accuracy
Normal	0.970	0.901	0.909	
Pneumonia	0.912	0.958	0.967	
Covid_19	0.907	0.912	0.911	0.957
Cavity tuberculosis	0.971	0.905	0.931	
Miliary tuberculosis	0.907	0.966	0.922	

The method discussed (Naeem et al. 2020), were limited to detect Miliary and Cavity Tuberculosis, and (Ayan and Ünver 2019) were limited to detect only pneumonia. The developed method could detect and classify various chest diseases i.e. pneumonia, COVID-19, and tuberculosis (Miliary and Cavity). The proposed model is compared to some of the developed methods for better understanding as shown in Table 3.

**Table 3. A comparison for evaluation**

S. No	Reference	Remarks	Methods	Accuracy
1	(Ayan et al. 2019)	Detects Pneumonia	Only VGG16 and Xception	87% using VGG16 and 82% using Xception
2	(Naeem et al. 2020)	Detects Miliary, and Cavity Tuberculosis	Deep Convolutional Neural Networks	88% for miliary and 89% for cavity
3	Developed Method	Tuberculosis, pneumonia, COVID-19	Multi-class Ensemble classifier	95%

The classifier employed in (Ayan and Ünver 2019) gave an accuracy of 87% using VGG16 and 82% using Xception. Similarly, in (Naeem et al. 2020), Deep Convolutional Neural Networks classification is utilized for detecting Miliary and Cavity tuberculosis. The developed method is tested on various chest diseases detection utilizing various feature extraction techniques, such as GLCM, HOG, and LBP. The proposed technique uses machine learning ensemble classifier namely, KNN, SVM, Random Forest, and Decision Tree for classifying the data. The accuracy for developed method is 95% as shown in the Figure. 3.

## Conclusion

Machine Vision-based technique is employed to detect various chest diseases i.e. tuberculosis, pneumonia, and COVID-19 in early stages that could further save important human lives. In this work, a model is developed to assist the radiologist intime observation detection of above-mentioned chest diseases to prevent fatalities. The proposed model is trained on publicly available datasets and the results exhibited accuracy, precision, recall, and F1 score of 0.957, 0.938, 0.938, and 0.923 respectively. It is concluded that the developed method successfully achieved the desired objective to detect various chest diseases that could evade the naked eye in CXR's. Currently, encompassing various dominant features for increased efficiency is under progress

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# Machine Vision-Based Tomato Plant Diseases Detection

(Ref No. ICETEMS-21-016)

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## Abstract

Tomato is a cash crop and significantly contributes toward the county's economic growth. In the past decade, the tomato crop is deprived due to various plant disease infections consequently less production. This study focuses on machine-vision based early crop (tomato leaf) disease detection, to avoid crop loss. For this reason tomato leaves as texture incorporated via employing single shot box detector method (SSD) for feature extraction (leaf surface texture), aiming for the identification of three prevalent species i.e., Bacterial, Septoria and Yellow leaf curl disease. The dataset include 1x10<sup>3</sup> images; the Data augmentation step was performed to increase the dataset to 3 x10<sup>3</sup>. For feature extraction, ensemble feature model along with VGG16 and Resnet were fused. The results were compared with other methods and exhibit the superiority of the proposed method by 95.6%. The developed techniques could effectively determine disease type at an early stage.

## Keywords

SSD, Machine Vision, Deep learning, Leaf Disease Detection, Texture analysis.

## Introduction

Tomato (*Solanum Lycopersicum*) is one of the most consumable vegetable crops (Din *et al.*, 2018). Vitamin C, vitamin E, and beta-carotene are all found in abundance in tomatoes. Tomato plants, on the other hand, are susceptible to a variety of diseases. Some disease pathogens are fungal, while others are bacterial or viral (Zulaikha *et al.*, 2020). Diseases are prevalent in tomato plants at all stages of growth due to crop sensitivity and climatic conditions. Plants infected with diseases account for 10-30% of overall crop losses and have an impact on adjacent crops as well (Goodridge *et al.*, 2017). It has been discovered that disease-affected crops result in annual losses of thousands of billions of dollars (Rehman *et al.*, 2020). The early detection of such illnesses in plants is critical for avoiding significant yield and quantity losses. Plant disease monitoring is a time-consuming & difficult endeavour due to its complexity. As a result, there is a need to reduce the manual work required for this process while still providing a precise prognosis and make sure that the ranchers lives are stress-free.

Plant disease's most common symptom is patterns that appear on the leaf surface which is the key indicator to detect and identify plant disease. Many farmers make incorrect conclusions about the disease because visually evident signs are difficult to discern at a peek. As a result, ranchers' preventative measures may be ineffectual and, in some cases, disastrous. This is the motivating factor behind the recommended technique, which attempts to precisely detect and identify ailments in tomato plants.

The methods proposed in the research apply to the most prevalent tomato plant diseases, such as Septoria Leaf Spot, Bacterial Spot and Yellow Leaf Curl. The input tomato leaf image could be declared healthy or classified into one of the disease classes. The evaluation database is extracted from Plant-Village, the respiratory contains 15,000 images of different tomato plant diseases.

In general, the proposed model consists of three-primary steps: data-acquisition, data preprocessing and classification. As mentioned earlier, the image utilized to execute the suggested technique was obtained from a dataset that is publicly accessible called Plant Village. Next step, being fed into the classification

algorithm, the images were scaled to appropriate dimensions. In the last step the input images is classified using a deep learning model called a single-shot box detector.

## Literature Review

In this work, review the most widely employed approaches in the relevant literature. Plant disease detection has appeal the interest of many scholars in this sector, who are working to develop solutions to address this issue.

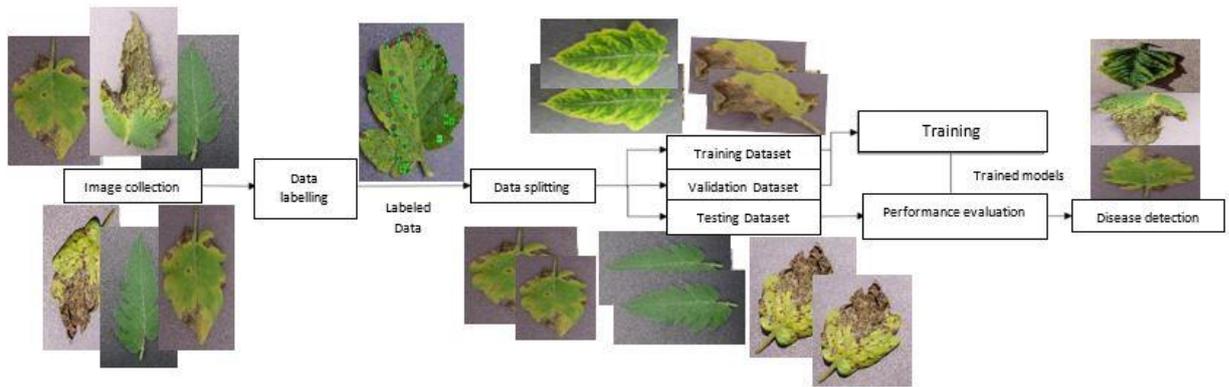
(Rehman *et al.*, 2020) introduced a strategy for programmed order and limitation using the k-means cluster and a multiclass SVM. The outcomes were contrasted, and different strategies and the created strategy has indicated better outcome by accomplishing an accuracy of 95% in plant infection identification. Similarly, (Basavaiah and Anthony, 2020) initiate a leaf screening process for tomato plants by developing precision detection and reduced processing time. The uniqueness of work is a combination of many features to improve the accuracy of the sections. Hu Moments, Color Histograms (CH), Haralick features and Local Binary Pattern (LBP) utilized for training and assessment purposes. For leaf diseases classification, using random forest and decision tree algorithms achieving an accuracy of 94% and 90%. (Sardogan *et al.*, 2018), use leaf disease diagnosis and classification is presented per the CNN and Learning Vector Quantization algorithm (LVQ). Three different information frames have been found in R, G and B channels to start mixing each image in the database. The image lattice of each detail is captured. The function of ReLU reactivation and max integration is stated in the output matrix. Experiments were performed on images of healthy and diseased leaves to make a distinction. (Durmus *et al.*, 2017) employed two different pre-trained CNN models Alex-Net and Squeeze to detect infections in tomato leaves from an uncluttered database. (Atabay, 2017) tune up a pre-trained model and prepared an advanced Convolutional neural network model to complete the analysis of tomato leaves. Their research shows that a unique CNN model simplifies better performance than previously trained models. Setting up the right CNN model is a daunting task of determining the most accurate and up-to-date prices. (Zhang *et al.*, 2018) set up a multi-channel CNN model based on Red Green and Blue colours to detect leaf diseases. In this work, special in-depth deep learning models were created, built on specific structures of the CNN, to detect plants diseases on leaves with images of normal or diseased plants. The use of the models is achieved using an a accessible database of images capture both in the lab and real-world scenarios in the field of agriculture. (Quan, 2018) discarded the Faster-RCNN regional model to teach collected images and identified images separately. (Ramcharan *et al.*, 2017) have applied in-depth study migration training of the CNN to detect three cassava diseases and two pest diseases. (Ji *et al.*, 2019) develop a method that gives an effective solution to identify grape diseases automatically based on CNNs.

(Jiang *et al.*, 2020) employed a deep learning technique for automated finding and classification of tomato diseases using plant leaf images. (Sladojevic *et al.*, 2016) applied a deep learning based method for the classification and detection of plant diseases from leaf images. The said model was so intelligent and accurate in detecting and discriminating healthy leaves and different plant diseases. The Single Shot MultiBox Detector (SSD) was used in a recent publication to demonstrate the DL method for diagnosing diseases in Cassava leaves (Ramcharan *et al.*, 2019). A recent study applied CNN's plant disease identification task to evaluate the degree of plant leaves defects (Ji *et al.*, 2020).

According to the literature, several contemporary studies have concentrated on the classifications of plant diseases. However, the difficult process of identifying plant diseases has received very little attention. As a result, used by us study employed a deep learning approach to tackle an essential agricultural problem: plant disease detection.

## Methodology

A deep learning Single Shot Multibox Detector was employed in our technique (SSD). Data collection, data preparation, proposed model description, and model training procedure are just a few of the sequences included in the construction. The work's performance and the result are described in the final section as shown in Figure 1.



**Figure 1: Flow diagram of the proposed method**

### ***Dataset Preparation***

The Plant-Village open source database provided the image data for tomato leaf health and disease in this research. The database is the world's largest crop database and contains a significant number of plant disease images. After collecting the images of tomato leaves, the images needed for this research were manually filtered to address issues such as image redundancy and classifying inaccuracies. Finally, a dataset of 4000 tomato leaf images is obtained, with each image's size set to 600\*400 pixels. There are four different types of tomato leaves in the dataset: healthy, septoria leaf spot, bacterial spot and yellow leaf curl virus.

The uniqueness of the data set could improve the model's prediction performance and resilience in deep learning. As a result, image enhancing techniques like rotation, translation, scaling, hue alteration, saturation, blurring, and noise are employed to enlarge the dataset size and variability while also adding new information. The number of samples in each category was increased thrice using the aforesaid data improvement approach, and the improved tomato leaf disease data set comprised 5000 images.

### ***Data Annotation***

The dataset was comprised of three sections: 60% (3000 leaf-images) for training, 30% (1500 leaf-images) for validation, and 10% (500 leaf-images) for testing. The initial step in using the DL technique to identify plant diseases was to annotate images from the training dataset. LabelImg, a free open source graphic image annotation tool, was applied to label the training images. The bounding box coordinates (Xmin, Xmax, Ymin and Ymax) were produced as a result of this. The ground truth boxes are calculated by intersecting the union (IoU) with the predicted bounding-box. The Pascal VOC format was used to preserve annotations as XML files. The Plant-Village dataset's classifications are described in Table 1.

**Table 1: Detail of labeled dataset**

<b>Classes of Dataset</b>	<b>Disease Cause</b>	<b>Annotation Label</b>	<b>Training Image</b>	<b>Validation Image</b>	<b>Test Image</b>
<b>Tomato Healthy</b>	-	Healthy	650	320	105
<b>Tomato Septoria leaf spot</b>	Fungi	Septorial_spot	790	395	142
<b>Tomato Bacterial spot</b>	Bacteria	Bacterial_spot	785	389	138
<b>Tomato Yellow leaf curl</b>	Virus	Yellow_leaf_curl	775	396	115

### ***Deep Learning Architecture***

Single Shot MultiBox Detector (SSD) model was studied in this research for automatically detecting diseases. This model is made up of two components: a base network and a feature

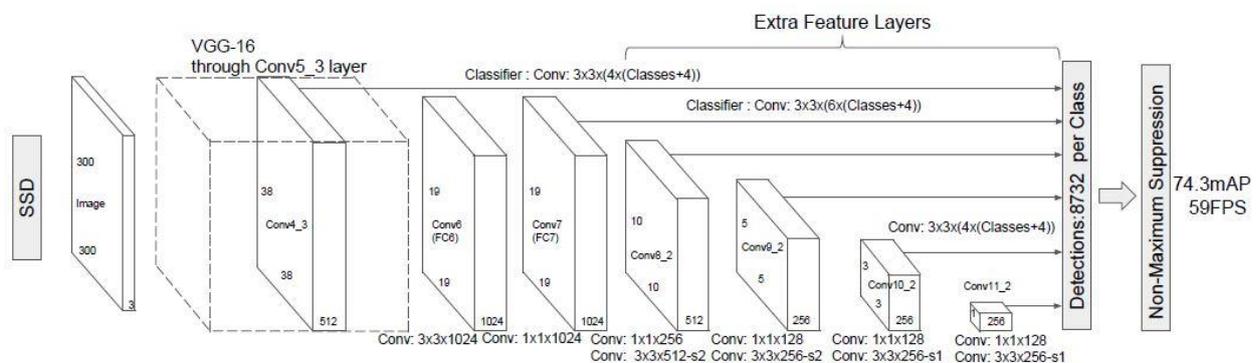
extractor. The sub-sections that follow give an overview of the DL model architecture and explain how it may be employed to perform image recognition and identification.

### Single Shot MultiBox Detector (SSD)

The Single Shot Detection is a feed-forward convolutional network that generates a set of bounding boxes with a predetermined size as well as the score for the presence of objects class instances in that casket, the final detections are produced after a non-maximal suppression phase. The early network layers, which are based on a conventional design for high-quality image categorization, add an ancillary edifice. The ancillary edifice was introduced to the network to provide detection with the key traits listed as, a) Detection using multi-scale feature maps; b) detection with convolutional predictors; and c) default boxes and aspect ratios. The SSD framework is depicted in Figure 1. Up to conv 6, this study use the Visual Geometry Group (VGG)-16 layers, then remove all other layers, even the fully-connected ones. The VGG-16 was chosen as the basic system owing due to its exceptional performance in high-quality visual classification tasks and its widespread use in situations where transfer learning might help improve results. The architecture is then updated with a set of new CONV layers, which are the foundation for the SSD framework. Each of these levels is also a CONV layer, as shown in Figure 1. This pattern indicates that current network is completely convolutional: we could take any size input image and are no longer constrained by VGG's 224x224 input constraints. The depiction of the VGG architecture is explained in Figure 2. SSD is based on two key components:

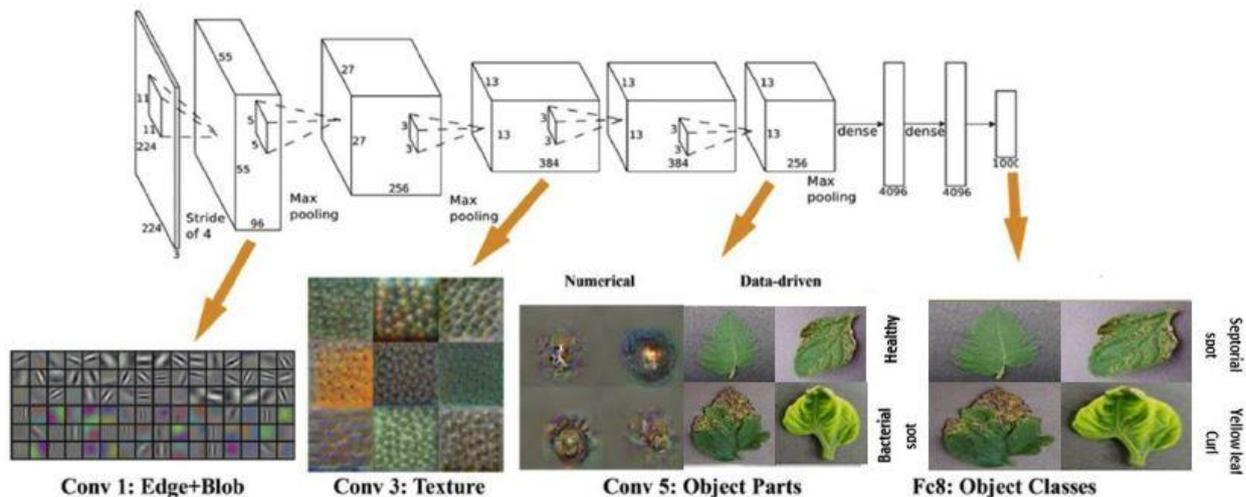
- i. As with a standard CNN, gradually lower the volume size in deeper layers.
- ii. The final detection layer is connected to each of the CONV layers.

Each aspect map must be linked to the hindmost detection layer, it enables the network to recognize and locate entities in images at various extents. In addition, extent localization occurs in a forward pass. Because aspect maps do not need to be resampled, SSDs may function entirely feedforward—which makes SSD quick and efficient.



**Figure 2: SSD architecture (Liu et al., 2016).**

For bounding box predictions, the SSD edifice employs an altered variant of the MultiBox method. As seen in Figure 3, the MultiBox method starts with priors. The priors are pre-computed fixed-size anchor boxes the size and localities of the ground-truth anchor boxes for each class in the database. We term them a prior because we're using Bayesian statistical inference, or more precisely, a prior probability distribution, to predict where objects would unfold in an image, as shown in Figure 3. The dimension of the boxes determines the type of characteristics. A single-shot box detector predicts class scores for each of the aspect maps that confirm the existence of a class exemplar in each of those boxes. To effectively transform the space of possible output shapes of the boxes, SSD produces different resolution feature maps. Figure 3 depicts how a network's feature mappings perceive a specific image.



**Figure 3: VGG Feature map visualization**

### **Implementation of SSD Model**

There are numerous frameworks for training and using deep learning algorithms in the state-of-the-art, however TensorFlow is the most well-known and widely employed. TensorFlow is a Google-developed machine learning system that works on a big scale and in a variety of contexts. TensorFlow is available as an open-source framework. It may be employed as a centralized or distributed system in a wide range of applications and devices. Only Tensor-Flow 1 had completely compatible tools for training and compiling models to the GPU throughout the development of the current evaluation of the model. As a result, TensorFlow r1.15.0 was employed for training and inference scripts. Scripts are executed in Google Colaboratory (Colab) notebook, which provides free powerful GPUs for deep learning model training and inference. The most time-consuming aspect of any object detection system is the generation of training data sets. Labeled 16044 objects over 4000 images. Every label image generates an.xml file that contains the label entities' detailed description (location, height, and width), change the images and its xml file arrangement to TensorFlow coherent TFrecord. A mapping regarding the location of the dataset is generated prior providing the label dataset to SSD. The learning rate set to minimum during the training phase. Later on, the learning rate improved with each iteration. Following the training phase, a.caffemodel is generated, which is utilised for testing object detection. This study employed the SSD network up to the CONV9 2 for current experiment.

### **Experimental Setup**

The employed tomato diseases dataset, which comprises four annotated disease categories, is used to conduct research. After acquiring the image, create a bounding box around the leaf diseased area and inform the system that the object in the frame is the entity to be learnt. Once the markup is finished, a directory named "annotations" is created, which contains the xml file for each image's bounding box. Make another data set to change the images and its xml file arrangement to TensorFlow coherent TFrecord. This paper use extensive data augmentation techniques to avoid overfitting, as discussed in the preceding section, because the number of images in dataset is still minimal. The proposed dataset has been divided into 03 sections for the experiments: 60% training, 30% validation, and 10% testing. The training is carried out on the training set, followed by an assessment on the validation set, and finally, when the experiments appear to provide the desired results, a final evaluation on the testing set is carried out (unknown data). The training and validation sets are applied for training and parameter selection, while the testing set is used to evaluate the findings on unknown data. The learning rate set to 0.0002 during the training phase. Later on, the learning rate improved with each iteration. The suggested system was trained and tested end-to-end using Google Colaboratory (Colab) notebooks with free powerful GPUs, utilizing an Intel Core I7 5500U/2.4 GHz processor.

## Results and Discussion

To validate the proposed method performance, performed a number of tests using healthy and infected tomato leaf image datasets and performed classification. One of the most challenging aspects of this study ailment detection is that the leaves with various diseases seem quite similar to one another. As a result of this resemblance, certain leaves may be folded into the erroneous class.

The results of classification are shown in Table 2 as a confusion matrix. For each class, 40 images were chosen. From the test data, leaves ranging from 37 to 40 of 40 for each class were properly identified, as shown in the table. Only a few leaves were erroneously categorized for each class, and the table shows which classes have these inaccurate classifications folded.

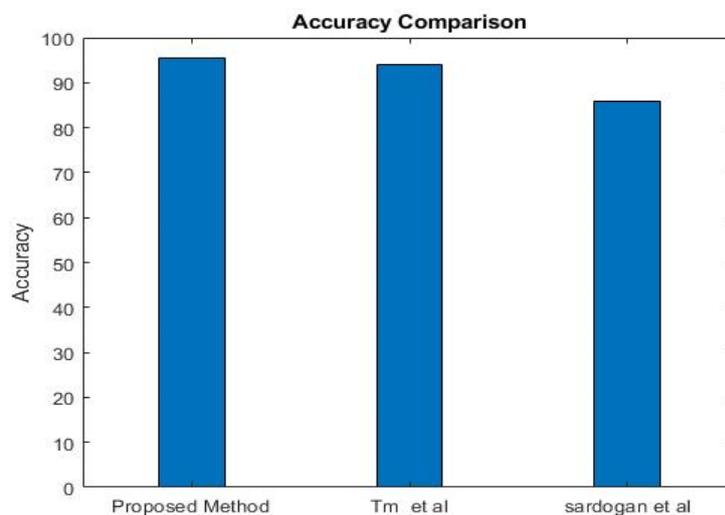
**Table 2: Classification Results as Confusion Matrix.**

Leaf Disease	Healthy	Septoria spot	Bacterial spot	Yellow leaf curl
Healthy	40	0	0	0
Septoria spot	0	38	1	1
Bacterial spot	0	1	38	1
Yellow leaf curl	0	1	2	37
Overall	95.6%			

The developed method classification accuracy is compared to that of existing cutting edge approaches as shown in Table 3.

**Table 3: A comparison for evaluation**

Authors/references	Techniques used	Classification accuracy (%)
Sardogan et al.	CNN + LVQ Algorithm	86
TM et al.	CNN + Adam Optimizer	94
Proposed Method	SSD + VGG16 + Resent	95.6



## Figure 4: Comparison of performance

(Sardogan *et al.*, 2018), use leaf disease diagnosis and classification is presented per the CNN and Learning Vector Quantization algorithm (LVQ) gave an accuracy of 86%. Similarly, (Tm *et al.*, 2018), use a CNN model called LeNet for leaf disease diagnosis gave an accuracy of 94%. The proposed method is tested on various tomato leaf diseases detection utilizing ensemble feature model along with VGG16 and Resnet were fused. The proposed method use deep learning classifier name as SSD for classifying the data. The accuracy for proposed method is 95.6% as shown in Figure 4.

## Conclusion and Future Work

The horticultural sector remains to be one of Pakistan's most major sector, with the majority of individuals relying on it. As a result, disease detection in these crops is crucial for economic growth. Tomato is still one of the primary crops that are grown in mass amounts. As a basis, the focus of this research is to detect and identify four major ailments in tomato plants. To categories tomato leaf infections collected from the Plant Village database, the suggested technique employs a single shot multibox detector model. To classify tomato leaf ailments into 04 distinct classes, the framework employed is a standard single shot multibox detector with an additional number of layers. As part of the future study, alternative learning rates and optimizing compilers might be implemented to experiment with the proposed approach. It might also entail experimenting with the newer framework to improve the model's performance on the train set. Thus, the aforementioned model may be utilized as a decision tool to assist ranchers in evaluating the ailments that could be detected in tomato plants. The suggested approach, with an accuracy of 95.6%, could detect leaf diseases precisely and with minimal computing effort.

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# A Vision-Based Pakistani Sign Language Recognition System Using Machine Learning

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## Abstract

In Pakistan, more than 250,000 deaf Pakistanis use Pakistani Sign Language (PSL). Communicating with others can be a major issue for the deaf people. A sign languages (SL) recognition system would greatly benefit these people. The objective of this study was to develop a vision-based system for the recognition of static PSL alphabets using Bag-of-Words (BoW) and Support Vector Machine (SVM) techniques. A total of 511 images were collected for 36 static PSL alphabet signs from a native signer of PSL. The SL recognition system used the collected images as input, and converted them to grayscale. The grayscale images were segmented using Thresholding technique and Speeded Up Robust Feature (SURF) were used to extract the features. The obtained SURF descriptors were clustered using K-means clustering. A BoW was formed by computing the Euclidean distance between the SURF descriptors and the clustered data. The codebooks obtained from the BoW were divided into training and testing using 5-fold cross validation. The developed system yielded a highest overall classification accuracy for static PSL signs of 97.87% at 1,500×1,500 image dimensions and 500 Bags.

## Keywords

Pakistani Sign Language, Pattern Recognition, Image Processing, Machine Learning

## Introduction

According to the World Health Organization, around 466 million people worldwide have disabling hearing loss, which are estimated to increase to over 900 million people by 2050 ("Deafness and hearing loss," March, 2020). The deaf people rely on sign languages (SL), native to their countries, to communicate with others. Researchers around the world have come up with a solution, i.e., automated sign language recognition systems.

In Pakistan, 1.6 out of a 1,000 people are deaf (Ali, 2010) and there are more than 250,000 deaf Pakistanis that use Pakistani Sign Language (PSL) as a medium of communication (Kausar *et al*, 2016). Developing a SL recognition system would be greatly beneficial for these people. The vision-based SL recognition system proposed in this study, will use image for static (still) signs of PSL. The studies mentioned in the literature review, give us the overall layout of all the techniques used for developing PSL recognition systems.

The objective of this research is to develop a vision-based system that recognizes Pakistani Sign Language (PSL) alphabets by using Bag-of-Words (BoW) and Support Vector Machine (SVM) techniques by using data collected from a native signer.

The paper is organized as follows: Section 2 states the literature review done for PSL recognition systems; Section 3 describes the methodology used in this study; Section 4 provides the experimental results; Section 5 provides the conclusion.

## Literature Review

The main focus of the literature review done for Pakistani SL (PSL) was to identify the methods used for the recognition of PSL alphabets.

Khan, e.t.al, used 500 images of 37 PSL alphabets, and applied Discrete Wavelet Transform (DWT) to extract features and achieved 84.6% classification accuracy using MLP (Khan *et al*, 2014). Ahmed, e.t.al, used 10 PSL alphabets and used 600 and extracted global features including length, area, rectangularity, eccentricity, and more and shape features and used multi-class SVM to obtain an 83% accuracy (Ahmed *et al*, 2016). Kausar, e.t.al, used 37 Urdu alphabets & 9 numbers, 455 images, and centroid distance signature in mathematical modelling (polynomial, sinusoidal, exponential, gaussian) and KNN to obtain 80% accuracy (Kausar *et al*, 2016).

Shah, e.t.al, used SVM was to achieve 77.18% accuracy, with six statistical features of local binary pattern histogram i.e., standard deviation, variance, skewness, kurtosis, entropy and energy, from 3,414 images, using 37 PSL alphabets (Shah *et al*, 2018). Saqib, e.t.al, used 20 dynamic PSL words, with 8,000 videos and used CNN to achieve a 90.79% accuracy (Saqib *et al*, 2021). Shah, e.t.al, classified 36 PSL alphabets, with 6,633 images, using SVM and obtained classification accuracies of 15.41% using Speeded Up Robust Features (SURF), 87.67% using Edge Orientation Histogram (EOH), 45.71% using Local Binary Patterns (LBP), and 89.52% using Histogram of Oriented Gradient (HOG) and the final reported accuracy of 91.98% (Shah *et al*, 2021).

All previous PSL studies only focused on static PSL alphabets and none have used dynamic PSL alphabets, only dynamic PSL words have previously been classified. Feature extraction techniques such as SURF, have not yielded good accuracies while being used with SVM and Bag-of-Words (BoW) technique has yet to be applied on PSL, suggesting that the use of these techniques and others, can be considered for vision-based systems for PSL recognition.

Therefore, we will develop a vision-based PSL alphabets recognition system will be developed in this study, that will use BoW using SURF features and K-means clustering and classify the obtained codebooks of static PSL alphabets using Support Vector Machines.

## Methodology

The images and videos from the collected data were stored in labelled folders. The videos were processed frame by frame, act as static images. The flowchart for the entire data analysis process is shown in *Figure 3.1*. A total of 511 images from 36 static signs of PSL alphabets were collected for this study, as specified in the *Figure 3.2*.



**Figure 3.1 – PSL recognition flowchart**



**Figure 3.2 – PSL static alphabets**

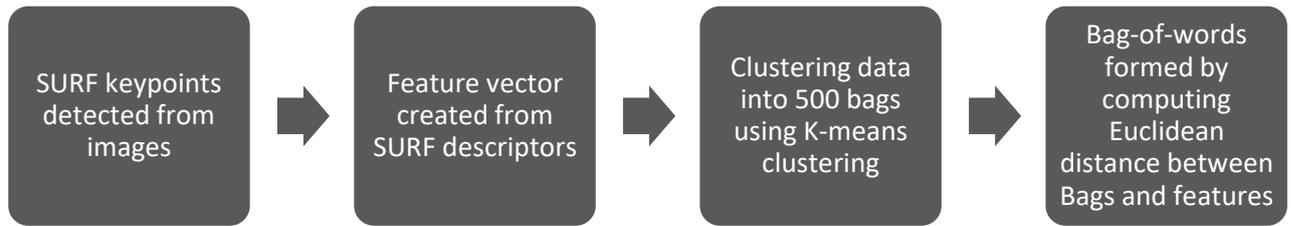
**Preprocessing:** The collected images for static PSL signs were resized from 3,000×3,000 to 1,500×1,500 and converted from RGB to grayscale.

**Segmentation:** The hand signs were segmented by applying thresholding technique on the grayscale images. The bounding box technique was used to crop each image and saved as the segmented image.

**Feature Extraction:** The SURF algorithm was applied on the images to extract their SURF features. The SURF points were detected for each image and then these points were used to extract the key point descriptors which are also called the SURF features. These extracted features of all the images were then clustering using unsupervised learning algorithm, K-means++ clustering.

A K-cluster value was used to form Bags (clusters) for the extracted features and each Bag is called a visual word. A set of these Bags form the visual vocabulary which are in-turn used to form the codebook or Bag-of-words. 500 K-cluster value was selected for Bag formation, as the maximum number of SURF descriptors found for 1,500×1,500, image dimensions, was 444.

The Euclidean distance between each surf descriptor or feature and the centroid for each Bag and the feature was calculated until all features the images was assigned a Bag. The codebook obtained had the dimensions of the K-cluster value used and the total number of images. This process of generating the codebook is shown in **Figure 3.3**. The obtained codebook was then used for the classification of these images.



**Figure 3.3 – Bag-of-words generation**

**Classification:**

In 5-fold cross-validation, the dataset being was partitioned into 5 subsets of approximately equal size, which partitioned the dataset into 80% for training and 20% for testing. The Support Vector Machine classifier (SVM) was used for to train classification models. The validation or testing dataset was applied on the trained models, and the performance was measured. This process was repeated until all of the  $k$  subsets served as testing sets. The cross-validated accuracy was obtained, by averaging the five accuracies achieved on the test sets.

**Results**

409 PSL images were used for training and 102 for testing from the total 511 images. The subsequent training and testing accuracies obtained from these models were used to compute the training and testing accuracies shown in **Table 4.1**. The overall accuracy was obtained by averaging the training and testing accuracies of each model. **Figure 4.1** shows the confusion matrix of the testing model, which was obtained by averaging the testing confusion matrices of all the five models.

**Table 4.1 – Classification accuracies for static signs at 500 bags**

	Model 1	Model 2	Model 3	Model 4	Model 5	Overall
Training	98.00	98.30	98.30	97.30	98.50	98.08
Testing	94.12	97.09	100.00	100.00	97.06	97.65
Overall	96.06	97.70	99.15	98.65	97.78	<b>97.87</b>

**Conclusion**

The purpose of this study was to develop a vision-based system for their recognition using BoW and SVM techniques. 36 static PSL alphabet signs were collected from a native signer of PSL and used as input in the developed system. The data was resized, segmented and converted into Bag-of-Words by finding the Euclidean distance between SURF descriptors and 500 Bags using K-means clustering. The obtained codebooks were trained using SVM and tested to obtain an overall classification accuracy of 97.87% for static PSL signs.

Static PSL Signs		True Classes																																					
		Aa'in	Alif	Bari Ye	Bay	Chay	Choti Ye	Daal	Dhaal	Do Chashmi Hay	Fay	Gaaf	Gha'in	Hamza	Hay	Kaaf	Khay	Laam	Meem	Noon	Noon Ghunna	Pay	Qaaf	Ruy	Say	Seen	Sheen	Suaad	Tay	Ttay	Tua'ay	Wow	Zaal	Zay	Zhay	Zua'ay	Znaad		
Predicted Classes	Aa'in	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	Alif	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	Bari Ye	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Bay	0.0	0.0	0.0	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	Chay	0.0	0.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	Choti Ye	0.0	0.0	0.0	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	Daal	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	Dhaal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	Do Chashmi Hay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	Fay	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	Gaaf	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	Gha'in	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	Hamza	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	Hay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	Kaaf	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	Khay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	Laam	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	Meem	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	Noon	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	Noon Ghunna	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	
	Pay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	Qaaf	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Ruy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Say	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Seen	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Sheen	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Suaad	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Tay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	Ttay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	Tua'ay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Wow	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0		
Zaal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	0.0	0.0	0.0	0.0		
Zay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0		
Zhay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	0.0	0.0	
Zua'ay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	
Znaad	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	

Figure 4.1 – Confusion matrix of static PSL signs at 1,500×1,500 image dimensions and 500 Bags

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# Classification of Healthy Skin and Plaque Psoriasis via Convolutional Neural Networks

(Ref No. ICETEMS-21-101)

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## Abstract

Psoriasis is an inflammatory skin disorder which stems from genetic, ecological and immunological factors. According to latest statistics, Psoriasis affects 125 million people worldwide. The most common type is the plaque psoriasis that encapsulates elevated and dry lesions that are red in color and tend to cause severe itching. Hence, we propose a novel technique for classifying healthy skin and plaque psoriasis using deep learning method of Convolutional Neural Networks (CNNs). A new annotated dataset consisting of 271 images has been created. This includes one hundred and seventy-two images of normal skin and ninety-nine plaque psoriasis images. The images are classified with the aid of a VGG-19 pre-trained convolutional neural network. A total of 55 images are tested yielding an accuracy of 84.2%. The accuracy reported exhibits the potential of deep learning techniques, in particular, CNN to achieve robust performance and classification.

## Keywords

Psoriasis, deep learning, convolution neural network (CNN), visual geometry group (VGG-19)

## Introduction

According to a study by George et al. (2017), it is estimated that there are 125 million individuals living with psoriasis, which accounts for 2 to 3 percent of the global population. No treatment exists for the skin disease, which is not contagious and cannot be transferred (Fadzil et al., 2009). Scratching and painful lesions in the skin area affected by psoriasis arthritis, also known as inflammatory arthritis, may be caused by the inflammatory condition. 30% of individuals suffering with inflammation arthritis, commonly known as P. arthritic, suffer from joint damage. Furthermore, it causes depression and is believed to increase the suicide risk by 30% and it has a major negative influence on the individual along with affecting their quality of life, and is frequently compared to a heart disease (Munira et al., 2017). It takes a variety of treatments or treatment methods to assist and manage the illness. If a dermatologist wants to establish that a particular therapy is successful, they must actively examine the severity of the psoriasis. There is a chance of this happening when your immune system messes up and alters your skin cells' life cycle. It takes 28 to 30 days for a skin cell to reach maturity, however the alteration leads the cells to appear on the skin's surface within seven days. When skin cells multiply too much, they form red patches that are itchy, puffy, and thick. Psoriasis lesions may spread. These lesions

may range in size from a few tiny spots to the whole body, depending on where they are. It's important to know that there are many different kinds of Psoriasis that you may have (George et al., 2017).

For psoriasis identification, Dash et al. (2019), used a fully convoluted neural layer. Dermatologists from 1026 patients were asked to take 5241 photos of lesions to utilize in this investigation. As a result of the experiments, there was 94.80% accuracy, which was deemed successful. In the process done by Yasir et al. (2014), the initial step in detecting skin disorders is the extraction of image characteristics. During this procedure, the more characteristics which can be extracted from an image improves the machine's accuracy. In nine different skin disorders, Yasir et al. (2014) was able to apply the technique with a 90 percent accuracy rate. Melanomas are rare forms of skin cancer that, if left untreated, may lead to death. Image recognition was used to analyze various segmentation methods that might be used to detect melanoma (Santy and Joseph, 2015). When the contaminated area is delineated, a segmentation technique is used to extract additional characteristics.

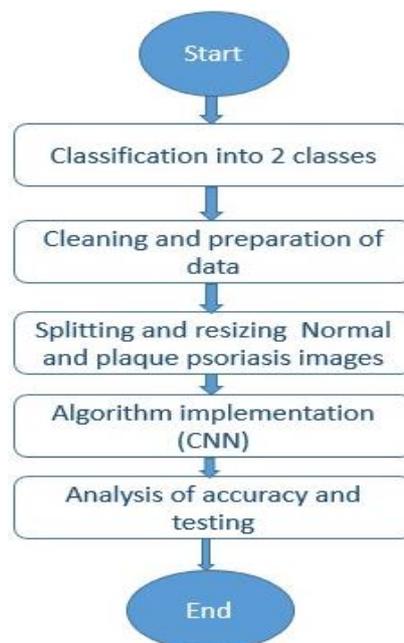
Convolutional Neural Networks (CNN) are a deep learning approach used to distinguish healthy skin from plaque psoriasis in this research study (CNNs). Normal skin and plaque psoriasis skin may be effectively classified using this suggested deep learning application. In addition, dermatologists and skin specialists will be able to make an early diagnosis and treatment plan before the illness progresses.

The objective of this research is to develop an image based system that recognize and classifies normal healthy skin from plaque psoriasis skin using deep neural network (CNN) by using data collected from online datasets.

This paper contains the sections as follows: Section 2 describes the materials and methods that are used in this research; Section 3 provides the experimental results; Section 4 provides the discussion; Section 5 provides the conclusion.

## Materials and methods

CNN's deep learning algorithms carried out the suggested study. *Figure 2.1* shows the work flow, which begins with an image-based dataset and concludes with the categorization of plaque psoriasis and normal skin.

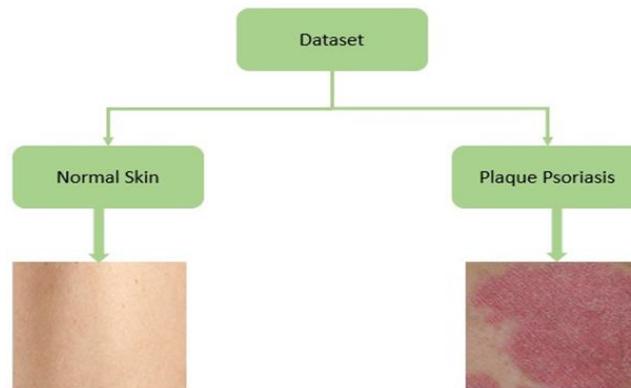


**Figure 2.1 – Proposed Flow Process of Classification Framework**

### *Dataset*

From the research of Rimi et al. (2020), dermnet dataset was utilized to train two classes of psoriasis pictures, whereas NTU dataset from the study of Shahroudy et al. (2016) was used to train normal skin

images for the training. This allowed us to distinguish between sick and non-diseased types of skin. **Figure 2.1.1** shows the dataset description. In order to create the one large dataset, the standard dataset was collected from two separate data sources and merged. Normal skin pictures included 172, whereas other plaque psoriasis images consisted of 99. Two hundred and seventy-one (271) pictures of both courses were obtained from internet sources. The data was then sorted and normalized into two separate files, indicating two classes, before being sorted and normalized again.



**Figure 2.1.1 – Dataset Illustration**

### ***Dataset Preparation***

This process included examining each picture in order to determine whether it clearly showed the sick area or not and selecting the most authenticated photos from each. To ensure accuracy, the model was trained using 172 pictures of normal skin that were gathered from various sources and then converted to JPEG format. A python-based environment was utilized to apply picture enhancing methods. The resize technique was used to segment the picture throughout this study. When a picture is resized by a given factor or dimension, it is called a resize operation. 64 pixels were used in this study for the resizing dimension. An image data segmented with a 64-percent proportion factor was thus generated. The scikit-image-processing library of Python's scikit-image-processing library was also used for anti-aliasing. Obtaining picture information is the primary goal of OpenCV. We utilized the cv2 package in Python to do various actions, such as scaling and extracting RGB colors from the picture. NumPy array of image is restored by using shape function. In addition to resizing and eliminating the shape element, the flatten operation may be used to eliminate the shape element. They are flattened into a single NumPy array that consists of the red, blue, and green components of the image.

### ***Splitting Dataset***

As a result of cleaning the data, it was divided into three parts: training (80%), validation (20%), and testing (20%). 80% of each class's data was used for testing, while 10% was used for validation, and the remaining 10% was used for testing. On the whole, there were 1459 training pictures for all 5 classes, 180 for validation and 188 for testing, as shown in Table 2.3.1.

**Table 2.3.1 – Training, testing and validation dataset.**

S. No	Classes	No. of Training Images	No. of Validation Images	No. of Testing Images
1.	Normal Skin	137	17	18
2.	Plaque Psoriasis	79	10	10

	Total	216	27	28
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### ***VG-19 Pre-trained CNN Model***

19-layer neural network was utilized called VGG-19 (Simonyan & Zisserman, 2014). Max pooling manages decreasing volume size. In order to reduce the amount of the calculation, max-pooling down samples the expression of the inputs. A CNN model used to identify pictures is called VGG.

### ***Architecture***

The VG-19 CNN model includes convolutional layers with varying filter sizes, as well as specific pooling layers that lower the volume for each succeeding layer. A fully connected layer (FC) with 4096 units is the result of all these pooling and convolution layers combined, and in a softmax output one of the classes. For the CNN model to operate more correctly and efficiently, we added a few trainable layers to VGG-19. In the classification, there will be four convolution layers, and each convolution layer will be followed by a max-pooling procedure. By extracting many important multilayer characteristics from the input signal, these four convolution layers will be utilized to identify psoriasis kinds.

### ***SPSS Analysis***

The statistical package for social sciences (SPSS) version IBM Statistics 22 was used to evaluate the accuracy of CNN's information on psoriasis and plaque psoriasis.

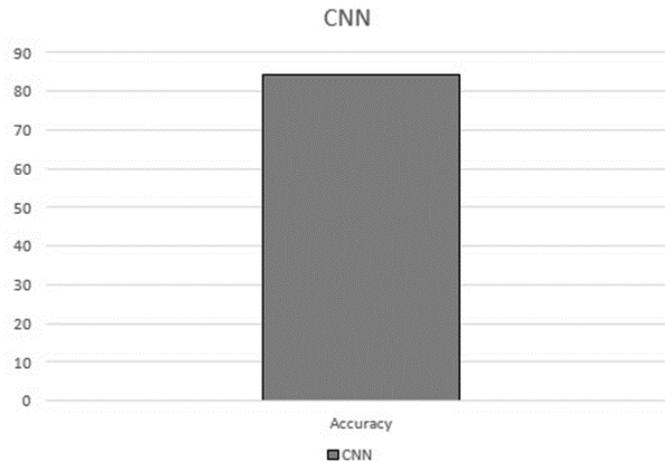
## **Results**

It took a total of 55 people to verify and test all of them. **Table 3.1** shows CNN's performance and classification results in the form of a confusion matrix (see below). Eight of the 28 test pictures categorized as plaque psoriasis, whereas 16 were classed as normal skin, according to **Table 3.1**. There was an 84.2 percent accuracy because 24 of the 28 pictures correctly categorized.

**Table 3: Classification results of CNN:**

CLASSES	CNN	
	Test Images	Truly Classified
Normal Skin(3)	18	16
Plaque(4)	10	8
Total	28	24

The graphical illustration of accuracy outcomes of both the models are shown in **Figure 3.2**.



**Figure 3.2: Graphical Representation of CNN Accuracy**

A random 80:20 split was used to test 30 iterations of accuracy. In order to evaluate the findings of the research, we used a paired sample T-test. The paired sample T-test was used since both values were independent and originated from separate classifiers. The following equation equates the SPSS results:

$$t(29) = 20.216, p < 0.001$$

## Discussion

Dermoscopic pictures of psoriatic plaques and normal skin will be collected, and deep learning methods such as convolutional neural networks will be used (CNN). Normal skin as well as plaque psoriasis in various types will be accurately classified by this deep learning application. Also, dermatologists and other skin experts will be able to make a fast diagnosis and develop a care and treatment plan well before the illness has gone further.

*Figure 3.2* illustrates the CNN model's claimed accuracy, which is 84.2%. It was found that throughout validation, CNN model accuracy ranged from 65 to 84 percent and loss was very high, but decreased towards the conclusion of the epoch while running the CNN accuracy vs loss. Accordingly, it is possible to conclude that CNN's accuracy was very high when it came to validation.

On the other hand, CNN (Pre-trained Alex) was used to create a skin lesion categorization system for psoriasis, melanoma and eczema (ALEnezi 2019). According to another research conducted by Pal et al. (2018), pictures of plaque psoriasis were used to categorize just plaque psoriasis, with CNN and other algorithms achieving a 60 percent accuracy rate. According to both experiments, CNN outperformed every other algorithm, and its superior performance is attributed to the mathematical operations that occur in the background.

A convolutional neural network (CNN) accuracy of 84.2 percent may be attributed to its use of kernel function (Hou et al., 2018), which converts the input into higher dimensions, and to its use of pixels by pixels (PPP) transformation (actor et al., 2020), which produces the optimum hyper plane.

## Conclusion

Using deep learning, this research suggested a method for separating plaque psoriasis from normal skin. Due to the fact that plaque psoriasis is the most common form of psoriasis, greater emphasis must be paid to its early detection. CNNs were used in the process of analyzing the data. CNN's application has an accuracy rate of 84.2% It is also possible to create a classifier with the assistance of deep learning algorithms. It is clear from the accuracy obtained that the suggested deep learning application is both dependable and effective. Further, the current application may be combined with additional deep

learning methods such as Artificial Neural Network (ANN) and PASI (Psoriasis Area and Severity Index).

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# COMPUTER SCIENCES & IT

# Model for Component Based Outsourcing Software Development

(Ref No. ICETEMS-21-070)

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## Abstract

Component-based software engineering is very useful to develop high-quality and secure software within limited time and money as well. This approach is implemented by many software outsourcing vendor organizations; however, it is important to identify the success factors that have a positive impact on software outsourcing vendor organizations in adapting the concept of the component-based approach of software development. In this research, we identify the success factors that have a positive impact on software outsourcing vendor organizations in adopting the concept of a component-based approach to software development. In the first phase, data will be collected and verified through a systematic literature review and questionnaire survey. In the second phase the final data will be synthesis accordingly. In the final phase, the analytic hierarchy process method will be used to prioritize success factors and their categories based on their relative importance.

## Keywords

Component based software engineering; AHP, software outsourcing vendor organization;

## Introduction

Many software companies have been faced problems in developing of large, complex, low cost and secure software within limited time [1]. Component Based software development is the only suitable approach to fixed the said issue, which based on conception to developed proper components and then fabricating them with a perspicuous software architecture [2]. Component based software development enhance reliability, quality and maintainability and also minimize the built-out expense and time [3].

Outsourcing is derived from ‘finding the source from the outer’, which is a kind of new service mode that the venders deliver all or part of their IT business to other professional service providers’ [4]. Outsourcing vendor organization can be described as a position where a company (a vender) contract with another organization (a client) to hand over all or parts of its software development activities (agreed services) for compensation [5]. A large number of companies in the US and UK have outsourced software development projects to seaward countries i.e. exceeding of 50% of the American Fortune 500 companies and Users of the seaward software outsourcing is increasing proportion in European and Japanese companies [6]. Software development outsourcing has many reasons; one reason is that some small and medium size companies which have lacking resources and technical expertise are best served by outside contractors [7]. Each company has their own success factor to achieve its goals. Success factor is nothing but is a term of management required for promising the achievement of companies [8].

## Background

Many researchers faced the failure of project due to rising investments in the field software development. So that software costs are the major component of corporate expenses and in the traditional software engineering, all the components were developed in house due to which project costs raised because of employees’ expenses, resources and tools purchasing. Complexity is another drawback of traditional software engineering because it is difficult to manage every parts of the project in house. For reducing complexity of the system, software engineer has used many methods to improve the usability and maintainability of the software system [9]. In traditional software development, the quality of the software is infeasible due to burden of works [10]. In traditional software engineering, all

parts of the software are developed sequentially due to which production of software takes more times and these are all the drawbacks of the traditional software engineering because of it we move to new paradigm that is Component Based software Engineering to eliminate the deficiencies of the traditional software paradigm. A component is independent object that communicate with other component by using interface and speeds up the system creation and delivery [11]. Component Based software development is to create a system by selecting the component and integrating it into one system. They have many advantages which are discuss here in brief [11].

### ***Great Command and Lower Maintenance Cost***

In component-based software engineering, developer have great command on component because code of the component is in one place. In case of any problem or enhancement required has be done without any extra effort [11]. System maintenance cost is very low because required enhancement or test only done in one implementation.

### ***Time saving and Revenue Increasing***

Developer create amazing system by using component bases software engineering paradigm to save time and increase revenue because of the reusability aspect of the component bases approach [11].

### ***Uses of Specialized Skills***

One the most important beauty of component based architecture is to take advantage of specialized skills because developer have specialized skill i.e. one developer experts in JAVA, another master in ASP.net and another guru in CSS, nevertheless one developer use the expertise of another developer to create system [11].

## **Objectives**

The objective of this research project is to identify the success factors that have positive impact on software outsourcing vendor organization in adapting the concept of component-based approach in software outsourcing development and also highlighted the characteristics of component based to assist the software outsourcing vendor organization.

We have the following objectives:

- To identified success factors and its practices through systematic literature review.
- To conduct questionnaire survey for the validation of the SLR findings.
- To synthesis the data according to requirement
- To conduct analytic hierarchy process method, prioritize success factors and their categories based on relative importance.

## **Research Gap/Problem Statement**

We have found many issues in traditional software engineering, which are listed here in brief: -

- i. Take more time to create complex system.
- ii. High development cost.
- iii. Lack of specialized skills.
- iv. Low quality.

To eliminate the above issues, we have move to new paradigm of software development that is component-based software development. In this research we have planned to identify the success factors that have positive impact on software outsourcing vendor organization in adapting the concept of component-based approach of outsourcing software development. This approach will not only easy the job for the vendor organization to develop specific component but will also give an option to client organization to develop their needed component whenever they required.

### ***Significance of Work***

There are various issues in traditional software development or in-house software development such that time consuming, high development cost, problem fixing and so on. Our proposed work is a mile stone for the vendor organizations to tend from complex system development to component software development. My research work will show and attract them that why they should tend toward component software development, where they will gauge their status for such kind of development. In component software development the outsourcing software vendor organizations will free to develop only those components where they have an expertise in it. In such situation they will be fully aware about their product and can easily hand all the obstacles regarding their developed software components.

### ***Research Questions***

We were facing various issue/problem for selecting of component-based software development by outsourcing vendor origination. The following three question occur in my mind which will elaborate in this research.

**RQ1:** What are the success factors that have positive impact on software outsourcing vendor organization in adapting the concept of component-based approach in software development?

**RQ2:** What are the practices for the identified success factors in the literature that have positive impact on software outsourcing vendor organization in adapting the concept of component-based approach in software development.

### **Research Methodology**

Research Methodology is used to collect and analyze the research data. In this research we will collect research data and will be analyzed by using the following methods as discussed below:

#### ***Systematic Literature Review (SLR)***

Systematic Literature Review (SLR) is a method of collecting and analyzing the research data included in the specific research topic/research question [12]. There are three phases of SLR. First phase is planning, second is implementation and third phase is conducting and reporting. In the first phase a protocol is developed on the bases of research question. In the second phase the required papers will be downloaded on the basis of defined search string. The extraction and synthesis of data takes part in this phase. All the data are documented in form of research paper or thesis to show its results [13]

#### ***Empirical Study***

Empirical Study is a technique of collecting and analyzing data based on direct observations and experiments instead of theoretical preparation [14]. The empirical term was initially used by medicine practitioner. In scientific, the term empirical is assembly of data with the help of evidence that is noticeable by senses [15]. It is evidence-based policy of effective treatment [16].

#### ***Analytical Hieratical Process (AHP)***

AHP was first developed by saanty [17]. It is the greatest common multi criteria decision process [17]. Since its inauguration, the AHP has been taken into account by different persons that making observations in a range of fields for getting answer to and way out of complex decision-making problems inclusive of qualitative and quantities aspects [18-21].

#### ***Plan of Work***

We have planned to collect the required data through SLR. Secondly, the identified data will be validated through questionnaire survey and will also tried to find some new data apart from the identified ones. These data will be synthesized according to defined requirements. Third, the identified data will be categorized accordingly and will be analyzed with the help of AHP.

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# Transfer Learning-Based Feature Ensembling for Multi- Class Detection of Cov-19 and Pneumonia Using Lungs X-Rays

(Ref No. ICETEMS-21-156)

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## Abstract

The entire world is trying to stop the rapidly spreading of the Covid-19 pandemic, causing significant public health and socio-economic issues around the globe. Early detection and identification of Covid-19 is a significant task. The aim of this study is the early detection and classification of Covid-19 and Pneumonia with the help of deep learning using Lungs X-ray images. In the proposed method, Lungs X-ray images are enhanced to create clearer images from which the object and structural features in the images can be properly recognized by the system. Data augmentation technique is proposed to increase the size of the dataset. The performance of the CNN model is not satisfactory on low datasets; therefore, the concept of transfer learning has been proposed. The proposed method extracts feature from pre-trained CNN architectures, namely GoogleNet and SqueezeNet. It then transfers the knowledge to a fully connected layer of our customized CNN architecture to classify Pneumonia and Covid-19 disease. The proposed method gives fast and accurate results compared to the traditional reverse transcription-polymerase chain reaction (RT-PCR) technique and achieved 98% accuracy.

## Keywords

Covid-19, CNN, Ensembling, Transfer Learning, Lungs X-rays images.

## Introduction

The Severe Acute Respiratory Syndrome Coronavirus-2 (SARS Cov-2) is considered the prime cause of infection with the novel Coronavirus or Covid-19. It was discovered during a respiratory disease outbreak in Wuhan, Hubei Province, China, and subsequently announced as a pandemic by the World Health Organization (WHO) on 11 March 2020 due to the degree of its severity and speedy spread across the world [1]. The most common symptoms of Covid-19 positive cases include episodic cough, fever, Ear-Nose-Throat (ENT) infections, headache, and the loss of taste or smell. Patients with more severe infections are reported to have suffered critical complications, including severe Pneumonia, short breathing, chest pain, loss of speech or movement, septic shock, multi-organ failure, and death of the worst-case scenario of a patient [2].

On average, the Covid-19 infection takes 5–6 days for clear symptoms to appear after a person has been infected with the virus. In some cases, this period may be prolonged up to 14 days [3]. The disease has no predisposition for gender or social status etc. However, the risk of severe complications or even death tends to increase in the elderly [4]. The diagnosis method for Covid-19 is Reverse Transcription Polymerase Chain Reaction (RT-PCR) tests which are considered the gold standard for Covid-19 screening. The shortage of facilities and tests makes it difficult to screen suspicious subjects quickly and accurately. Besides, RT-PCR testing is said to have a high rate of false negatives [5]. Radiological imaging methods such as X-rays and Computed Tomography (CT) have shown efficacy in the diagnosis and follow-up assessment and evaluation of the disease evolution [6].

A chest X-Ray is a form of imaging used to examine several diseases, including fractures, bone displacement, Pneumonia, tumors, etc. An X-Ray can be a significantly helpful method in detecting Covid-19 infections because it provides a quick way to see the existing condition of the chest and lungs [7]. The early diagnosis of Covid-19 infection is a challenging task for health professionals. With the

substantial shifts in social interactions, health policies, commerce, work, and educational environments, the pandemic affects billions of people socially, economically, and medically. Consequently, it has inspired the research community to study the mitigation, identification, and prevention of the virus [8].

In this paper, we propose an automatic method that uses transfer learning and convolution neural networks to identify Lung X-ray images as COVID-19 patients, Pneumonia patients or healthy patients. We propose an ensemble deep learning model in this research, in which two alternative deep CNN architectures are integrated to improve prediction accuracy. The proposed deep learning model based on ensembles is predicted to provide higher accuracy scores with smaller inaccurate predictions than the previous recent research works.

This study is significant in that it combines three approaches Image Enhancement, Features extracting using CNN model, and Image Classification using ensemble model with transfer learning to identify Covid-19, Pneumonia and healthy patients. Our work is unique in that it uses a completely balanced dataset to eliminate biases towards any one class in our prediction, and as a result, it performs better than models trained on imbalanced datasets.

The main contribution of this paper is

1. To compensate for the lower sensitivity of RT-PCR, this work uses Lung X-ray images to detect and diagnose Covid-19.
2. Lung X-rays are recommended over CT scans in this paper. The reason for this is that X-ray machines can be found in almost all hospitals. Even so, an X-ray machine is less expensive than a CT scan machine. Apart from that, X-rays emit fewer ionizing radiations than CT scans.
3. Covid-19 provides radiological patterns that are easily detectable on Lung X-rays. As a result, deep learning-based techniques can be used to automatically analyze Lung X-rays, potentially reducing analysis time.
4. Using several performance metrics such as accuracy, f-measure, sensitivity, and specificity, extensive comparative analyses are also drawn to evaluate the performance of the proposed model.

## Related Work

Various researchers have shown their efforts to detect Covid-19 using different machine learning approaches with their respective limitations in the literature. Serte et al. [9] used the ResNet-18 deep learning architecture to detect pleural effusion from Pneumonia, Tuberculosis, and Covid-19 respiratory diseases before they proceed to pleural effusion. However, the dataset size (138 images), as well as the accuracy (65%) of this research, was quite limited [9]. Mohamed et al. [10] used regular blood test results to detect Covid-19 by using several machine learning approaches. These algorithms are then merged to form ensemble learning which leads to their classification and the conclusion that is having regular blood tests, while useful in many other diseases. They do not help much in detecting Covid-19. The true positive rate is very low, while the imbalanced data may also reduce the true positive rate. Xi Ouyang et al. [11] developed a dual-sampling attention network to automatically diagnose Covid-19 from the Community-Acquired Pneumonia (CAP) in chest computed tomography. The visualization results of this study do not suggest significant accuracy in identifying the Pneumonia infection regions and the Covid-19. Sakib et al. [12] developed a deep learning strategy for classifying chest X-ray images to predict COVID-19 with a 93.94 percent accuracy. Due to a shortage of COVID-19 X-ray images, they used data augmentation approaches to overcome the data imbalance problem. A recent study by K. Lee et al. [8] analyzed chest X-ray and CT images from nine COVID-19 infected patients by two radiologists to assess the correspondence of abnormal findings on X-rays with those on CT images.

Shi, Feng et al. [14] used medical imaging and analysis techniques involved with COVID-19, including image acquisition, segmentation, diagnosis, and follow-up. The author focused on the integration of AI

with X-ray and CT, both of which are widely used in the frontline hospitals, to depict the latest progress of medical imaging and radiology fighting against COVID-19.

Khan et al.[15] used the Xception architecture to classify chest X-ray scans from normal, bacterial, and viral pneumonia cases to detect COVID-19 infection.

Afshar et al.[16] constructed DNN-based diagnostic solutions and proposed a modeling framework based on Capsule Networks that can analyze tiny data sets.

Alqudah et al.[17] employed two alternative approaches to diagnosing COVID-19 utilizing chest X-ray pictures in their investigation. The first one made use of CNNs from AOCTNet, MobileNet, and ShuffleNet. Second, the images were categorized using the softmax classifier, K closest neighbor (kNN), Support vector machine (SVM), and random forest (RF) algorithms after the features were deleted.

In another study by T. Ozturk et al. [18], proposed a deep learning model called Dark CovidNet for the automatic diagnosis of COVID-19 based on 125 chest X-ray images to diagnose i) binary classification (COVID-19 vs no findings) and ii) multiclass classification (COVID-19 vs no findings vs pneumonia) and report accuracy 98.08% on binary and 87.02% on the multiclass classification task. No segmentation task has been done yet on COVID-19 image.

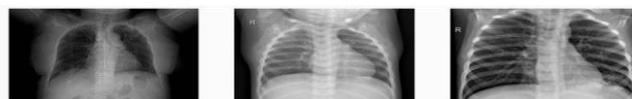
## Mehodology

In this section, we present the proposed methodology by using the Lungs x-rays images for detection and classification of Covid-19, Pneumonia and Healthy patient. First, we described the Dataset which is used in this study, then we have explained the features extracting using the Transfer Learning technique. After this step, we have explained the classification step using features ensembling of two pre trained- model. In the last section, we have used the matric to evaluate the results and compare them with other techniques.

It is generally accepted that the current state of deep CNN architectures is highly optimized in terms of both computational complexity and classification performance. As a result, in this paper, an ensembling technique for Covid-19 Pneumonia and healthy patients X-ray image detection is presented, which makes use of several state-of-the-art deep CNNs, Googlenet and Squeezenet. It should be noticed that the number of CNNs can easily be changed, but in this work, the performance is demonstrated using the above two CNN models.

### A. Pre processing

The balanced Lungs X-ray (LXR) datasets that were used for feature concatenation and decision fusion remained constant. For implementation in the testing phase, the Lungs X-ray pictures are given to minimal preprocessing. Before further processing with the ensembled deep neural network, the images are just reshaped to a uniform size.



Covid-19

Normal

Pneumonia

### B. Training approach for ensembling by feature concatenation strategy

Two network i.e Googlenet and Squeezenet are trained on balanced Lungs X-rays image dataset. Both of the networks are initialized with 'Imagenet' weights, which are changed during the training phase. This technique of transfer learning allows for better initialization and convergence.

### C. Dataset

Dataset used in our study is created by combining three open -source datasets used from the Kaggle which consist of Lungs X-rays images. The dataset consists of Lungs X-Ray images of 3 classes.

1. Covid-19 Positive Patient's Lungs X-Ray
2. Pneumonia Patient's Lungs X-Ray
3. Normal Person Lungs X-Ray

Table Number of Data In Each Class

<b>Data</b>					
Class	Images	Augmented Total	Training	Validation	Test
Covid-19	2500	8000	6500	800	700
Pneumonia	2000	10000	8500	900	600
Normal	2000	10000	9000	600	400

Furthermore, the quantity of data available on the various networks varies (COVID-19 X-Ray being the limiting factor). As a result, to avoid any bias in the dataset and to reduce any abnormality in the training and testing datasets, various data augmentation techniques have been applied thus the training and testing datasets have been trimmed down.

#### **D. Convolutional Neural Networks**

The most widely known and used deep learning models are convolutional neural networks. Convolutional neural networks CNN consists of one or more convolution layers and filter numbers, fully- connected layers, pooling layers, and dropout layers are among the layers that make up architecture. This can be achieved through the use of a process known as transfer learning, Pre-trained models are utilized in transfer learning. Models have been trained on one dataset but may be used to process other datasets of a similar description are known as pre-trained models. These models can be altered slightly depending on the situation, but the essence of the model remains the same. Two models are employed in this study, both are trained on the ImageNet dataset which is a large dataset of around 14 million images divided into about 1000 different classes.

#### **E. GoogleNet**

The GoogleNet architecture consists of nine inception module. Notably, there are two max-pooling layers between some inception modules. The purpose of these max-pooling layers is to down sample the input as it's fed forward through the network.

#### **F. SqueezeNet**

SqueezeNet is the name of a deep neural network for computer vision that was released in 2016. In designing SqueezeNet, the authors' goal was to create a smaller neural network with fewer parameters that can more easily fit into computer memory and can more easily be transmitted over a computer network

#### **G. Transfer Learning With Convolutional Neural Networks**

Transfer learning is a technique for using a CNN's knowledge from one problem to solve a different but related problem. This knowledge is then transferred to a new dataset, which is often smaller than the size required to train a CNN from scratch.

In deep learning, this method requires an initial training of a CNN for a given task, using large datasets. The availability of a large dataset is the most important component in ensuring the method's success since the CNN can learn to extract the most important features of a sample. The CNN is deemed suitable for transfer learning if it is found to be able to extract the most important image features. The CNN is

then utilized in transfer learning to evaluate a novel dataset of a different nature and extract features based on the knowledge gained during the first training. Transfer learning is commonly used to avoid the computational costs of training a network from scratch or to maintain the feature extractor trained while the first task is being completed.

## Results and Discussions

In this study, we proposed the ensembling of two CNN by features concatenation technique. The classification performance of each of the proposed systems is examined in this section. Five commonly used performance measures are used for this study. Precision, Sensitivity, Specificity, F1-Sco and Accuracy. For each proposed technique, classification results for the initially given dataset for three class scenarios are computed. The accuracy attained by the suggested approach using the feature concatenation approach is 98% for 3-class classification, respectively.

The dataset used was randomly split into two independent datasets with 80% and 20% for training and testing respectively. A cross-validation method, k-fold was chosen and results were obtained according to 5 different k values (k=1-5).

### Evaluation criteria

In this study we applied standard evaluation metrics like recall, precision, accuracy, and f1-score to evaluate the models' prediction performance. The number of instances that accurately predicted is known as true positive (TP), whereas the number of cases that wrongly predicted is known as false negative (FN). The number of accurately predicted negative instances is known as true negative (TN), while the number of incorrectly predicted negative instances is known as false positive (FP). All evaluation metrics were calculated using TP, TN, FP, and FN as follows.

**Recall or sensitivity** is the measure of Covid-19 cases that are correctly classified. Recall is critical, especially in the medical field and is given by:

$$Recall = \frac{TP}{TP + FN}$$

**Precision or positive predictive value** is defined as the percentage of correctly classified labels in truly positive patients and is given as:

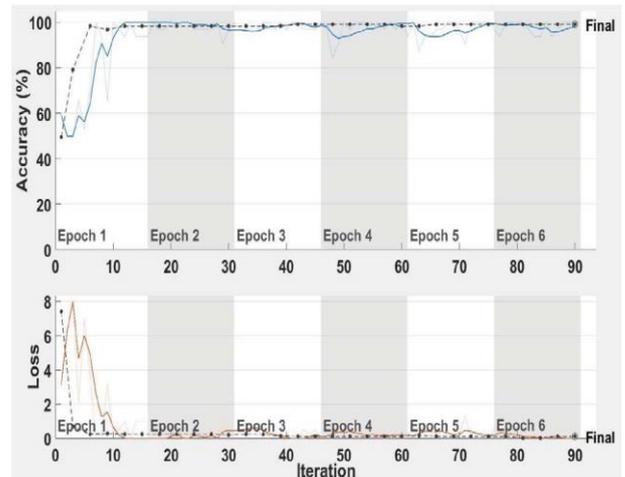
$$Precision = \frac{TP}{TP + FP}$$

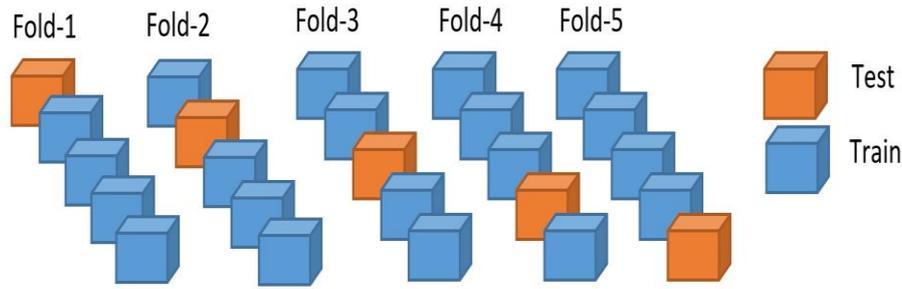
**Accuracy** shows the number of correctly classified cases divided by the total number of test images, and is defined as:

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN}$$

**F1-score**, also known as F-measure, is defined as the weighted average of precision and recall that combines both the precision and recall together. F-measure is expressed as:

$$F1 - score = 2 \times \frac{Recall \times Precision}{Recall + Precision}$$





Representation of 5-fold cross validation method

## Conclusion and Future Work

It is essential to predict Covid-19 patients early in order to prevent the disease from spreading to other people. In this study, we suggested a deep transfer learning-based approach for automatic detection of Covid-19 Pneumonia using Lungs X-ray images obtained from Covid-19 patients, normal and Pneumonia. Covid-19 was detected with greater than 98 percent accuracy using the proposed classification model. Due to the great overall performance of our findings, it is widely assumed that it will assist medical doctors in making decisions in scientific practice. This paper explains how deep transfer learning algorithms can be utilized to find Covid-19 at an early stage in its development. Covid-19 has already caused a threat to the global healthcare system, and thousands of people have died as a result. Deaths were caused by a lack of oxygen in the lungs, which led to the failure of other organs. Because doctors' time is limited due to the large number of patients attending out-of-hospital or emergency rooms, computer-assisted analysis can save lives through early screening and proper care. By effectively training itself from a considerably smaller number of images, the Googlenet & Squeeze model displays great performance in diagnosing Covid-19 pneumonia. We expect that this computer-aided diagnostic tool will increase the speed and accuracy of diagnosing Covid -19 cases significantly. In the future, we want to expand the dataset by adding fresh lungs X-ray images of Covid-19 patients with new symptoms as soon as they become available. We also intend X-ray exams of other lung-related disorders, therefore confirming the efficacy of the suggested approach.

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# EDUCATION

# **A Correlational Study of Test Anxiety and Students' Academic Performance at College Level in Khyber Pakhtunkhwa, Pakistan**

*(Ref No. ICETEMS-21-095)*

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## **Abstract**

Anxiety is a common phenomenon among the students when they have to appear for test. The situation gets worst if the student is subjected to greater expectations. The students may face mental tension, affective imbalance and procrastination. This study endeavored to highlight the stresses and strains a student undergoes in such situations. The study investigated the students' test anxiety encompassing Cognitive, Affective and their tendency of Procrastination. The study employed survey method to collect the data through two adapted questionnaires. Population of the study comprised all the students of class 2<sup>nd</sup> year studying in Public and Private Colleges in District Peshawar. The sample was selected on random sampling techniques which consisted of 200 students both equally from boys' and girls' colleges. The data collected on 5 points Likert scale was processed on Statistical Package for Social Sciences (SPSS)-24. The main independence variable of the study was Student Test Anxiety having three sub variables as Cognitive, Affective and Procrastination which were measured through an adapted instrument developed by Cassady, and Johnson, (2002), The main dependent variable was students' Academic Performance which was measured by instrument developed by applying DePaul J.G., Rapport D.M & Perriello M.L (1991).The data analysis was carried out by applying various statistical tools like Descriptive statistics, One Sample t-test, Independent Sample t-test and Pearson Correlation. The study established significant correlation between the test anxiety and the students' academic performance. The study confirmed the positive correlation between cognitive and affective test anxiety and the students' academic performance. However, the students' Procrastination was found insignificant. It recommended that the school management may take measures to contain test anxiety among the students. For example, the timely completion of the course work, revision, testing and retesting, and satisfying the students regarding their doubts. The results concluded that test anxiety within the manageable range enhances the students' Academic Performance.

## **Keywords**

Cognitive Test Anxiety, Affective Test Anxiety, Procrastination Test Anxiety, Student's Academic Performance

## **Introduction**

Anxiety is a psychological condition when a person may feel abnormal mental and physical conditions while faced with new or somewhat challenging situations. A student may experience anxiety while preparing or appearing to take a test. It is a known phenomenon that every person experience certain degree of anxiety while appearing for a test, however, it may affect student's learning and may put shadow on his/her test score. Some level of anxiety actually starts the dynamics to move. But its excess may prove damaging to mental abilities and also it affects personal health. A moderate anxiety may make you get up on time in morning but high-level anxiety may not allow sleeping at night. According to Kalisch et al. (2005) anxiety refers to a condition which human beings experience in their daily life interaction. Generally, it refers to continued human sentiments as a physiological reaction and caused by anxiety. Anxiety has physiological and cognitive arousal which is normally unpleasant.

Lowe et al., (2008) is of the opinion that anxiety may be beneficial which causes excitement and enthusiasm. However, it may have negative effect when it results in worry, confusion, fear and decreasing self-esteem. Anxiety among the students is caused by testing and evaluation in our education

system. Various researches already carried out had established that anxiety caused by test inversely affects student's achievements therefore this study examined various dimensions of anxiety that can affect student's performance in educational testing and evaluation. Test anxiety is all pervasive even intelligent students may feel a certain level of anxiety towards tests. It is more evident as its outcomes may nullify whole year's efforts and academic struggle. If a person has headache on the day of test and performs low, he/she may be downgraded in achievement. This phenomenon generates fear and a level of anxiety among students. The examination system is based on reproduction of stuff and not critical analysis. The students fear that examiners may not accept what they expressed.

## Objectives

The study pursued following objectives.

- i. To explore the relationship between students' cognitive test anxiety and their academic performance.
- ii. To assess relationship between student affective reaction to test anxiety and their academic performance.
- iii. To evaluate relationship between students' procrastination leading to test anxiety and their academic performance.
- iv. To find out the difference in the level of test anxiety between male and female students and its effect on their academic performance.

The Study tested the following hypotheses.

- i. **Ho1:** There is no relationship between the students' cognitive test anxiety and their academic performance.
- ii. **Ho2:** There is no relationship between the students' procrastination causing test anxiety and their academic performance.
- iii. **Ho3:** There is no relationship between the student's affective reaction to test anxiety and their academic performance.
- iv. **Ho6s:** There is no difference in the level of male and female students test anxiety and its effect on their academic performance.

## Review of Literature

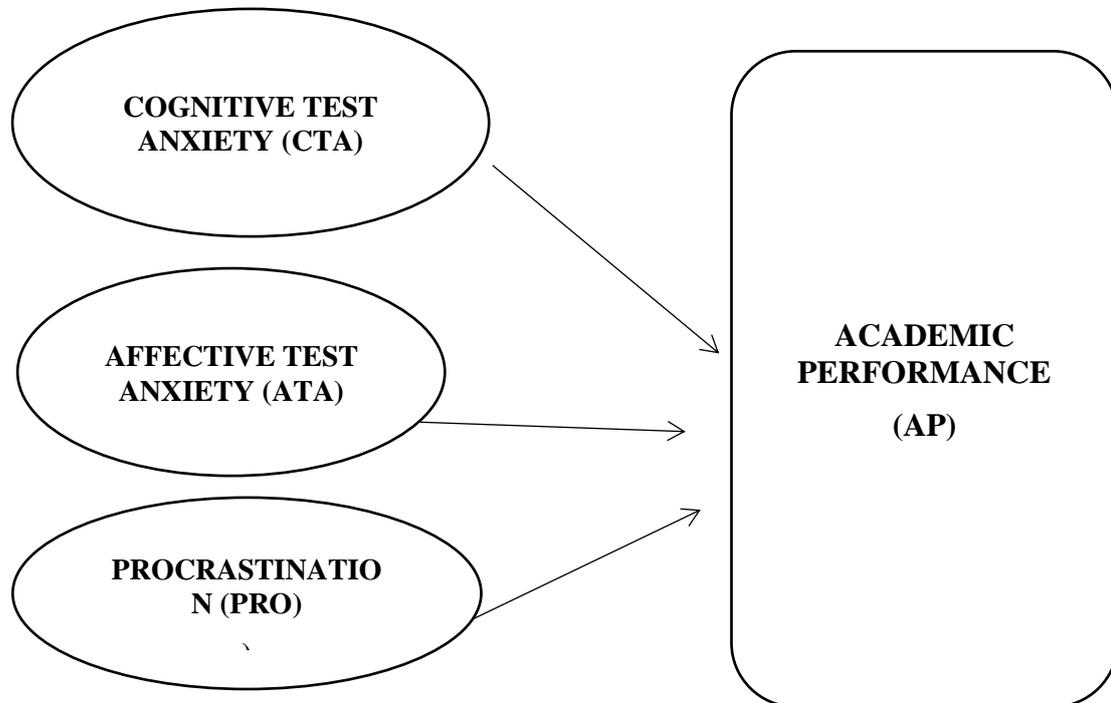
Test anxiety among students is the burning issue in teaching learning process. Various researches have been carried out in Pakistan and elsewhere in the world highlighting the key issue of present evaluation system based on rote memory and mere reproductive. Again, the prevailing admission system entry to professional colleges for require highest grade and percentages. Success in these entrance examinations has become quite exhaustive causing high tension among the students. This review of literature encompassed researches carried out on various aspects of evaluation systems, use of unfair means, faulty marking system etc. but very less literature is available on the effect of test anxiety on the achievement level of students.

### *Theoretical & Conceptual Model*

The theory by George Mandler and Sarason (1952) established that anxiety is a factor that may be detrimental in deciding the performance during testing situations. If a student feels anxious during tests, he/she may have poor performance. These anxieties filled conditioned may be more felt in case the examination has any deciding value of promotion or position. When a student gets into state of anxiety, he/she may go blank on the feelings of forgetting and this interference by anxiety may generate irrelevant responses instead of relevant one. The anxiety decreases the performance due to lack of focus as ability of focusing depresses in tense conditions. A person having low anxiety may focus more than a person with higher anxiety level. Students who feel higher levels of anxiety do not perform well as their focus is disturbed. It can result in feelings of hopelessness and poor performance. The anxiety may

increase in situations where a student feel that the degree of assessment is far more than their capabilities and they start feelings of failure even before the attempt.

Based on the related literature review, the researcher designed the following Model. The research Model highlights 03 independents variables i-e Cognitive, Affective, and Procrastination. The dependent variable of the Model is Academic Performance of students.



**Fig. 1: Theoretical and Conceptual Model.**

#### ***Cognitive Reaction to Test Anxiety***

The process of thinking, perceiving, problems solving and ability to remember are the actions that are considered to be cognitive activity of the brain, (Mckay et al., 2000). The students who have cognitive reaction to test anxiety may resort to a state of worry or fear that lead to, a) Self-depreciating thoughts like thinking too low of themselves to the challenge they face, b) Distraction in the process of study and also while attempting tests, c) Comparison with peers, a fear and worry of peers may score more and may make from of them, d) Perceiving tests as threat to self-esteem and status in peers, e) Avoidance of test and preparation and process of evaluation to avoid the competition. Recent researches have focused on social aspects of cognitive reaction to test anxiety that may lead to devise better coping strategies for students who face high level of test anxiety, (Lowe et al., 2011). The cognitive dimension of test anxiety may have more reaction in the shape of low performance by student, (Cassady, 2010).

#### ***Procrastination (As reaction to Test Anxiety)***

Academic procrastination is one of the main causes of test anxiety, (Van Eered 2000). It is a voluntarily delaying tactic to delay important matters causing negative consequences. Patzel & Optiz (2014) in their research commented that procrastination means delaying learning or during any assignment which result in low grade, long tuition hours, and even drop out. It may be distinguished from planning itself. Because delay is not purposive but rather the postponing of the implementation. It is an inability to delay gratification due to lack of impulse control. Impulse control is the ability of a person to give up short term outcomes. Pekrun (2006) indicated the positive effects of impulse control over many years.

#### ***Affective Reaction to Test Anxiety***

Test anxiety may lead to some affective reactions to alongside cognitive reactions, Zeidner, 2014). Such reactions may manifest in the shape of increased heartbeat, desire to urinate, sweating, cramps in muscles, thirst, cold hands and shaking body. With all these physiological reactions, emotional feelings of failure threat, worrying, may also be there in an individual. In case of affective reaction to test anxiety, a student may face failure to control emotions, feelings of pressure, tense sensations, fear and creation of a hard-uncontrollable situation, (Cassady & Johnson, 2002).

### ***Test Anxiety and Academic Performance***

Steel (2001) found that longitudinal study on finding association between test anxiety and academic performance are scarce, although there are many studies on the subject. Most of the studies found a reciprocal association between test anxiety and academic performance. Students with test anxiety may show poor results in academic testing situations. In a study by Nicholson, (2010) it was found that there existed a negative correlation between test anxiety and academic performance when  $r$  was found  $=-0.21$  whereas emotional component was found having little effect on student's academic performance as compared to worry or cognitive component.

Attentional Control Theory (ACT) by Eysenck et al., (2007) suggests a negative effect of test anxiety on academic performance. This theory states that anxiety may impair effective function of student's attention systems and decrease its efficiency. Thus, according to theory, the anxiety by impairing attention system affects student's cognition.

## **Methodology**

Primarily this research was descriptive in nature, where survey method was used for data collection. The study encompassed three Independent Variables; Cognitive test anxiety, Procrastination test anxiety; Affective test anxiety and Students Academic Performance as Dependent variable.

### ***Population***

Population of the study comprised of 2<sup>nd</sup> year students in Govt and Private Colleges in District Peshawar. There are eight Boys and eight Girls colleges in the Govt sector in district Peshawar. The total number of 2<sup>nd</sup> year Boys students are 28871 and Girls are 13636 students. Equal number of Private Girls and Boys colleges were purposively selected. Where number of 2<sup>nd</sup> year students Boys are 11865 and Girls are 3679. So the total population of study was Boys are 40,736 and Girls are 17,315. (BISEP 2020)

### ***Sample size and Sampling Techniques***

Multi stage stratified sampling technique was used for the sample selection. Initially 20 colleges 10 Govt. and 10 Private colleges, 5 each Boys and Girls were purposively selected. Subsequently 10 students for Govt. and Private both Boys and Girls were randomly selected. This making the sample size as 200 students equally 100 Boys and 100 Girls.

### ***Research Instrument***

Research instrument known as "Test anxiety scale" by Cassady, and Johnson (2002) was adopted for the collection of research data. It has three variables as: Cognitive Test Anxiety, Affective Test Anxiety, and Procrastination Test Anxiety having 16 items. And for students' Academic Performance scale 'Academic Performance Rating Scale (APRS) developed by DuPaul, Rapport & Perriello (1991) was used and having 7 items, to measure student's & Academic Performance.

### ***Data Analysis***

The data so collected was tabulated and processed through SPSS-24 applying various statistical tools such as Descriptive Statistics, Reliability Test, frequency analysis, One Sample t-Test, Pearson Correlation etc. Based on the data analysis certain findings were formulated. The conclusion was drawn based on the findings of the study which led to certain suggestion/recommendations.

### **Reliability Analysis**

Reliability test was applied to determine the reliability level of the collected data. The data indicates that reliability values of variables Cognitive Test Anxiety (CTA), Affective Test Anxiety (ATA), Procrastination Test Anxiety (PRO), and Academic Performance (AP) as .854, .799, .878, and .803 respectively in terms of Cronbach's Alpha. According to Umma Sekaran (2003), these values fall in the range of good to excellent. Hence, we can use the data for further statistical analysis.

### **One Sample t-Test**

To find out the statistical significance of the agreement by the respondents, the researcher carried out.

The data indicates mean value of respondent as 3.1960 that is .1960 higher than test value 3, with alpha as 0.006 that is less than .05. The results show that majority of the respondents agree to the query asked stating that Cognitive Test Anxiety has significant effect on students' Academic Performance.

### **One Sample t-test for Affective Test Anxiety (ATA):**

The data indicates mean value of respondent as 3.35250 that is .35250 higher than test value 3, with Alpha as .000 that is less than .05 showing statistical significance. The results show that majority of the respondents agree to the question asked that state Affective Test Anxiety has effect on students' Academic Performance and this agreement carries statistical significance.

### **One sample t-test for Variable Procrastination Test Anxiety (PRO):**

The data indicates mean value of variable (PRO) was as 3.26250 that is .26250 higher than test value 3, with Alpha as .000 that is less than .05. The results show that majority of the respondents agree to the query asked stating that Procrastination Test Anxiety has effect on students' Academic Performance and this agreement carries statistical significance.

### **Pearson Co-relation analysis for variable Cognitive Test Anxiety and Academic Performance (AP)**

To find out statistical significance of correlation between variable Cognitive Test Anxiety (CTA) and Students Academic Performance (AP), we carried out Pearson Correlation test for variance. Following tables shows the results obtained.

		<b>Correlations</b>	
		CTA	AP
CTA	Pearson Correlation	1	.910**
	Sig. (2-tailed)		.000
	N	200	200
AP	Pearson Correlation	.910**	1
	Sig. (2-tailed)	.000	
	N	200	200

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

Table shows results of Pearson Correlation analysis for variables CTA (Cognitive Test Anxiety) and AP (Academic Performance). The table shows that Pearson Co-efficient as relationship is .910 with significance level as  $.000 < .05$ . The results establish a strong relationship between Cognitive Test Anxiety and Student's Academic Performance. The results at above table indicate students' opinion

that Cognitive Test Anxiety strongly infuse urge to perform best in the tests. Hence H<sub>02</sub> There is no relationship between the students' cognitive test anxiety and their academic performance is rejected.

***Pearson Correlation Test for variables Affective Test Anxiety (ATA) and Students Academic Performance (AP)***

		ATA	AP
ATA	Pearson Correlation	1	.418**
	Sig. (2-tailed)		.000
	N	200	200
AP	Pearson Correlation	.418**	1
	Sig. (2-tailed)	.000	
	N	200	200

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

Table shows results of Pearson Correlation analysis for variables ATA (Affective Test Anxiety) and AP (Academic Performance). The table shows that Pearson Co-efficient for relationship is .418 with significance level as .000 <.05. The results establish a moderate relationship between Affective Test Anxiety and Student's Academic Performance. The correlation between variables ATA and AP is moderate, however, it is statistically significant. Hence Hypotheses H<sub>04</sub> 'There is no relationship between the student's affective reaction to test anxiety and their academic performance'' is rejected.

***Pearson Correlation Analysis for Variables Procrastination (PRO) and Students Academic Performance (AP)***

		PRO	AP
PRO	Pearson Correlation	1	.020
	Sig. (2-tailed)		.774
	N	200	200
AP	Pearson Correlation	.020	1
	Sig. (2-tailed)	.774	
	N	200	200

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

Table shows results of Pearson Correlation analysis for variables PRO (Procrastination Test Anxiety) and AP (Academic Performance). The table shows that Pearson Co-efficient for relationship is .020 with significance level as .774 that is >.05. The results establish a weak relationship between procrastination and Students' Academic Performance (AP) however it is statistically insignificant.

Hence Ho3 ‘There is no relationship between the students’ procrastination causing test anxiety and their academic performance’ is accepted.

***Pearson Correlation analysis between Test Anxiety (TA) and Students’ Academic Performance (AP)***

In order to investigate the overall combined effects of sub variables of CTA, ATA and PRO, the researcher conjoined these sub variables to form a variable TA (Test Anxiety). Following are the results of the test applied. The Mean of conjoined variable test anxiety TA was calculated as 3.2703.

**Correlations**

		AP	TA
AP	Pearson Correlation	1	.787**
	Sig. (2-tailed)		.000
	N	200	200
TA	Pearson Correlation	.787**	1
	Sig. (2-tailed)	.000	
	N	200	200

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

Table shows indicates that Pearson correlation coefficient between variable Test Anxiety (TA) and Students’ Academic Performance (AP) is .787 and the significance level is .000 which is less than .05. The results establish that there exists a strong relationship between test anxiety and students’ academic performance and this relationship has statistical significance. Hence on the result of the above table we reject hypotheses Ho1 ‘There is no relationship between students’ test anxiety and their academic performance stands rejected.

***Independent sample t-test for variable Gender and Test Anxiety (TA)***

To check the hypothesis Ho 5 “There is no difference in the level of male and female students test anxiety and its effect on their academic performance” the researcher carried out Independent sample t-test for variable Gender and Test Anxiety (TA). Following are the outcomes.

**Group Statistics**

		Gender N	Mean	Std. Deviation	Std. Error Mean
TA	M	100	3.4974	.46249	.04625
	F	100	3.0433	.55148	.05515

Independent Samples Test									
	Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
	F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
TA Equal variances assumed	1.541	.216	6.309	198	.000	.45411	.07197	.31218	.59604
Equal variances not assumed			6.309	192.169	.000	.45411	.07197	.31215	.59607

Equal variances were assumed as Levene Test was statistically insignificant at  $F=1.541$  ( $p=.217$ ). The mean of male students was 3.4974 and female students was 3.0433. It shows that there is no difference in opinion among male and female students regarding relationship between test anxiety and students' academic performance. The t-test values obtained was 6.309 at p value as 0.000 showing statistical significance of responses by respondents. On the basis of above results we reject  $H_0$  5 "There is no difference in the level of male and female students test anxiety and its effect on their academic performance" is accepted.

## Summary of Findings and Conclusion

The result of one sample t-test regarding the independent variables indicated that the respondent were positive in their response to the question raised and the difference between the responses and the test value was significant. The results of the Pearson Correlation between CTA and AP showed that there is a correlation between these two variables. Co-efficient of Correlation as .910 at alpha value as .000 that is less than .05. It indicates a strong Correlation between CTA and AP variables. Pearson Correlation analysis for variables ATA (Affective Test Anxiety) and AP Student's Academic Performance showed the Co-efficient of Pearson Correlation as .418 with significance value as .000. The results indicated that Affective Test Anxiety (ATA) has moderate Correlation with students' Academic Performance having statistical significance. Pearson Correlation analysis between PRO (Procrastination) and Students Academic Performance (AP) i.e. .202 which is statistically less significance as the p value is .000. To test if there exists any difference of opinion between male and female students regarding Correlation between Test Anxiety and Academic Performance, we carried out independent Sample t-test. The results show F value as 1.54, at alpha .216 that is more than .05. It shows that the variance is equal. So, there is no difference of opinion among male and female students regarding variable TA and AP. The Correlation between conjoined variable TA (Test Anxiety) comprising (CTA, ATA, and PRO) with students' Academic Performance (AP), was found .787 which is highly significant.

## Conclusion

The study confirmed that center tendency of the response was positive.

The results of One sample t-test regarding all the variables confirmed that majority of the respondent agreed to the query posed. The results of Pearson Correlation indicated positive relationship ranging from less significant to higher level significance. The correlation between Cognitive Test Anxiety was .910 which was the highest. The Correlation between other two variables, Affective Test Anxiety, Procrastination Test Anxiety was .418 and .202 respectively indicating moderately correlated and less significant in case of Procrastination Test Anxiety. The Correlation between the conjoint variable i-e Test Anxiety (TA) and students' Academic Performance was highly significant. The study established the similar express opinion regarding relationship between Test Anxiety and the students' Academic Performance both Boys and Girls.

## Recommendation

Following are recommended:

- i. Teacher may adopt concept-based teaching to enable the students comprehend the concept rather than the rote memorization.
- ii. The college management may ensure the timely completion of the courses followed by revision and practical.

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# **Teachers' Perceptions Regarding Multi Grade Teaching and Its Impact on Students' Academic Performance at Primary Level in Khyber Pakhtunkhwa, Pakistan**

*(Ref No. ICETEMS-21-104)*

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## **Abstract**

Multi-grade teaching at primary level in Khyber Pakhtunkhwa is a broad area to research as it is a very old and traditional way of teaching as compared to the current advanced learning approaches with the help of ICT. The study was made to collect the perceptions regarding the multi-grade teaching at Primary level in Khyber Pakhtunkhwa, Pakistan. The population of the study were all teachers who teach in multi-grade schools at District Peshawar. There are 315 teachers teaching at multi-grade schools in Peshawar. 120 teachers were selected as sample using purposive sampling technique. Data from the respondents were collected using Likert scale. A questionnaire adapted from Shehzad (2016) that had 4 variables Curriculum (CUR), Instructional Strategies (IS), Instructional Materials (IM) and Teachers Training (TT) as independent variable and Students' Academic Performance (SAP) as dependent variable was distributed among the respondents after pilot study, establishing its reliability. After retrieving the data, SPSS 24 statistical tests of Reliability, Descriptive Statistics, One Sample t-test, Pearson Correlation and Regression Analysis were used to reach at conclusions. The result established that Curriculum, Instructional Strategies, Instructional Materials and Teachers Training have statistically significant effect on Students' Academic Performance. The study established the efficacy and usefulness of multi-grade teaching in specific environment. The research also recommends need for further research on the subject.

## **Keywords**

Multi Grade Teaching, Teacher's Perception, Student's Academic Performance

## **Introduction**

Multi-grade teaching in educational context refers to a teaching methodology where one teacher teaches all students of different ages and grades having different curriculum for every grade. Brunswick and Valerian (2004), defined multi grade teaching strategy where a teacher teaches different grades of pupils at a same time in a same classroom. Multi grade teaching has many reasons and motivations. (Kamal 2010). Many countries adopt multi grade teaching method due to varied circumstances as it become an imperative for them. Most of the countries struggled to achieve the desired goal of educating their peoples applying multi grade teaching method which is most suitable and easy way for a small population area. It specially suits for females in those areas where they have many hurdles to get education due to cultural and socio economic constraints. The main Millennium Development Goal (MDG) of the United Nation is to universalize the primary education for which this teaching methodology is very helpful (ibid). He went on to say that multi-grade teaching improves students' cognitive and non-cognitive abilities.

Multi-grade educating is viable during crisis and struggle regions around the world. The literacy rate of our country is very low as compared to most of our neighboring countries which is the main cause of terrorism and extremism. Less developed countries have poorest children who lack basic education. To improve the literacy rate Multi Grade teaching is a better technique used especially in rural areas. In this strategy one teacher will have to handle the students of more than one grade at one time having different curriculum. Worldwide about 30% of schools are using multi grade teaching strategy and in

South Africa this strategy is used in 50% of schools Gene (2005). Many European countries and America also use Multi Grade teaching strategy. It is a pedagogical technique to organize students in this strategy. In some of south Asian countries and other developed countries multi-grade teaching strategy is used as a significant teaching style. Multi-grade teaching is when a single teacher is responsible for several grades at the same time. It occurs in schools where there are more students than teachers. Some Multi-grade teachers can instruct students in two grades. (Brown, 2008). Teaching Multi-Grade classes is very challenging. Teachers complained of a lack of sufficient time in handling classes. In Africa, Turkey and Netherlands, Multi-Grade teachers experience challenges such as Transportation, illiteracy of parents, poor economic backgrounds, excessive effort of the teacher, lack of time, language problems and teacher challenges in the actual teaching and learning process (Condy & Blease, 2014; Engin, 2018).

Multi-grade instruction has a long history in China, and it is now required for the implementation of the nine-year compulsory education in remote and difficult areas. The number of school-aged children is declining in some areas as a result of rapid economic growth, rapid urbanization, and rural population migration. Furthermore, with the introduction of nine-year compulsory schooling, two school distributions were readjusted, i.e. smaller schools were consolidated into larger ones, and multi-grade instruction was reduced as a result. In these circumstances, China's growth and reform of multi-grade instruction faces a slew of new challenges, (Lanzhou, 2009). In rural and mountainous areas, multi-grade instruction has played an important role in encouraging primary schooling, rising enrollment, and preventing school dropout. The Chinese Communist Party and the government gradually shifted their attention to economic growth in the late 1970s, and governments at all levels, in order to encourage rural education, first restored the normal state of rural education and then made numerous efforts to increase the enrollment rate in rural schools. Multi-grade instruction schools and teaching spots were built in remote and mountainous areas for this purpose, and community-employed teachers were hired to teach multi-grade classes. Rural multi-grade schools in China used to educate 23% of all Chinese students, accounting for one-third of the country's population. When the enrollment rate had increased and the consolidation rate had reached the desired level, it was important to increase the admission rate to higher schools. Multi-grade teaching refers to the mix class of various grades in one classroom taught by one teacher. Typically, the problem is observed in the areas that are populated thin and governments are unable to run the schools at normal organizational pattern by applying one teacher one class. It is not always possible to post more teachers due to financial constraints. When a teacher is missing for one purpose or another and a replacement is not available, multiple class teaching can be used in large schools.

## **Statement of the Problem**

In public sector schools multi-grade teaching is a typical issue especially in rural areas of Pakistan. Due to lack of resources and facilities it is very necessary to adapt multi grade teaching method. Average class size of a single grade primary school is estimated to be in the region of 40 learners which is much higher in some rural area schools. Teaching two or more of these grades in one class can be a daunting experience. We do not know much or understand to any great extent the circumstances, situations, or factors that multi-grade teachers regard as challenging and/or beneficial to learning (and/or teaching) in multi-grades. Personal observation of teachers in multi-grades in the schools under investigation indicates that these teachers would rather not teach multi-grade classes. Although speculations can be made, the factors which prompt teachers to reach such decisions are unclear. This study is also an endeavor that may determine how multi-grade teaching is able to affect the learning of students at primary schools in Khyber Pakhtunkhwa, Pakistan.

## **The Study's Objectives**

- To investigate the effect of a multi-grade teaching methodology on students' academic performance.
- To determine the effect of Curriculum on Multi Grade teaching on Students' Academic Performance.

- To determine the impact of instructional strategies of teachers in multi grade teaching on students' Academic Performance.
- To evaluate the impact of instructional materials in multi grade teaching on students' Academic Performance.
- To determine the impact of teachers training for Multi Grade Teaching on students learning.

### ***Research Hypotheses***

Ho1: Multi-grade teaching does not affect students' academic performance.

Ho2: Curriculum has no impact in the course of multi-grade teaching on students' academic performance.

Ho3: Teaching Instructional Strategies of multi-grade teaching have no impact on students' academic performance.

Ho4: Instructional material for multi-grade teaching has no effect on students' academic performance.

Ho5: There is no impact of teachers training for multi grade teaching on students' academic performance.

### **Significance of the Study**

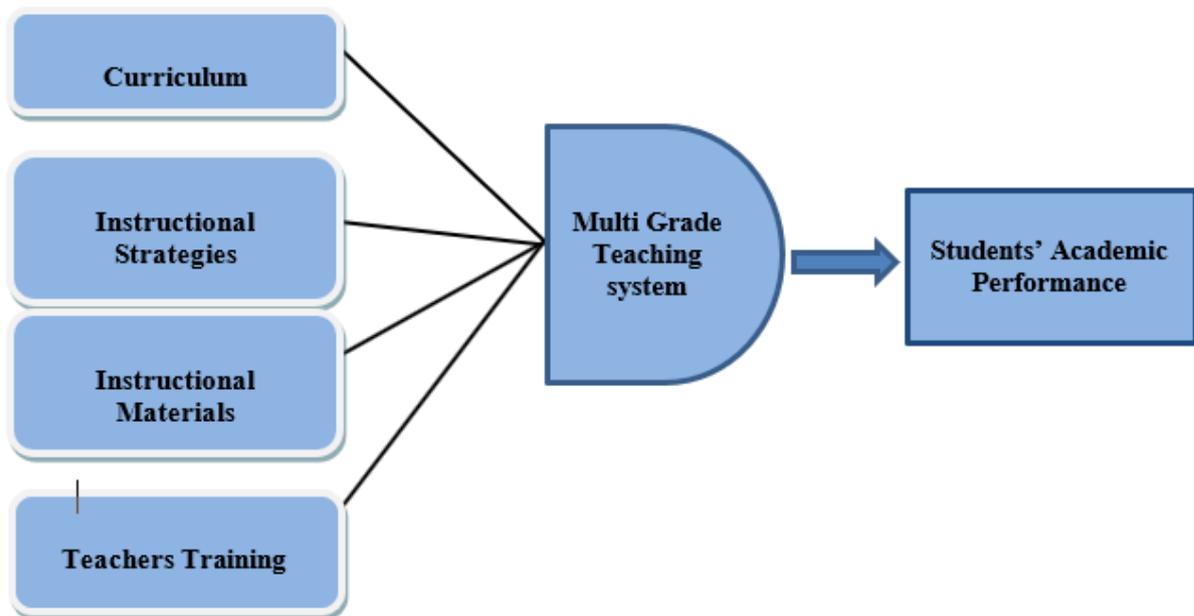
This study would be valuable for policy makers, administrators, curriculum developers, guardians of the students' and teachers. MGT Students can benefit from guidance in order to explain their own understanding. This research has the potential to increase the cognitive development and self-esteem of both younger and older students. In single grade classrooms, MGT is being experienced in "Buddy" activities, but in a multi grade classroom, MGT is being followed as a policy. The findings of this study would make a significant contribution to a greater understanding of the problems, difficulties, and challenges as well as benefits to learners and teachers of multi-grades. The Department of Education in the province may gain awareness of the needs of multi-grade teachers and classes, data from which can inform policy decisions especially regarding training and development of teachers. The findings of this study would motivate policymakers and curriculum developers to implement a special policy catering for teachers in multi-grade settings. The benefits of MGT teaching in multi-grade as well as the recommendations of tools to promote quality in teaching and learning in a multi-grade setting could influence practices at school level. Related issues such as adjustment of school curriculum, material resources, and separate in-service courses could be justified on this basis.

### ***Gestalt Theory***

The aim of this study's conceptual framework is to show how multi-grade teachers interpret the benefits and challenges of learning and teaching in multi-grade settings. The Gestalt theory offers a basis for interpreting perception (1912). The Gestalt concept outlines perception theories, perceptual experience, and perceptual experience calculation. Around the 1920s in Germany, the Gestalt theorists were the first group of psychologists to systematically research perceptual organization. Bowman and Brownell (2003) accept the Gestalt theorists' belief that everyone experiences life as a whole rather than in discrete parts. Objects were viewed within an environment according to all of their elements taken together as a global construct, according to early 20th century theorists such as Kurt Koffka (1921), Max Wertheimer (1922), and Wolfgang Kohler (1920). The environment in this study is a multi-grade setting, and the people who perceive the benefits and challenges of studying and teaching in multi-grade settings are multi-grade teachers. Gestalt proposes that the brain's operational philosophy is holistic, since it is the theory of mind and brain. This means Gestalt has proposed a systemic theory for comprehending human systems, such as how multi-grade teachers view their students. Gestalt, according to Max Wertheimer (1924), is perceptually primary, describing the parts of which it is made up, rather than being a separate product from the component parts. The Gestalt effect refers to our senses' ability to shape shapes, especially when it comes to visual recognition of entire forms rather than just a series of simple lines or curves. The aim of this Gestalt or "whole form" approach was to establish perception principles. To put it another way, Gestalt theorists describe how people interpret

objects. In this case, the environment is the multi-grade setting in which teachers work. What is emphasized here is that all that teachers see in a multi-grade environment is not seen in isolated pieces; rather, the process is seen as a whole.

### *Conceptual Framework*



## **Methodology**

This research was descriptive in nature. It followed the survey design using the questionnaire as research instrument. The research was based on quantitative approaches. A five-point Likert scale questionnaire was used. The research aimed at the determining the impact of multi-grade teaching method on the students' academic performance. The main independent variable was Multi Grade teaching. The sub variables included curriculum (CUR), Instructional Strategies (IS), use of Instructional Materials (IM), Teachers Training (TT) and Students' Academic Performance (SAP) was the dependent variable. The universe of population was all multi-grade teachers of Khyber Pakhtunkhwa. The study's target population included all teachers of multi grade schools in District Peshawar. There are 113 multi-grade primary schools in District Peshawar. The total number of teachers in these schools is 315 (EMIS Data 2020). Multi grade primary school is an innovation by the government to rationalize the provision of the teaching faculty to these schools with less population. A multi stage sampling technique was adopted. The total number of school following multi grade teaching system is 113. Out of these 113 schools, 40 schools were purposively selected keeping the convenience in mind. The number of sampled teachers was 120 teachers and they were selected randomly. A questionnaire developed and used by Shehzad (2016) was adapted for the collection of the quantitative data. On a five-point Likert scale, the responses solicited with the help of 5 point Likert's scale. The questionnaire consisted of 5 variables namely Curriculum (CUR) having 9 items, Instructional Strategies (IS) having 8 items, Instructional Material (IM) having 5 items, Teachers' Training (TT) having 5 items, and Students Academic Performance (SAP) having 5 items respectively was used for the purpose of collecting quantitative data. As the questionnaire was trailered to local conditions, it was deemed appropriate to referred its validity and reliability. The questionnaire was presented to 3 Ph. Ds who validated it on its face value and suggested minor changes. The questionnaire was then distributed among 20 teachers of multi-grade schools apart from sample. Test re test method was used that showed Cronbach's alpha in the range of .72 to .82. This range falls in good range. The quantitative data was processed through SPSS-24. Reliability Analysis, Descriptive Statistics, One Sample t-test, Pearson Correlation, and Regression Analysis were used to determine the influence of Multi-Grade Teaching on students' results.

### Reliability Analysis

The reliability values in terms of Cronbach's reliability co-efficient termed alpha are .70, .83, .74, .71 and .81 for variables Curriculum (CUR), Instructional Strategies (IS), Instructional Materials (IM), Teachers' Training (TT) and Students' Academic Performance (SAP) respectively. It can be deduced from above table that all values of alpha fall in the range of good. Hence, the data could be used for further statistical analysis.

### Regression Analysis for variable Multi-grade Teaching with Students' Academic Performance

#### Model Summary<sup>b</sup>

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	Change Statistics			Sig. F Change	Durbin-Watson
						F Change	df1	df2		
1	.578 <sup>a</sup>	.334	.328	.68450	.334	59.199	1	118	.000	2.481

a. Predictors: (Constant), MGT

b. Dependent Variable: SAP

#### ANOVA<sup>a</sup>

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	27.737	1	27.737	59.199	.000 <sup>b</sup>
	Residual	55.287	118	.469		
	Total	83.024	119			

a. Dependent Variable: SAP

b. Predictors: (Constant), MGT

Model		Unstandardized Coefficients		Coefficients <sup>a</sup>		95.0% Confidence Interval for B		
		B	Std. Error	Standardized Coefficients	t	Sig.	Lower Bound	Upper Bound
1	(Constant)	.474	.363		1.307	.194	-.244	1.192
	MGT	.844	.110	.578	7.694	.000	.627	1.061

a. Dependent Variable: SAP

Results show that R square value is .334, F change was estimated at 59.199 having significant value as 0.000. These statistics show that model is statistically fit. Following is detail of estimated values.

$R^2 = 0.334$        $R^2 \text{ adj} = .328$        $R^2 \text{ change} = .334$        $F = 59.199$

Significance = .000       $DW = 2.481$        $N = 120$

To find the effect of estimated regression analysis, we use following equation

$$Y = \beta_0 + \beta_1 X + e \quad \text{(i)}$$

$$\text{In our case } SAP = \beta_0 + \beta_1 \text{ MGT} + e \quad \text{(ii)}$$

Putting the values table 4.17 (c), the co-efficient

$$SAP = .474 + .578 \text{ MGT} + e \quad \text{(iii)}$$

$$= 1.307 \quad 7.694 \quad + e \quad \text{t-value}$$

$$.000 \quad .000 \quad + e$$

The above equation shows that predictor variable MGT (Multi-grade Teaching) has a positive effect on outcome variable SAP (Students' Academic Performance). The equation (iii) show that if predictor variable MGT (Multi-grade Teaching) is increased by .578 points it yielded 1-unit increase in outcome variable SAP (Students' Academic Performance). Hence, on the basis of the above results we reject "Ho1: There is no impact of Multi Grade Teaching on students' Academic Performance".

## Findings

The results of Pearson's Correlation test show that majority of respondent were in agreement for the questions asked for variable Curriculum (CUR), Instructional Materials (IM), Instructional Strategies (IS), Teachers' Training (TT) and Multi Grade Teaching (MGT) method having positive affect on Students' Academic Performance.

## Conclusions

The results of Regression analysis confirmed that curriculum (CUR), Instructional Strategies (IS), Instructional Materials (IM), Teachers' Training (TT) and Multi Grade Teaching (MGT) had positive effect on Students' Academic Performance, and we reject the entire hypothesis that Multi Grade Teaching, Curriculum, Instructional Strategies, Instructional Materials and Teachers' Training had no impact on Students' Academic Performance.

## Recommendations

1. The study has confirmed that Multi-grade teaching method is highly effective in improving students' academic performance therefore, it is recommended that multi-grade teaching method may be considered as an option besides other modern method of teaching.
2. The study has confirmed that multi grade teaching method is highly economical therefore is recommended that multi grade teaching system may be applied where the human resource constraints are experienced specially in core subjects.
3. The related literature and government policies have confirmed that the multi grade teaching methodologies has not been recognised as such therefore it is recommended that multi grade teaching methodology may be made integral part of the curriculum for teachers training.
4. The Multi- Grade teaching methodology may be used where the economy/deficiency of teachers arise as an option.

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## **Correlation between Principals' Leadership Styles and Teachers' Perception Regarding their Conflict Resolution Strategies at Secondary Level in Khyber Pakhtunkhwa**

(Ref No. ICETEMS-21-106)

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### **Abstract**

The present study was conducted to determine the relationship between Principals' Leadership Styles and their choice of Conflict Resolution Strategies as perceived by teachers. The target population of the study comprised all the secondary school teachers in District Peshawar. The sample consisted of 240 secondary school teachers both public and private sector male and female teachers. The perception of the teachers was solicited through an adapted 5 point Likert's Scale questionnaires adapted from Mugenda Mugenda (2003) for Principals' Leadership Styles and Kombo & Tromp, 2006 for Conflict Resolution Strategies, respectively. The data so collected were processed through Statistical Package for Social Sciences version 26. The data was analyzed applying various statistical tools such as Reliability, Descriptive Statistics, Frequencies, Pearson's Correlation analysis and Independent Sample t-test. The findings of the study confirmed the positive and significant correlation between the independent variable i.e. Principals' Leadership Styles and dependent variable, their choice of Conflict Resolution Strategies. The independent variables included; Transactional, Transformational and Laissez-faire and dependent variables included; Integrated, Obliging, Dominating, Avoidance and Compromising. The study established significant relationship between various Leadership Styles and Conflict Resolution Strategies. The study did not find any significant difference in the perception of public, private and male, female respondents regarding the Principals' Leadership Styles and their Conflict Resolution Strategies. The study suggested that the Principals should adopt the conflict Resolution Strategies according to their Leadership Style depending on demand of the situation.

### **Keywords**

Transactional Leadership Style, Transformational Leadership Style, Laissez-Faire Leadership Style, Conflict Resolution Strategies

### **Background of the Study**

Leadership may be defined in many ways depending on the different situations. Leadership style normally refers to pursue directly and influence a person to manipulate in a given direction. Principals' leadership in school is primarily related to the processes and procedures for channelizing, directing the teachers, students and management personnel towards achieving the educational objectives. The principal has to lead and manage all aspects of school life aiming at improvement of the standards and performance of students. The success of any institute hinges upon its leadership and involvement of all stakeholder. Schools are the important agencies of the society responsible for the development of next generation to meet the challenges of modern life. Educational leadership is no exception to the concept of leadership in other organizations, where the leaders face the challenges in meeting the goals of their institutions. The primary role the education leader is to provide quality education to address the needs of the society (Lunenburg, 2013).

Conflicts do arise in any organization therefore the leaders resolve the issues applying various strategies Ahmed, (2015). Difference of opinion and choices give rise to conflicts among the human beings. To resolve these differences the society develops its norms, customs, traditions, rules regulations and laws.

Disputes in any organization may arise between the management and employees. The executive head of the organization influence, direct and peruse his/her subordinates to settle their disputes or conflicts by applying varies conflict resolution strategies. According to Ahmed (2015), Leaders spend 20% of their time to resolve conflicts arising between the management and the employees. Boucher, (2013), considers that effective leaders resolve the conflicts amicably rather than enforcing the rules and regulations. Fink & Brunner, (2011), consider individual insisting achieving a status value, a position and a role which draws apposition in a group among different individuals. (Yasin & Khalid, 2015). Historically the conflict existed in educational institutions even in Greek era Alzahrani (2013), conflicts in any institution are considered as counterproductive leading to job dissatisfaction quitting or leaving the job lack of commitment, absenteeism and violence. This mind set has undergone a lot of sublimation and now conflict is considered as a useful occurrence in an institution. If handled properly it promotes creativity, innovation, quality of decision making an allegiance to the organization. Chan & Huang, (2010).

### ***Statement of the Problem***

The study aims at finding the relationship between the principals' leadership styles and their conflict resolution strategies as perceive by teachers at secondary level in Khyber PakhtunKhwa. In order to find gap and discrepancies resulting in the inefficiency of the schools, the study is aimed to develop strategies for the affective conflict resolution.

### ***Research Questions***

The following questions have been addressed by the study;

- 1 Does the principal's Transformational Leadership Style correlate with his choice of conflict resolution strategy?
- 2 Does the principal's Transactional Leadership Style correlate with his choice of conflict resolution strategy?
- 3 Does the Laissez faire Leadership Style of the principal correlate with his choice of conflict resolution strategy?
- 4 How do the male and female teachers differ in their perception regarding the principal's leadership styles and his choice of conflict resolution strategies?
- 5 How do the public and private school teachers differ in their perceptions regarding the relationship of principal's leadership styles and his choice of conflict resolution strategies?

### **Objectives of the study**

The study aimed at following objectives:

- 1 To determine the principal's transformational leadership style and teachers perception regarding his choice of conflict resolution strategy.
- 2 To examine the principal's transactional leadership style and the perception of teachers regarding his choice of conflict resolution strategy.
- 3 To evaluate the principal's laissez faire leadership style and the perception of teachers regarding his choice of conflict resolution strategy.
- 4 To explore the difference between male and female teachers perceptions regarding principals' leadership style and their conflict resolution strategies.
- 5 To assess the difference in the perception of public and private schools teachers regarding the principal's leadership style and their choice of conflict resolution strategies.

## *Hypotheses*

The study tested the following hypotheses:

**H<sub>0</sub>1.** There is no correlation between the Principals' Transformational leadership style and their choice of conflict resolution strategies.

**H<sub>0</sub>2.** There is no correlation between Principals' Transactional leadership style and their choice of conflict resolution strategies.

**H<sub>0</sub>3.** The Principals' Laissez Faire leadership style is not correlated with their choice of conflict resolution strategies.

**H<sub>0</sub>4.** Male and female teachers don't differ in their perception regarding the principals' leadership styles and their choice of conflict resolution strategies.

**H<sub>0</sub>5.** There is no difference between the perceptions of the public and private schools teachers regarding the principals' leadership styles and their choice of conflict resolution strategies.

## *Theoretical frame work of the study*

There are various leadership theories explaining different leadership styles. These theories are characterized into four main areas: Behavioral, Situational, Trait and Charismatic. Besides, Transformational Transactional and laissez faire leadership styles also prevail among the leaders at different levels. Transformational leadership is a course whereby front-runners and the subordinates reinforce each other to the upper level of morality, ethics and inspiration. The schools are highly influenced by the societal complexities therefore the school principal as a leader needs to realign himself according to the changes occurring in the society. Rowold and Schlotz (2009). Consider transformational leaders (the principals) should possess capabilities like team based, strong communicators, team players, problem solvers and change-agents. Many studies have indicated positive correlation between the transformational leadership style of the principal and the teacher performance. A transformational leadership is expected to prepare the team leaders for a change and improvement. Transformational leadership while assessing the motives of the subordinates and fulfilling their needs, value their opinions as well. This leaderships styles stands for inculcation of commitments, improvement in the capacity and devotion among the subordinates in meeting the organizational goals.

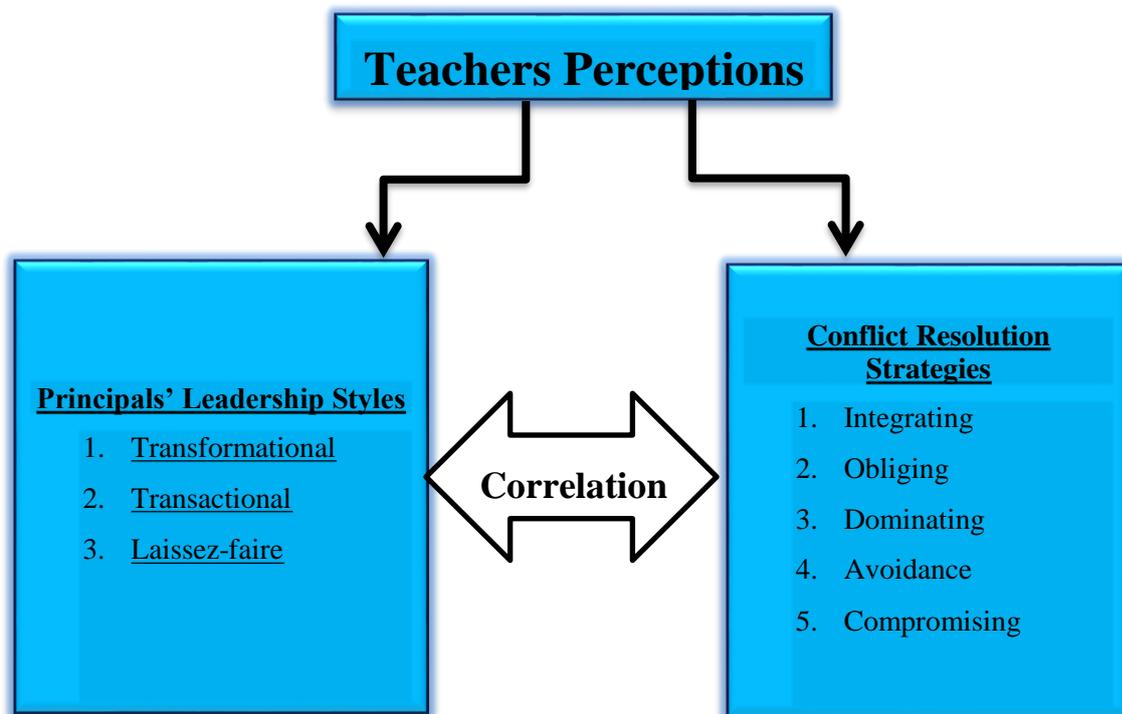
There are four important aspects of transactional leadership style including consideration, inspirational motivational and intellectual stimulation. Intellectual stimulation arises when the principals makes his subordinates aware of the challenges and face the situations from different angles. (Burns, 2001). Kemp and Nathan (1989) categorized leadership styles as Democratic, Authoritarian and laissez-faire. The authoritarian leadership style is used when leaders without consulting his/her subordinates tell them what he wants to be done. This style creates antagonistic feeling among the subordinates and ultimately results in conflicts. Primarily democratic leadership style is consultative where the team is involved in decision making. Various researchers have established a strong association between the principals' leadership styles and his school (Hallinger & Bickman, 1996). Liu (2005) indicated the transactional leadership has been more successful in most of the cases including Pakistan. However the laissez-faire leadership style has been labeled as the least effective leadership style. The transformational leadership has been found to encourage satisfaction willingness to have extra efforts among the teachers. To conclude thus leadership in the educational institutional level is a self-motivated process where the principal is not only responsible for his teamwork but also actively requires the willing cooperation of his/her group members.

Cole, (2002) described educational leadership as a dynamic process whereby the principal is responsible to meet the institutional goals and get the willing cooperation of the team members in attaining these goals. Educational leadership pursue productive performance in schools in two ways: examines the assigned goals to be accomplished by the team members and secondly providing reinforcements/recognitions like rewards, promotions and appreciations etc.

Transformational leadership style encourages the team workers while assessing their motives, fulfilling their need and valuing their opinion. It promotes the leaders ability to increase teams commitment, aptitude and involvement in achieving institutional goals.

**Conceptual framework**

The principals’ leadership styles mentioned earlier serve as Independent Variable whereas the conflict resolution strategies of principals remain as explanatory variables. The study is aimed to explore the teacher’s perceptions regarding the principal’s leadership styles and his priorities of conflict resolution strategies. The study also determined the correlation between the principal’s leadership style and his choice of conflict resolution strategies. The study assessed the degree and significance of relationship of principal leadership styles and his conflict management strategies.



**Figure-2.3 Conceptual framework**

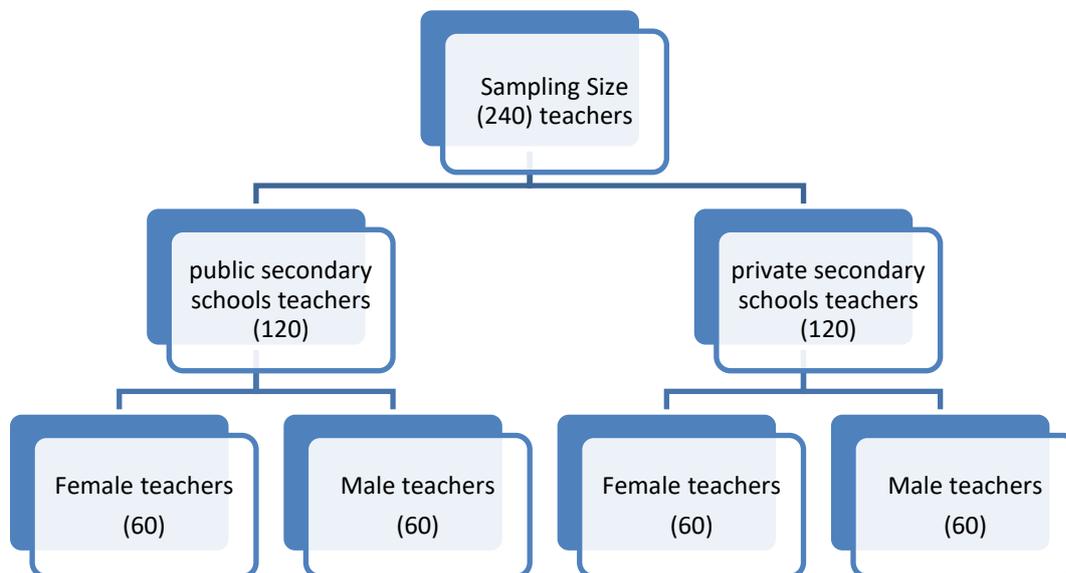
This conceptual model illustrates the schematic correlation between the principals’ leadership style and their choice of conflict resolution strategies as perceived by teachers. On the left hand block it highlights the leadership styles of the principals prevalent in schools and in the opposite block the conflict resolution strategies are noted. The both way arrow shows the correlation between leadership styles and conflict resolution strategies employed by principals. In the present study the principals’ leadership styles are independent variable and whereas the conflict resolution strategies are dependent variables. The above model was designed Based on literature review and Theories of leadership styles and conflict resolution strategies.

**Design of the Study**

Design of the study was descriptive where survey method was used for the data collection. A questionnaire was adapted to solicit the expressed opinion of the respondents on 5 point Lickert Scale. The main independent variable of the study was Principal’s Leadership Styles having sub variables; Transformational, Transactional and Laissez-Faire. Conflict Resolution Strategies was dependent variables with sub variables Integrating, Obliging, Dominating, Avoidance and compromising.

### **Population**

Population of the study comprised all the teachers of public and private secondary school both boys and girls in Khyber Pukhtonkhwa. The sample of the study comprised 240 teachers as per the following figure.



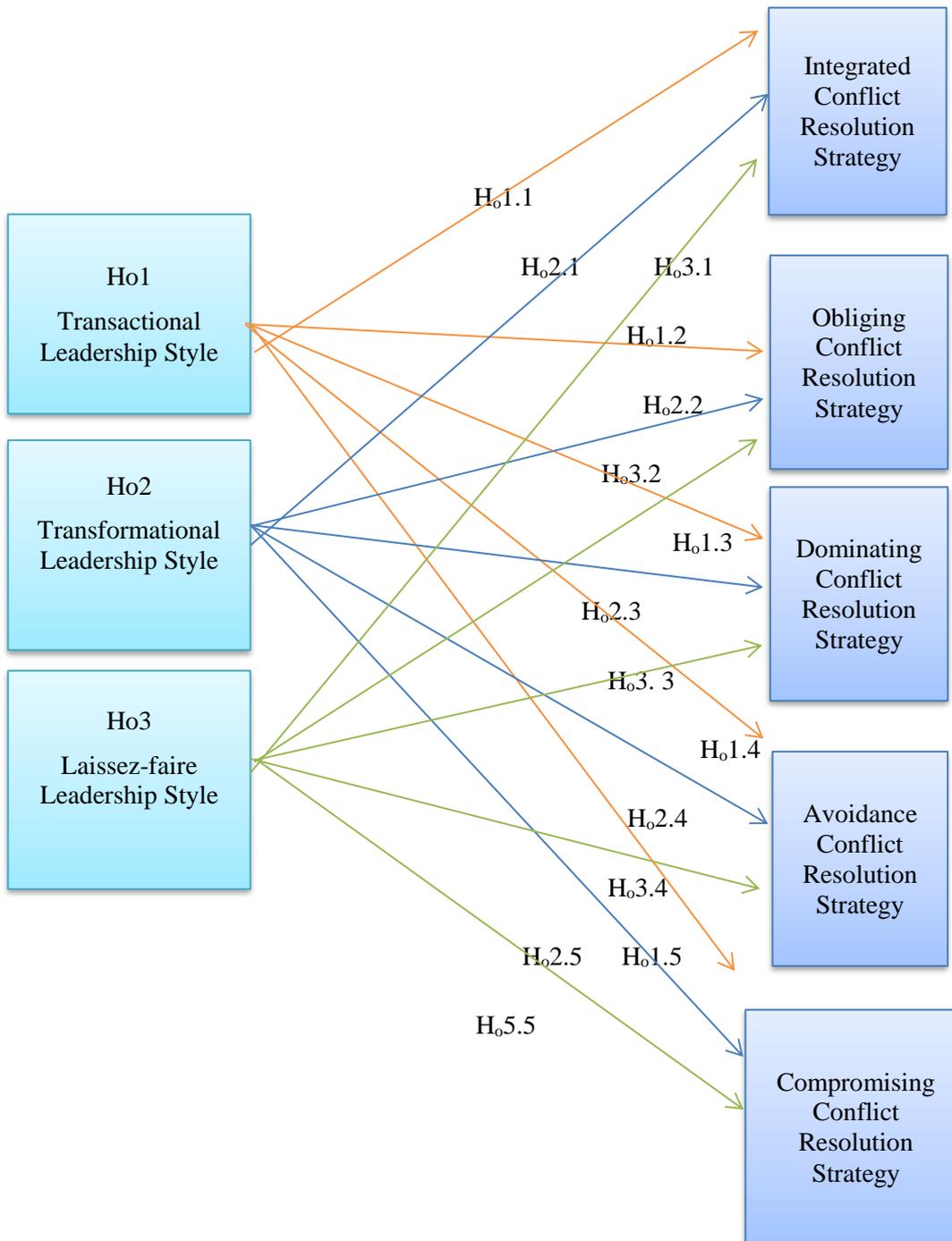
### **Research Instrument**

Two research instruments were adapted for data collection. For Conflict Resolution strategies the instrument formulated and used by Kombo & Tromp, (2006) was adapted whereas for leadership styles an instrument used by Mugenda and Mugenda (2003) was used. The former questionnaire relates to variables of conflict resolution strategies; Integrating Conflict Resolution strategy (ICR), Obliging Conflict Resolution strategy (OCR), Dominating Conflict Resolution strategy (DCR), Avoidance Conflict Resolution strategy (ACR) and Compromising Conflict Resolution strategy (CCR) whereas the later pertains to Transformational Leadership Style (TLS), Transactional Leadership Style (TrLS) and Laissez-faire Leadership style (LFLS).

### **Data Analysis**

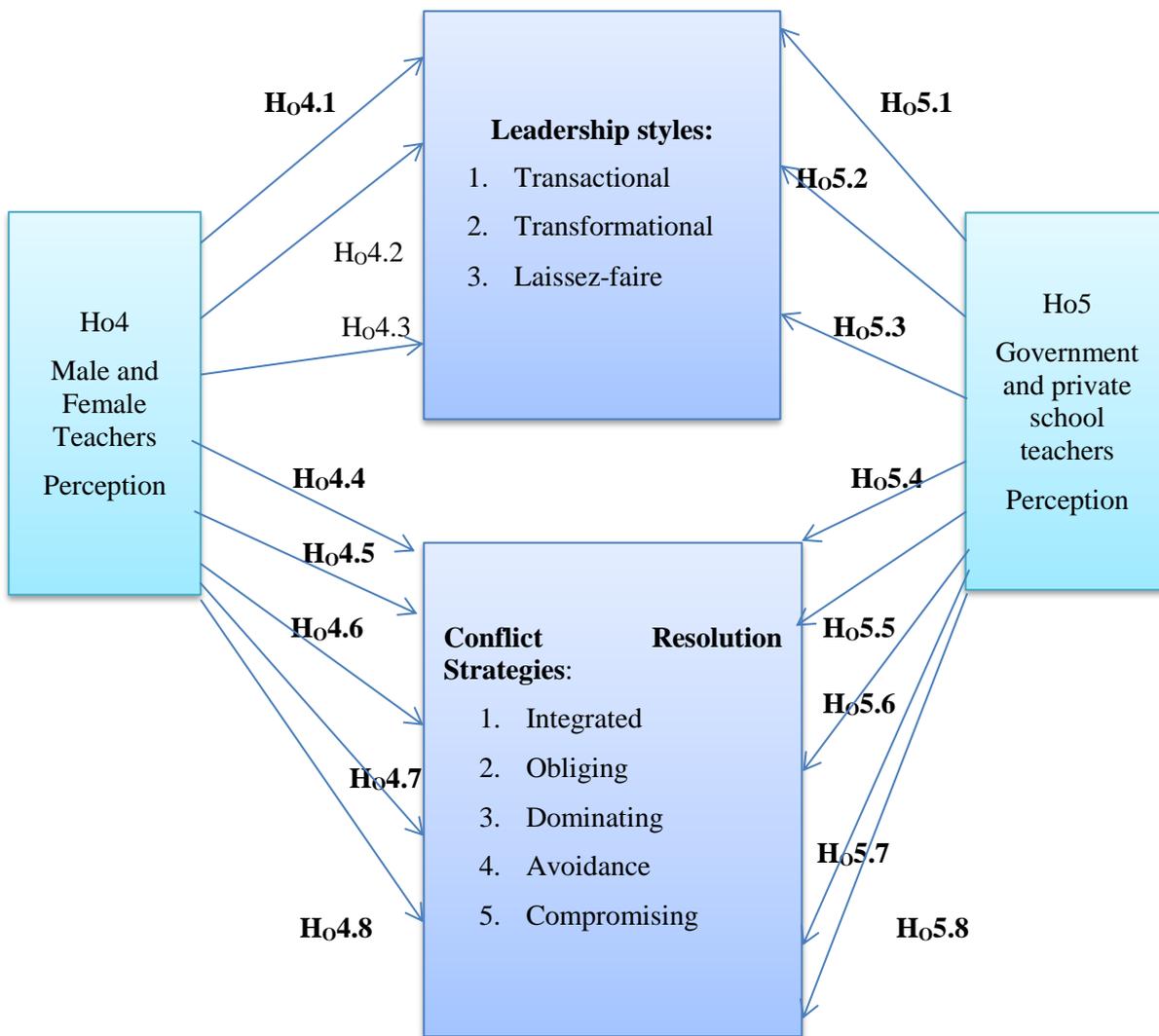
The collected data was tabulated, characterized and processed through SPSS version 26. Various statistical tools like Frequency Analysis, Reliability test, Descriptive Statistics, One Sample t-test, Pearson Correlation and Independent Sample t-test were applied. The confidence interval for the whole data was tabulated at 95% and the significance value i-e Alpha was set as .05.

The first three null hypotheses were tested and analyzed on statistical tool i-e Pearson's Correlation Analysis. The responses of the respondents were based on five (5) facets of strategies of conflict resolution strategies and three (3) facets of variable of principal leadership styles, each variable of leadership style was tested with every 5 conflict resolution strategies for that purpose 5 sub-hypothesis were designed by the researcher, for each Principal's Leadership Style, that were illustrated in the following figure number 3.2



**Figure-3.2 Sub hypotheses of leadership styles**

The null hypothesis fourth and fifth were tested and analyzed on Independent Sample t-test. The responses of the two groups (gender and sector) were based on five (5) facets of strategies of conflict resolution strategies and three (3) facets of variable of principal leadership styles, each group was tested with every 3 leadership styles and 5 conflict resolution strategies for that purpose 8 sub-hypothesis were designed by the researcher, that are illustrated in the following figure number 3.3.



**Figure- 3.3 Sub hypotheses of Conflict Resolution Strategies**

## Results

The result of Pearson's's Correlation Analysis between Integrated Conflict Resolution Strategy with Transformational Leadership Style indicates statistically significant and moderate correlation amid the two variables. The result of Pearson's's Correlation Analysis between Obliging Conflict Resolution Strategy with Transformational Leadership Style indicated statistically significant but weak relationship amid the aforesaid variables. The result of Pearson's's Correlation between Dominating Conflict Resolution Strategy with Transformational Leadership Style indicated statistically insignificant but the relationship is weak between the two variables.

The result of Pearson's's Correlation Analysis between Avoidance Conflict Resolution Strategy with Transformational Leadership Style indicated statistically insignificant but the relationship is moderate between the two variables. The result of Pearson's's Correlation Analysis between Compromising Conflict Resolution Strategy with Transformational Leadership Style Indicated a moderate correlation amid two variables having statistical significance,

The result of Pearson's correlation between Integrated Conflict Resolution Strategy with Transactional Leadership Style Indicated statistically significant and the relationship is strong between the two variables. The result of Pearson's correlation between Obliging Conflict Resolution Strategy with Transactional Leadership Style Indicated statistically significant but the relationship is moderate between the two variables. The result of Pearson's correlation between Dominating Conflict Resolution Strategy with Transactional Leadership Style Indicated statistically insignificant and the relationship is weak between the two variables.

The result of Pearson's correlation between Avoidance Conflict Resolution Strategy with Transactional Leadership Style indicated statistically significant but the relationship is moderate between the two variables. The result of Pearson's correlation between Compromising Conflict Resolution Strategy with Transactional Leadership Style Indicated statistically significant but the relationship is moderate between the two variables. The result of Pearson's correlation between Integrated Conflict Resolution Strategy with Laissez-faire Leadership Style Indicated statistically significant but the relationship is moderate between the two variables. The result of Pearson's correlation between Obliging Conflict Resolution Strategy with Laissez-faire Leadership Style Indicated statistically significant strong correlation between the two variables.

The result of Pearson's correlation between Dominating Conflict Resolution Strategy with Laissez-faire Leadership Style Indicated statistically insignificant and the relationship is weak between the two variables. The result of Pearson's correlation between Avoidance Conflict Resolution Strategy with Laissez-faire Leadership Style Indicated statistically significant but the relationship is moderate between the two variables. The result of Pearson's correlation between Compromising Conflict Resolution Strategy with Laissez-faire Leadership Style Indicated statistically significant but moderate relationship between the two variables.

Independent Sample t-test for Integrated Conflict Resolution Strategy showed  $F = .040$  at  $p = 0.842$  suggesting that  $F$  is insignificant suggesting that variances are equal. The test estimates mean value of male respondents as 3.5617 against the same value of female respondents as 3.5367. It suggests there exists a difference of opinion between male and female teacher respondent to the question asked in the range of .02500 but it is insignificant to be counted. The results of Independent sample t-test for Obliging Conflict Resolution Strategy showed  $F = .164$  at  $p = 0.686$  suggesting that  $F$  is insignificant suggesting that the variances are equal. These results estimated mean value for the responses of male teachers as 3.2850 in contrast to their female counterpart's 3.3967 having difference as -.11167 estimating no difference of opinion between the two groups in sample. Independent sample t-test for Dominating Conflict Resolution Strategy showed  $F = .002$  at  $p = 0.969$  suggesting that  $F$  is insignificant that the variances are equal. The outcomes of the test show mean of male teacher's responses as 3.2383 and female teacher's as 3.2367 showing a difference of .00167. This difference of opinion is meager and it indicate same opinion among male and female respondents to the variable in question.

The results of Independent sample t-test for Avoidance Conflict Resolution Strategy showed  $F = .285$  at  $p = 0.594$  suggesting that  $F$  is insignificant suggesting that the variances are equal. According to the results, the mean of male teachers' responses was recorded as 2.8817 against the female teachers' 2.8750 showing a difference of .00667. This difference is not that significant to count. The outcomes of Independent Sample t-test for Compromising Conflict Resolution Strategy showed  $F = .061$  at  $p = 0.805$  suggesting that  $F$  is insignificant suggesting that the variances are equal. The estimates showed mean of the responses by the male teachers as 2.6733 against the mean of female teacher' 2.6633 having a difference of .01000. as the difference between the male and female teachers mean values of responses is significantly low, it shows no difference among the majority of both respondents to the question asked.

The estimates of Independent Sample t-test for Transformational Leadership Style showed  $F = 1.635$  at  $p = 0.202$  suggesting that  $F$  is insignificant suggesting that the variances are equal. The test estimated mean values of male and female respondent teachers as 2.9650 and 2.8492 respectively indicating a thin difference of .11583. These statistics indicate that majority of the respondents from both groups have same opinion towards the variable in question. The outcomes of Independent Sample t-test for Transactional Leadership Style showed  $F = .498$  at  $p = 0.481$  suggesting that  $F$  is insignificant

suggesting that the variances are equal. The mean value of male and female teacher respondents were calculated as 3.3736 and 3.3278 respectively. It suggests that both male and female respondent teachers have same opinion regarding the variable of interest having mean difference of opinion as 0.04583.

The results of Independent sample t-test for Laissez-faire Leadership Style showed  $F = .007$  at  $p = 0.932$  suggesting that  $F$  is insignificant suggesting that the variances are equal. According to estimates, the mean value for responses of male and female teacher respondents is 2.6391 and 2.6186 having a difference of .02051. the difference between the two means of responses is too low and hence it shows a same opinion between the two groups of sample as same. The results of Independent sample t-test for Integrated Conflict Resolution Strategy showed  $F = 1.266$  at  $p = .262$  suggesting that  $F$  is insignificant suggesting that the variances are equal. Mean of Govt. respondents as 3.5200 and Private respondents is 3.5783 that suggests both the male and female teachers of public and private sector share same opinion among them regarding the variable in question as the difference in their mean of responses is -.05833. The results of Independent sample t-test for Obliging Conflict Resolution Strategy showed  $F = 2.489$  at  $p = .116$  suggesting that  $F$  is insignificant suggesting that the variances are equal. Mean of Govt. respondents as 3.2517 and Private respondents is 3.4300 having a difference of -.0583 that suggest that both the male and female teacher respondents from public and private sector share same opinion regarding the variable as the difference is quite measure to count.

Independent Sample t-test outcomes for Dominating Conflict Resolution Strategy showed  $F = .147$  at  $p = .702$  suggesting that  $F$  is insignificant suggesting that the variances are equal. mean of Govt. respondents as 3.2400 and Private respondents is 3.2350 showing a difference of .00500 that suggests it to be nominal. The results conclude that both the respondent male and female teachers belonging to public and private sectors have same opinion regarding the variable in question. Independent sample t-test for Avoidance Conflict Resolution Strategy showed  $F = .014$  at  $p = .904$  suggesting that  $F$  is insignificant suggesting that the variances are equal. While calculating means of respondents, the test estimated that male and female respondent teachers from public and private sectors had mean of 2.9250 and 2.8317 respectively and the difference was calculated as .09333. The statistics estimate that there is no difference of opinion among the male and female teachers of both public and private sector schools towards the variable in question.

The results of Independent sample t-test for Compromising Conflict Resolution Strategy showed  $F = .425$  at  $p = .515$  suggesting that  $F$  is insignificant suggesting that the variances are equal. The mean values of male and female respondents were calculated as 2.6867 and 2.6500 indicating a difference of .3667. this difference in opinion among the teachers of public and private sector male and female teacher is insignificant showing that both have same opinion regarding the variable in question. Independent sample t-test for Transformational Leadership Style showed  $F = .160$  at  $p = .686$  suggesting that  $F$  is insignificant suggesting that the variances are equal. The tests calculated means of male and female respondents of both public and private sector teacher as 2.9175 and 2.8967 having a difference of .02083. The difference in means is not significant and it shows equality of opinion among the male and female teachers of both public and private sector school teachers towards the questions asked.

The results of Independent sample t-test for Transactional Leadership Style showed  $F = .341$  at  $p = .560$  suggesting that  $F$  is insignificant suggesting that the variances are equal. Mean of Govt. respondents as 3.3389 and Private respondents is 3.3625 showing a difference of -.02361 and this difference is not significant, The results estimates an equal level of responses by the male and female teachers of both the public sector and private sector teachers towards the question asked. The results of Independent sample t-test for Laissez-faire Leadership Style showed  $F = 1.714$  at  $p = .192$  suggesting that  $F$  is insignificant suggesting that the variances are equal. Mean of Govt. respondents as 2.6891 and Private respondents is 2.12051 that suggest a difference of .12051 and this difference is statistically insignificant. Thus it is shows that teachers of both groups male and female and public and private sector have no difference of opinion towards the variable in question.

## Conclusions

The finding derived from the statistical analysis established that there is an association between Principal's Transformational Leadership Style and his choice of conflict resolution strategies. The study

confirmed that Integrated, Avoidance and Compromising Conflict Resolution Strategies exhibit moderate relationship while Obliging and Dominating Conflict Resolution Strategy exhibited weak relationship. The study concluded that relationship exhibited based on teachers' perceptions that Principals followed Transformational Leadership Style and had strong negative relationship with Obliging and Dominating Conflict Resolution Strategies.

The study concluded that there is a relationship between the Principals Transactional Leadership Style and five conflict resolution strategies. It further established that the Integrated Conflict Resolution Strategy has strong relationship while Obliging, Avoidance and Compromising Conflict Resolution Strategies exhibited moderate relationship and Dominating Conflict Resolution Strategy exhibited weak relationship with Principals Transactional Leadership Style. The study concluded that a significant relationship exists between Transactional Leadership Style and Integrated Conflict Resolution Strategy, while the Dominating Conflict Resolution Strategy had negative relationship.

The study also confirmed that the Principals Laissez-faire Leadership Style has an association with five conflict resolution strategies. The Obliging Conflict Resolution Strategy exhibited strong relationship, Integrated, Avoidance and Compromising Conflict Resolution Strategy exhibited moderate relationship while Dominating Conflict Resolution Strategy exhibited weak relationship.

The findings of the statistical analyses also estimated that there is practically no difference in opinion among the male and female teacher regarding the correlation between leadership style and conflict resolution strategies across the public and private sector educational institutions.

## Recommendations

- 1 After examining the findings and conclusions of the study it was found that the teachers are well aware of the principals' leadership styles and their choice of conflict resolution strategies however the study found some grey areas where the teachers lacked clear perception regarding the phenomenon because of the crisscrossing nature of principals leadership style and conflict resolution strategies therefore it is suggested that the teachers may be put through workshop on the subject.
- 2 The principals of the government and private secondary schools lack educational leadership which leads to 'Crises of Leadership in Education'. In government secondary schools the principals are mostly appointed / promoted on the basis of seniority almost having no technical and management skills. Therefore it is recommended that the principals may be given adequate training regarding educational management and leadership.
- 3 The study examined all the three important leadership styles and choices of conflict resolution strategies and found that the principals' has different choices regardless of their leadership style. Therefore it is recommended that the principals may be imparted instructions and trainings to have broader view of the phenomenon. It has been observed that leaders opt for their choice of conflict resolution strategy based on the situation in which they are at that particular moment, so it is the personal judgment of the principal based on his previous experience which matters.

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**ENGINEERING  
&  
TECHNOLOGY**

# Experimentally Study on Confinement Effect and Efficiency of Concentrically Loaded RACFST

(Ref No. ICETEMS-21-009)

Names Missing

## Abstract

Recycled aggregates concrete (RAC) is an environmentally friendly building material. Past research indicates that recycled aggregate concrete (RAC) could be successfully used in concrete-filled steel tubular (CFST) columns. This paper investigates the mechanical behavior of recycled aggregate concrete-filled steel tubes (RACFST). Specimens were designed and tested, under axial compression to obtain failure modes, failure loading, and curves on loading deformation and loading strain. Two factors were considered in the experiment which were recycled aggregates replacement percentages (0%, 50%, 70%, 90%, and 100%) and eccentricity in an effort to analyze consequences on mechanical property. The result shows improvement in the recycled aggregates steel tubes as compared to the natural aggregates steel tubes in aspects of bearing capacity, failure modes, deformation features, and strain distribution in section, particular attention should be given to the application of recycled aggregate concrete in actual structures.

## Keywords

Steel tubular tubes, ductility, load-deformation relationship, recycle aggregates.

## Introduction

Recycle aggregates concrete (RAC) is a type of concrete material that is made from recycled concrete aggregate (RAC) obtained from waste concrete by cleaning, crushing and grading [1, 2]. RAC not only reduce the demand of the natural aggregates but also it reduces the environmental pollution caused by the construction waste [3]. RAC produced with the amalgamation of recycled aggregate from wasted concrete is widely recognized as green concrete. RAC method is an effective way to reduce construction wastes and to protect the natural resources. But there are some drawbacks of RAC such as it has low strength and elastic modulus [4], creep and high shrinkage [5, 6].

Over the past few decades, human awareness has been strengthened by the global climate changes resulting from the solid waste disposal, rapid expansion of industry and infrastructure and greenhouse emission etc. Carbon dioxide (CO<sub>2</sub>) has become a major target for all human and a key of the sustainable growth, to reuse solid waste and control the greenhouse gas emissions. Therefore, in infrastructure constructions besides smart styles and using of latest technologies, the “Low carbon” concept should be taken into account. As a binder material ordinary Portland cement is used as a concrete customarily. However, the ordinary Portland cement manufactory is a highly energy consuming process in result of releasing 10% of CO<sub>2</sub> [15]

The usage of recycle aggregates has been widely used by the researchers but working on steel tubes is less studied and in the focus of our study. Recycle aggregates has been used in steel tube by improvising the wastes. Concrete filled tubes are well recognized and widely applied for composite actions, with the advantage of both steel tube and infilled materials. In the past many types of material were encased in the steel tubes by considering environmentally friendly materials in order to control the pollutions and energy consumption, for example steel tubes with RAC [8-12] involving the reuse of the waste cement and concrete, self-settling concrete with vibrations effects for energy saving and constructions [13-14]. Also, by enhancing the tensile strength and adhesion capacity, lower weight and shrinkage as well as improving the ductility. Few studies have been done on the recycle aggregates concrete fill steel tubes has been done.

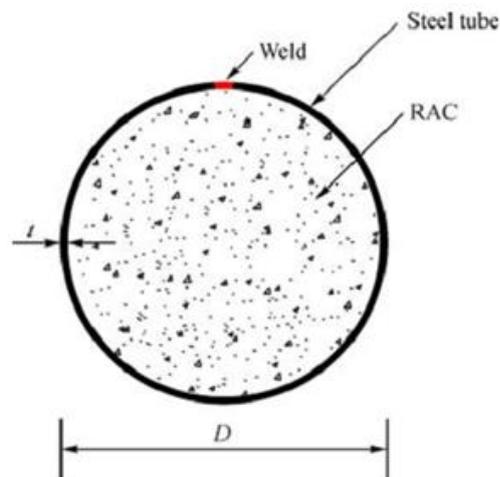
Nowadays, concrete-filled steel tubes (CFST) are widely applied as for their excellence performance properties such as high strength and high stiffness. When the concrete is confined by the steel tubes as they have no moisture exchange with the outside environment and its creep and shrinkage properties

can be therefore smaller as those of ordinary concrete. Concrete confinement can also restrict the extension of internal micro cracks, which in results improve the compressive strength and the deformation performance of the core concrete. Confinement of concrete by steel tubes also seems to be a way to improve RAC strength and stiffness.

In recent years, number of studies were carried out on RACFST tubes to improve the recycled aggregates concrete (RAC) strength, stiffness and to reduce its creep and shrinkage properties. In 2005, the mechanical properties of recycled aggregate concrete with different coarse aggregates replacement ratio were studied by the Xiao et al. and the results showed that the peak strain of RAC is higher than that of the normal concrete. When RAC replacement percentage equals 100%, the peak strain was increased by the 20%. In 2007, Evangelista et al. studied that the replacement rate of fine aggregates up to 30% is safe and reliable. To this end some scholars studied the different confining effects between concrete and steel or other materials. Because of its excellent machinal properties and environment friendliness, (RACFST) tubes has become an active research topic globally. These studies have focused on the mechanical properties of (RACFST) tubes using different percentage of recycle aggregates. Based on the above literature with the limited studies investigating the behavior of RACFST tubes, this paper investigates the behavior of RACFST tubes with different variables on recycled aggregates replacement ratios under axial loads.

### ***Experimental investigation***

Main parameters in this study is recycled coarse aggregates replacement ratio, (50%, 70%, 90% and 100%). A total number of 21 circular tubes were investigated in this study. Figure (1) (a) shows the cross section of the specimens, where  $D$  is the outside diameter of the circular tube and  $t$  is the tube thickness. All the specimens have identical heights  $L$



**Figure 1 Cross section of the specimens**

A steel plate was used to produce the tubes by welding and machining. Cement used was ordinary Portland cement, natural aggregate was commercially available while the recycled was collected from the waste and demolished structures which were then cleaned and grind. Table 1 provides the details of the specimens of natural and recycled aggregates. 7, 14 and 28 days of testing were performed.

**Table 1: Details of specimens**

<b>Label</b>	<b>Confinement details</b>	<b>D (mm)</b>	<b>T (mm)</b>	<b>L (mm)</b>	<b>No.of Samples</b>
RAC 100%	Without steel tube	150	2	300	1
RAC 100%	With steel tubes	150	2	300	1
RAC 90%	With steel tube	150	2	300	1
RAC 70%	With steel tube	150	2	300	1
RAC 50%	With steel tube	150	2	300	1
RAC 0%	With steel tube	150	2	300	1
NAC	Without steel tube	150	2	300	1

**Aggregates**

Normal size of aggregate of RA and NA were 20mm and 14mm, respectively as shown in **Table 2**. As the table shown that the RA are lower than those of NA by about of 15%, 9% and 18% for density, SSD and dry density respectively. However, water absorption of RA is about as 5 times as that of NA. It's all because due to the existence of porous and less dense adhering to RA, as well as much more micro cracks produced during the crushing process.

**Table 2: Physical properties of NA and RA**

<b>Aggregate type</b>	<b>Density/std (kg/m<sup>3</sup>)</b>	<b>Dry density/std (kg/m<sup>3</sup>)</b>	<b>SSD density(kg/m<sup>3</sup>)</b>	<b>Water absorption (%)</b>
NA	2749/4.55	2719/5.37	2807/6.44	1.07/0.02
RA	2322/2.65	2304/2.48	2654/6.78	5.70/0.12

**Mixture design**

Due to the high-water absorption of the recycle aggregates, water was determined according to the desired absorption property of the RA was used soaked before mixing and the RA were introduced to mixture as Saturated surface dry (SSD) state. The mixing of the concreting was done according to the AS1012.2 [16]

**Manufacturing process**

Steel tubes were cut into 300mm lengths. Concrete were placed in the steel tubes and the compaction were done with the help of the vibrator. 25 number of blows were provided in the steel mold during concreting on vibration table. For curing steel tubes were covered with polyethene sheets. When the concrete cylinders were casted the top surface were polished using concrete grinder to ensure flatness

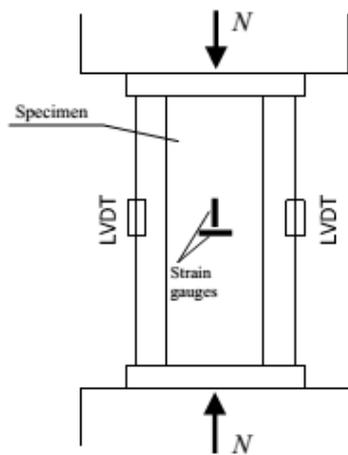
so that loading was applied on the concrete and steel tube simultaneously. Total 21 numbers of steel tubes were manufactured.

**Curing conditions**

The RACFST columns and RAC cylinders specimens were cured under the polyethene sheets under ambient environment in the laboratory. RAC cylinders were transferred to water tank after 24hours with saturated limewater under room temperature.

**Test setup and procedures**

The experimental study aimed to investigate not only the maximum load of the columns but also deformation and failure mode beyond the ultimate load. All the concrete specimens were tested under axial load in the civil engineering lab. Strain gauge were connected to specimens on each side to record the deformation of the steel tubes. The test setup was shown in the below **Figure (b) and (c)** during the experiment the axial and longitudinal deformation were automatically collected by the data logger every second. The specimens were tested in the UTM machine.



(b) Schematic of Specimen

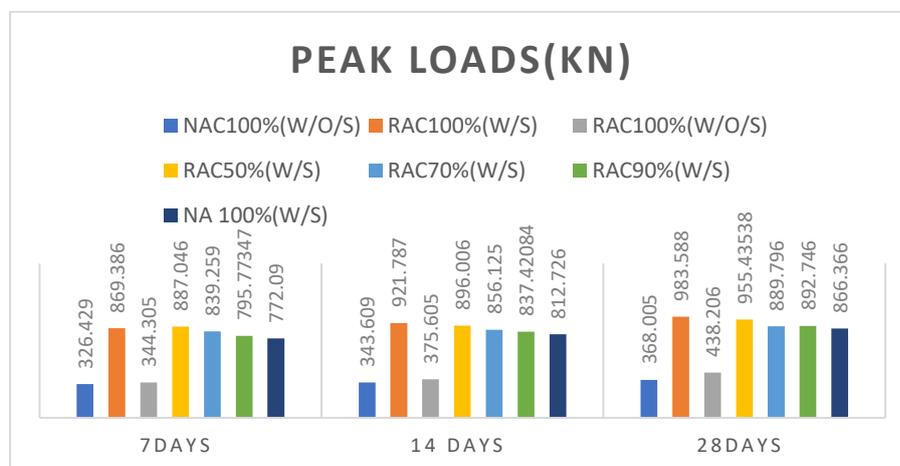


(c) Steel confinement RAC to be tested

**Figure 2: Experimental setup and instrumentation**

**Results and discussions**

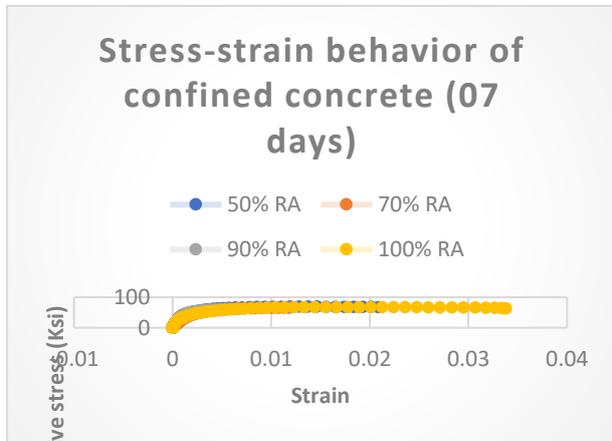
As the results, load vs displacement and load capacity and ductility as well as the failure modes and peak loads of all the concrete filled tubes are discussed and presented below **Table 3**



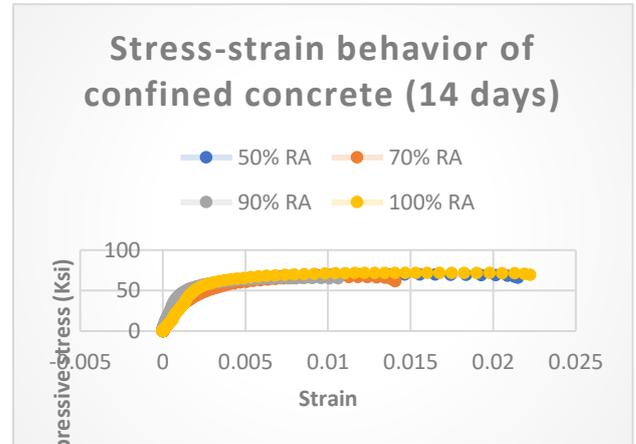
**Table 3: Shows Peak Loads**

**Simulation of load deformation data**

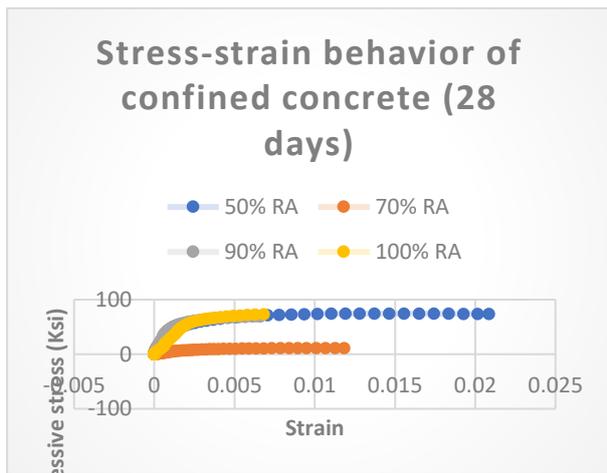
Based on the definition of the materials relationship, the load deformation relation of RAC steel tubes under the axial loading can be investigated by the below **Figure 3**.



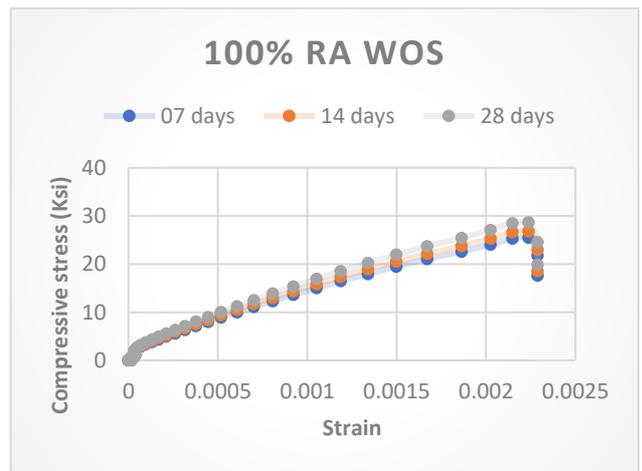
a) 7 days testing with steel confinement



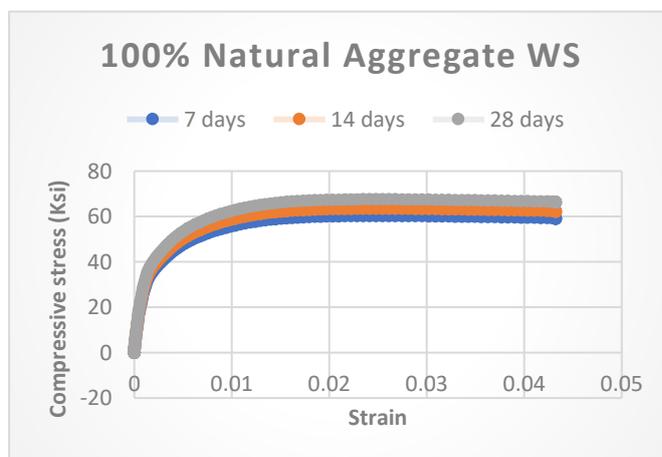
b) 14 days testing with steel confinement



c) 28 days testing with steel confinement



d) RA without steel



e) RA with steel confinement

**Figure 3: load vs. strain relation with and without steel of RA and NA**

## Conclusion

The present study is an attempt to investigate the behavior of RAC in steel tubes under axial loading using UTM machine. Experiments were conducted on RAC steel tubes with different recycle aggregates replacement. Load deformation behavior were studied. Overall reinforced concrete with 50% RA resulted high compressive strength of approximately 75ksi. The stress strain behavior of confined concrete after 7 days and 14 days is comparable. 100% replacement of recycle aggregates experiences maximum deformation. Complete replacement of RA shows comparable behavior with that of natural aggregates. Compressive strength of RA with complete replacement is slightly higher than that of natural aggregates. Concrete with steel shows nearly linear stress strain behavior for all type of curing times. Concrete with NA have similar stress relationship for different curing time with slight difference in maximum compressive strength. 28 day curing time samples shows maximum compressive strength.

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# To Study the Serviceability of Pedestrian Bridges and Underpasses in Pakistan

(Ref No. ICETEMS-21-018)

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## Abstract

Pedestrian bridges and underpasses are the structures that provide excess to pedestrians to cross the roads. The main objective of this study is to analyze and evaluate the serviceability of pedestrian crossing facilities. Two pedestrian bridges and an underpass located on the national highway and major inter-city highways of Peshawar and Nowshera were selected for this research. These facilities' selection was based on different characteristics, i.e. the number of lanes, type of median barriers and type of facility (bridge/underpass). Pedestrian volume data including both grade-separated crossing and at-grade were collected seven days of the week for each facility. The grade-separated pedestrian crossing was recorded manually and at-grade pedestrian data was recorded using video photography. The data is categorized based on gender and age into four groups i.e. male, female, age<25 and age>25. The analysis shows that the majority of the pedestrians (83.73%) did not use the crossing facilities, resulting in the poor serviceability of these structures. Comparison between bridges and underpass also reveals that the underpass usage (62.55%) is far greater than the bridges (3.39%). This result identifies that pedestrians prefer to use underpasses instead of bridges. Besides facility type, other factors that affect the serviceability of pedestrian crossing includes the number of lanes and the existence of median barriers.

## Keywords

Pedestrian bridges, Underpasses, Serviceability, Pedestrian crossing

## Introduction

A grade-separated crossing provides continuity of a bicycle/pedestrian facility over or under a barrier. A bicycle/pedestrian crossing structure may be either a bridge or an underpass. A grade-separated crossing should be considered when a bicycle facility meets a barrier, such as an active multi-track railroad, stream, or freeway, and continuity of the route is desired. There are two main types of grade-separated crossings: overpasses (bridges) and underpasses (most often these would be culverts). When a heavily utilized multi-use pathway intersects with a high volume multi-lane roadway, it is desirable to provide an overpass or an underpass to separate multi-use pathway users from conflicts with motor vehicle traffic.

Underdeveloped countries are facing the issue of the serviceability of the crossing facilities that result in accidents and a decrease in the vehicles' speed. The installation of these facilities require huge cost/budget, But due to its installation huge loses due to accidents and delay in traffic speed can be mitigated.

According to the Journal of Pakistan Medical Association (JPMA), in the 2003-12 period, 3,280 crashes were reported, including 856(26%) fatal and 2,424(74%) non-fatal ones. Moreover, 602(69%) fatalities and 1,782(59%) injuries of overall road traffic fatalities and injuries during the period studied were borne by pedestrians in Peshawar.

Peshawar, the capital city of Khyber Pakhtunkhwa (KPK), is one of the megacities of the world in terms of Population. According to the world population review, the Population of Peshawar up to 2021 is 2,272,812 with a growth rate of 3.17%. Among 1170 populated cities in the world, Peshawar city is in 217 positions. Similarly, according to Wikipedia, the population of Nowshera is 120,131 in 2021, with an increase of 33.76% from the previous year. It is connected with Peshawar through an inter-city

highway. A large population also has a great impact on the serviceability of grade-separated pedestrian crossings.

Due to this increasing population, the travel demand is also increasing very rapidly in the city causing enormous pressure on the existing transport infrastructure. As a result, traffic congestion, delays, lack of traffic safety, poor pedestrian facility, inadequate and inefficient public transport, inadequate traffic management, conflicts of jurisdiction and poor coordination among agencies are becoming common characteristics of the transport environment of Peshawar and Nowshera. Therefore, in this research, we have to study the serviceability of grade-separated pedestrian crossings in Pakistan and its comparison with other studies.

## Literature Review

There are some previous studies related and similar to the effective utilization of Underpasses and Overpasses in different contexts. Starting from the definition of pedestrians, as human traffic who are supposed to walk as a part of their movement and to use those facilities such as footpath, overpass, zebra crossing, subway etc. at any stage of their travel to accomplish their activities with which they are engaged in (Waresh 2011).

The Underpasses and Overpasses are pedestrian infrastructures considered as crossing facilities for pedestrians. In the urban traffic system, the pedestrian system is a supporting and supplementary system with high importance. A properly designed pedestrian system can effectively reduce the incidence of traffic accidents, improve the quality of public travel and the city image (Jiang and Yang 2012). Footbridges and underpasses in urban areas are provided as a part of pedestrian's infrastructure and they are normally raised above the ground or subdued in the sub-terrain. They are optimally designed to provide unhindered travel for pedestrians across potential barriers such as high-volume-high-speed motorways, railways, water channels and valleys thereby facilitating the much-needed accessibility and linkages between land uses. Footbridges and underpasses play other varied roles such as revolving complex intersection between transport modes and as useful urban design elements (Maigo 2018).

However, the effectiveness of these pedestrian infrastructures is one of the blooming issues (Bandara and Hewawasam 2020). The effectiveness of the pedestrian bridge depends on the amount of use by the pedestrian. Highways and interstate freeways fragment corridors and often result in increased mortality of terrestrial migrants from collisions with vehicles (Simpson, Stewart et al. 2016). Generally, the use or non-use of pedestrian facilities is a habit not coincidental behavior (Rankavat and Tiwari 2016).

When the pedestrians did not use the facility, it results in traffic congestion, delays, lack of traffic safety, poor pedestrian facility, inadequate and inefficient public transport, inadequate traffic management, conflicts of jurisdiction and poor coordination among agencies are becoming common characteristics of the transport environment (Saha, Tishi et al. 2013).

The pedestrian bridge is one of the elements in the system path for pedestrians. Pedestrian bridges are, for the use of pedestrians to cross-busy roads with vehicles. In addition, the pedestrian bridges can be considered as a tool or crossing facilities the safest and most efficient for pedestrians. It is a form of segregation between pedestrians and vehicles on the road. To ensure that pedestrian bridges are provided to give the maximum return that corresponds to the cost incurred to build, then it should be located in strategic areas and where users do not have to walk far to use them (Hidaya 2012).

Usually, underpasses are more expensive than overpasses. Underpasses need to ensure ventilation, drainage, and lighting facilities. In general, overpasses are much less attractive to pedestrians than underpasses, as they increase travel distance along with the difficulty of walking against gravity (Waresh 2011).

In Indonesia, the effectiveness of the utilization of pedestrian bridges was identified, for this purpose three (3) days of data were collected in peak hours, the data comprises pedestrians crossing the bridge and pedestrians not crossing the bridge. Then a criterion was identified and based on the criteria the effectiveness of the bridge was determined. The analysis shows that the pedestrian percentage that doesn't use pedestrian bridge crossing is very big, that is 87% at a busy time and 88% at a not busy time. The reluctance factor of the user is that pedestrian bridge crossings are less maintenance (dirty),

often used beggars, less secure due to shielding by sponsoring boards so pickpockets and such are easy to operate. (Ramadani, Rahmani et al. 2018). Similarly, In Jordan, the evaluation of pedestrian bridges and Pedestrian safety was studied, the result reveals that 60% of the pedestrians are not using the pedestrians' bridges. Reasons for not using the bridge include the discomfort and waste of time of extra walking distance, the high stairs, health reasons, or fear of safety. The main factors that affecting the use of pedestrian bridges are the posted speed limit, the overall width of the cross walkway, and the existence of a median barrier (Abojaradeh 2013). The same study is also done in Uganda; the effectiveness of overpass was studied. The overall prevalence of pedestrian overpass use was 35.4%. There was a low prevalence of pedestrian overpass use, suggesting a flaw in its conception and design. A careful study of overpass interventions is recommended before they can be replicated elsewhere. Cheaper alternatives at more frequent intervals may be more effective (Mutto, Kobusingye et al. 2002). Similarly, In Dhaka, the research was carried out on two (2) pedestrian bridges and its effectiveness was studied based on a pedestrian survey. The result shows that 50% of the pedestrians were using the overpasses. A continuous median barrier over a long distance can reduce violation as observed in the field. Unless compelled, a significant portion of the crossing pedestrians will violate the overpass compliance rule (Gulzar Hossain 1991).

The 'pedestrian crossing rules' of the Road Traffic Act 2004 require pedestrians to use a designated pedestrian crossing wherever it is provided. They can be fined for jaywalking within 50 m on either side of such a crossing. Jaywalking is discouraged by having railings on the footpath next to the road for 50 m on each side, rather than by enforcement (Chin and Menon 2015). Six general types of warrants for grade-separated pedestrian crossings (GSPCs) were identified: threshold, priority ranking, economic, system, policy, and political. The first three are quantitative, and the next three are qualitative (Axler 1984). No research paper has highlighted the impact of the number of lanes on the serviceability of the crossing facility. In this research, the impact of the median barrier and the number of lanes on the serviceability of grade-separated pedestrian crossing is analyzed.

## Methodology

First, a preliminary survey of the area was completed where the facility is located. After that survey of the structures and at the end survey of the road and its characteristics was performed. In data collection, Pedestrian's volume counts both grade-separated and at-grade was done in peak hours for one week on each site. Grade-separated pedestrian crossing data was done manually and at-grade pedestrian's data was done using video photography. The pedestrian data (both at-grade and grade-separated pedestrian crossing) is divided into four groups based on gender (Male/Female) and age (>25 and <25). From the literature review, it is clear that the majority of the pedestrians are not using the grade-separated pedestrian crossing. Therefore, the main objective of this research is to study the serviceability of Pedestrian bridges and underpasses.

**Table 1: Characteristics of Stations**

Station	Type of Facility	Location	Number of road lanes	Types of median barrier	Duration
Station 1	Overhead bridge	Badaber, Kohat road, Peshawar	4 lanes	Concrete blocks	5 days (both weekdays and weekends)
Station 2	Overhead Bridge	Pabbi, GT Road, Nowshera	8 lanes	Fences	5 days (both weekdays and weekends)
Station 3	Underpasses	Tehkal Payan, University road, Peshawar	6 lanes	Green belt	5 days (both weekdays and weekends)

Station 1 was mainly constructed as a crossing facility for primary school's students. At station 2 there were gaps between the fences where pedestrians were easily crossing the facility. All facilities are made

of steel having stairs on both sides of the roads for pedestrian usage except station 3 where proper stairs from PCC were constructed. At station 2 service road is located on both sides of the road. The number of pedestrians were observed at four peak hours (7:30-9:30 am, 2:00-3:00 pm and 4:30-5:30 pm).



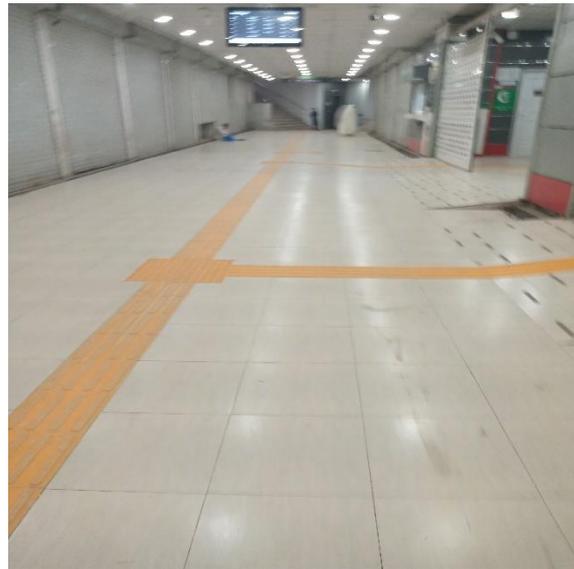
**Figure 1: Station 1 (concrete blocks as median)**



**Figure 2: Station 2 (Fences as median barriers)**



**Figure 3: Station 3 entrance**



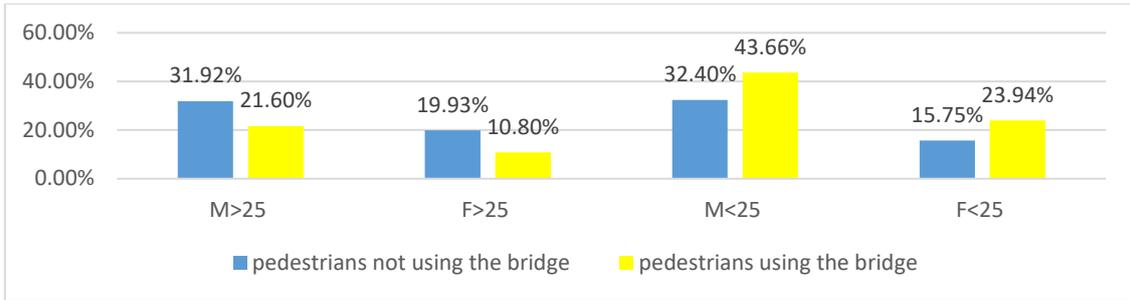
**Figure 4: Inside view of station 3**

## Results and Analysis

Based on the analysis total 59,306 pedestrians were noted on the stations out of which 83.73% are the jaywalker. The results of different sites are explained below:

### Station 1

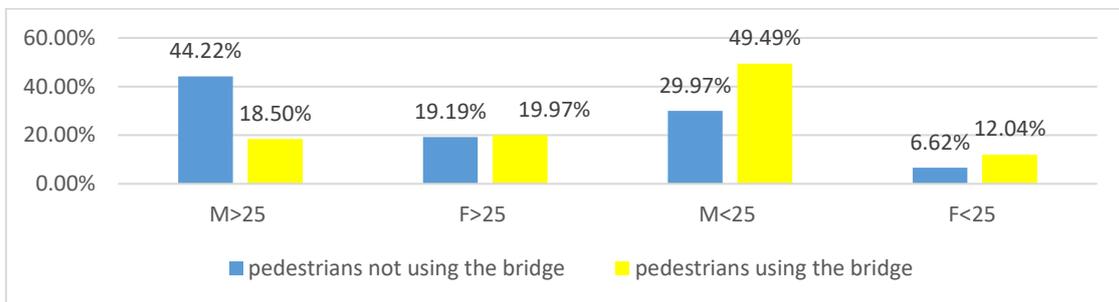
Total 4734 pedestrians were recorded in a week. The number of pedestrians using the facility was 4.5%. The greater percentage of the pedestrians not using the overhead bridge was male (age<25). Since they are energetic and physically fit. That's why their percentage is maximum. Moreover, there is no proper median barrier that's why the huge number of pedestrians were not using the facility.



**Figure 5: Comparison between Pedestrians using Vs not using the Bridge**

**Station 2**

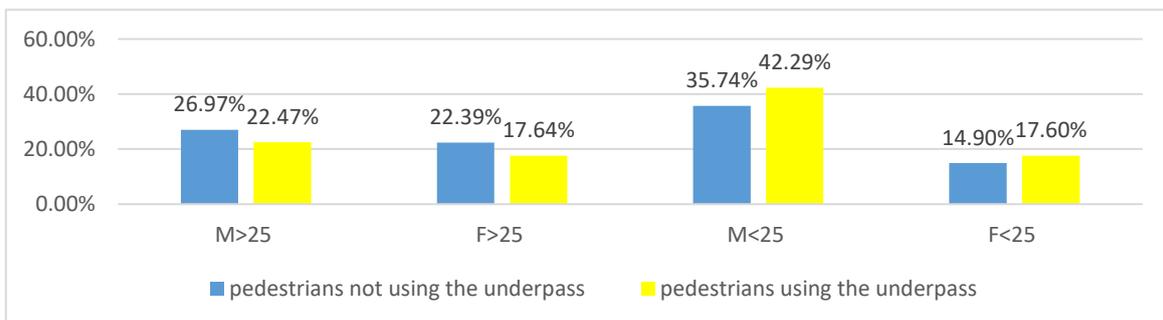
Total 41667 Pedestrians were recorded in a week. The number of pedestrians using the facility was 3.27%. Irrespective of station 1, the greater percentage of the pedestrians not using the facility (station 2) was male (age>25). Since the number of lanes at this station is greater than the previous station because of which the serviceability of the facility is more affected.



**Figure 6: Comparison between Pedestrians using Vs not using the Bridge**

**Station 3**

Total 12905 Pedestrians were recorded in a week. The pedestrians using the underpass were 62.56%. There was a green belt act as a median barrier due to which crossing of the road is easy for the male (age<25).



**Figure 7: Comparison between Pedestrians using Vs not using the Bridge**

**Comparison between Bridges and Underpass**

Total 46401 pedestrians were recorded on both bridges out of which 96.60% were not using the facility and only 3.39% were using the facility.



**Figure 8: Comparison between Bridges**

Total number of steps at station 2 is 30 and height of the bridge is up to 20 feet. Similarly, total number of steps at station 1 is 41 and having height up to 24 feet. Similarly, at station 3 total number of steps is 28 and total height of the underpass is 15 feet. There is a psychological impact of the height of overhead bridges due to which the serviceability is affected.



**Figure 9: Comparison between Bridges and Underpass**

**Table 2: Results comparison with other studies**

Country	Results (percentage usage)	Reasons	Recommendation
Jordan	40% (Overpass)	The discomfort and waste of time of extra walking distance, the high stairs, health reasons, or fear of safety	Increase enforcement, penalties for violation of traffic laws and rules
Uganda	35.4% (Overpass)	Flaws in its design	Public education and enforcement
Bangladesh	50% (Overpass)	Discontinuous median barrier, absence of traffic police, Irregularly situation.	Continuous median barrier over a long distance can reduce violation
Indonesia	13% (Overpass)	Less maintenance (dirty), often used beggars, less secure due to shielding by sponsoring boards	Maintenance of crossing bridge, Road safety education programs
Srilanka	98.35% (Underpasses)	Comfort and Personal safety which effect for the	Permanent security system,

	& 56.17% (Overpasses)	effectiveness of the Underpass/Overpass.	good air quality, and illuminated lighting
Pakistan	62.55% (underpass) & 3.39% (overpasses)	The number of lanes, type of median barriers and type of facility (bridge/underpass)	Proper median barrier can increase the serviceability

## Conclusion and Recommendation

From the above results, it is clear that pedestrians opt to use the underpasses instead of bridges because of the psychological effect of the height of the overhead bridges. No proper median barriers are the main cause of the poor serviceability of grade-separated pedestrian crossings. The number of lanes has also directly related to the serviceability of the facility.

To beat these flaws, the subsequent recommendation is critical to figure on, the following recommendation is based on the literature review and the analysis,: correct installation of fences and barriers, correct cleansing of the stations, there should be a complete ban of the advertising boards on these facilities, lighting facility should be installed in these facilities, the structural condition needs to be improved, for senior citizens and sick person installation of elevators and escalators is necessary, Proper punishment in the form of heavy fines should be imposed on jaywalkers, correct education regarding the importance of grade-separated pedestrians crossing must be given through seminars and courses.

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# Comparative Analysis of Cross-Laminated Timber and Reinforced Concrete Structures

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## Abstract

With the advent of the latest technologies, newer building materials are being produced and utilized that are substantially more energy-efficient, less costly, and environment friendly. In comparison to traditional constructional materials such as RC, bricks, steel, and timber, CLT is now being considered to possess more advantages in terms of energy efficiency, carbon emissions, and structural performance. This study will help bridge the gap in research on the comparative analysis of different engineering properties, environmental, economic, and social impacts of RC and CLT in the Pakistani construction industry. We carried out a closed-ended questionnaire-based survey and analyzed multiple statistical tests such as normality tests, T-test, Chi-square, and Harman's single factor test using SPSS software. As per the non-missing sample size, the responses were more positively inclined towards RC in terms of engineering properties, economic, and social impacts considering the overall material strength, cost, availability, social practices, and norms of the Pakistani construction industry. The responses were also positively inclined towards CLT in terms of environmental impacts. The preferable choice of building materials in Pakistan is RC, but the shift towards CLT is still a long way to go. The research area needs further in-depth analysis to comprehend the characteristics, performance, cost, and viability of RC and CLT for adopting the evidence-based practice to make an informed and sustainable choice of building materials.

## Keywords

Energy-efficient, Structural Performance, Closed-ended Questionnaire, Statistical, Tests, Sustainable

## Introduction

The construction industry in Pakistan is primarily based on the reinforced concrete (RC), which is considered as one of the common and best construction materials worldwide. However, current decades have seen a tremendous change in the construction industry based on rising environmental and economic challenges. The consumption of cross-laminated timber (CLT) is taking place in the market as it is considered as more viable and environment friendly material. Research suggests that CLT is a comparatively a sustainable construction material than RC. Nonetheless, there are many features of both the construction materials that are yet to be studied in the form of a comparative analysis in terms of the engineering properties, production and processing methods, workability, and their environmental, economic, and social impacts in Pakistan. Timber is a universal material that has been in use for making furniture, sculptures, and then for the construction purposes. Timber is a natural material and its crown diameter offers strength, conduction, and storage capacities (Polyanin & Manzhurov, 2000). CLT is a form of timber that is a plate-like, quasi-rigid, and multi-layered composite. It has multiple layers of boards placed cross-wide perpendicular to each other and can take load in and out of the plane (Brandner et al., 2016).

On the other hand, reinforced concrete is the common construction material since the last century primarily used for construction of public structures. Such structures contain steel bars and concrete and make up the members such as beams, columns, boards, and trusses (Zhang et al., 2011). The steel bars are completely wrapped within concrete; however, research shows that the durability of concrete may deteriorate due to steel corrosion (Kikuchi, 2000). Wood-based structural components not only possess

significant ecological importance but also offer greater sustainability and versatility. There are numerous building materials, but timber is the most homogenous in its features and versatile mechanical properties (Kandler & Füssl, 2017). CLT is made by laminating the dimension lumber at the right angle, and its structural properties offer higher attributes such as stability, renewability, material recycling, reuse, and carbon storage.

The construction process includes various steps such as extraction and production of materials, processing, and transportation require a huge amount of cost and energy affecting the environment by carbon dioxide emissions, economic and societal perception of construction industry and scrutiny among builders related to structural strength and durability. According to a study, RC-framed structures utilize about 80% more energy than CLT-framed structures during the stage of material production. RC buildings also contribute to releasing (100-200) % more net greenhouse gases (GHG) emissions (Guo et al., 2017). It is suggested that CLT is a viable option as compared to RC in high-rise building structures. Though RC is a common building material, the total value of energy consumption in RC structures is considerably high. Moreover, concrete is non-recyclable and cannot be reused. On the contrary, CLT has considerably lower non-renewable energy consumption. The cost comparison between CLT and RC structures also exhibit a substantial factor in the development and acquisition of building materials. Recent reports implicate that the cost of CLT structures is not much different from that of conventional building materials. However, CLT structures require supplemental fire protection since it has fire characteristics because of the slow char rate of heavy timber framing. RC, on the other hand, is a non-combustible and fire-resistant material and an appropriate concrete cover offers additional protection. With the help of refined design optimization, while meeting lower operational energy demands, the advantages of using CLT over the RC building system are improving. More research is required to provide a deep insight into differences between environmental, economical, durability, and sustainability of CLT and RC structures to lay a solid foundation for constructing better and more sustainable structures in the future. In this paper, we will conduct a comparative analysis between the two building materials in terms of their engineering properties, economic viability, social and environmental impacts. This analysis will help us find the scope of RC and CLT in Pakistani construction industry (Ramage et al., 2017).

## Methodology

The study approach followed for this research is as follows:

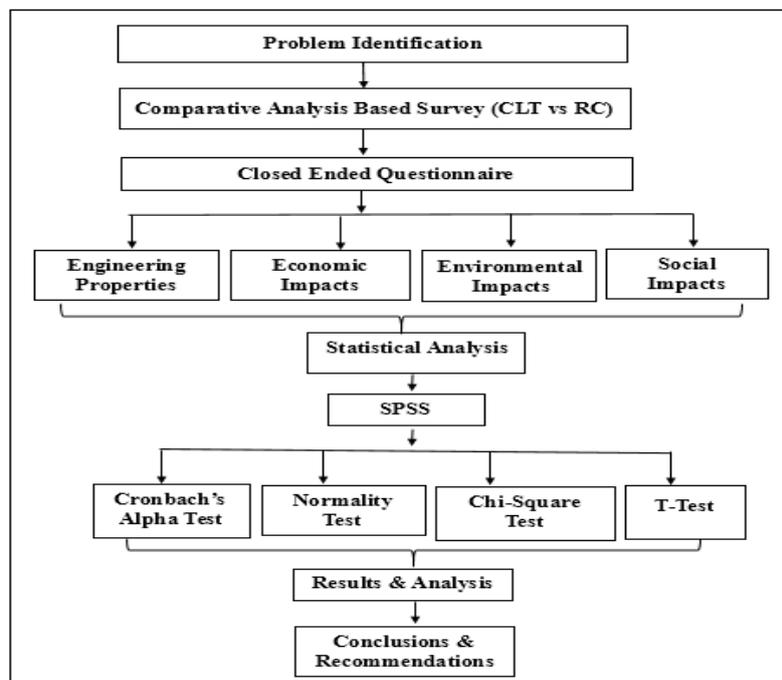


Figure 1: Study Approach

### ***Problem Identification***

The first approach for conducting the comparative analysis was to identify the problem. During the literature review, we found out that there is a huge research gap that lacks the necessary knowledge on the comparison of different building materials such as CLT and RC. This lack of research leads to uninformed and non-sustainable choice of building materials resulting in environmental and economic havocs.

### ***Questionnaire***

Our first approach was to conduct a quantitative research where we designed a closed ended questionnaire (see Annexure) to follow up our survey-based research. The questionnaire was then filled by the professionals working in the construction industry to examine the societal perspective on the use of new building material CLT instead of the traditional material RC. The survey questionnaire consisted of 32 closed ended questions that were divided into two different sections i.e., CLT and RC. The comparison factors consisted of 4 categories;

- Engineering Properties
- Economic Impacts
- Environmental Impacts
- Social Impacts

The response scale consisted of five category response scale. The legend can be seen in the table below:

**Table 1: Response Scale for Questionnaire**

	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
<b>Legend</b>	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

### ***Data Collection***

The survey questionnaire was uploaded on the Google forms and rotated among the professionals in the field of civil engineering. Our sample size was 101, out of which 99 were non-missing samples. The data was extracted in the form of a response sheet provided by the Google forms and was then exported to the SPSS software for statistical analysis.

### ***Statistical analysis***

#### ***SPSS***

SPSS is a program used for statistical analysis that can help make a systematic arrangement of the statistical data. It is used for organizing, processing, and analyzing the data collected from the surveys. We used SPSS for conducting various tests such as Cronbach's alpha test, normality test, T-test, and Harman's single factor test.

#### ***Cronbach's Alpha Test***

Cronbach's alpha test also known as the reliability test is the measurement of internal consistency. It is performed for multiple Likert questions in any questionnaire in which the reliability of the scale is determined.

#### ***Normality Test***

Normality test is a condition for several parametric statistical tests such as T-tests to check if the data is normally distributed within the SPSS statistics package. SPSS runs two kinds of tests of normality:

Kolmogorov-Smirnov appropriate for  $\geq 50$  samples and Shapiro-Wilk is used for  $< 50$  samples although it can handle larger sample sizes (Mishra et al., 2019). If the results have P-value  $\leq 0.05$ , it implies that the data is statistically significant and rejects the null hypothesis. If the P-value is  $> 0.05$ , it is insignificant and is a strong evidence for the null hypothesis.

### *T-Test*

A t-test is an inferential statistics test that determines any significant difference among the means of two groups that are related in specific characteristics. We performed two types of T-tests; paired samples and one-sample t-test. The paired sample t-test determines if the mean difference between two sets of samples is zero. While, the one-sample t-test determines if a sample is from a group with a specific mean that may not be always known.

### *Chi-Square Test*

Chi-Square test is used for hypothesis tests to find if the data is as expected comparing the observed values to the expected values and association between categorical variables.

### *Harman's Single Factor Test*

Harman's single factor test identifies the common method variance. If a single factor appears or one specific factor accounts for majority of the covariance within the measures, it implies that a significant amount of common method variance is found.

## **Results & Discussion**

### *Cronbach's Alpha Test*

We performed this test to check the reliability of our data based on the criteria explained in the figure below.

<b>Cronbach's alpha</b>	<b>Internal consistency</b>
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq 0.6$	Questionable
$0.6 > \alpha \geq 0.5$	Poor
$0.5 > \alpha$	Unacceptable

**Figure 2: Internal Consistency Criteria for Cronbach's Alpha Test**

According to the results obtained from the SPSS, the value of alpha " $\alpha$ " came out to be 0.915, which is greater than 0.9 as shown in the table below. Therefore, we can say it is reliable enough as the internal consistency lies within the excellent category based on Cronbach's alpha criteria.

**Table 2: Reliability Statistics for Cronbach's Alpha Test**

<b>Reliability Statistics</b>	
Cronbach's Alpha	N of Items
.915	32

### *Normality Test*

The results table for the normality test obtained from the SPSS is shown below. According to the results, the p-value for all the variables is 0.000, of which the mathematically correct version is  $p < 0.0001$ ,

which is statistically significant and the data is normally distributed. As we consider the Shapiro-Wilk test, if the sample size is moderate or large, any violation of normality in SPSS may still mean that the p-values are accurate.

### Paired-Samples T-Test

The paired samples statistics table displays the mean, sample size, standard deviation, and the standard error for all the variables entered. The screenshots of the table from the software can be seen in the figures below.

Paired Samples Statistics					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	The production and processing of RC as a building material is easier.	3.6634	101	1.13382	.11282
	The production and processing of CLT as a building material is easier.	2.9406	101	1.08464	.10793
Pair 2	RC structures possess greater mechanical properties (compressive, shear and tensile strength).	4.0700	100	.94554	.09455
	CLT structures possess greater mechanical properties (compressive, shear and tensile strength).	2.8700	100	.96038	.09604
Pair 3	The strength and stiffness of RC can reduce with time due to corrosion of steel bars, magnitude, and duration of load.	3.6364	99	.98410	.09891
	The strength and stiffness of CLT can reduce with time due to magnitude, and duration of load.	3.2727	99	.97748	.09824
Pair 4	RC offers the ability to advance the architecture and designs of high-rise structures according to the changing trends.	3.7624	101	1.08764	.10822
	CLT offers the ability to advance the architecture and designs of high-rise structures according to	3.0693	101	1.18539	.11795
Pair 5	The engineering properties of RC structures are suitable for the landscape of Pakistan.	3.7129	101	1.10758	.11021
	The engineering properties of CLT structures are suitable for the landscape of Pakistan.	3.2079	101	.94145	.09368
Pair 6	RC is readily available in Pakistani construction market.	3.8911	101	1.02860	.10235
	CLT is readily available in Pakistani construction market.	2.6535	101	1.02407	.10190
Pair 7	The manufacturing and processing cost of RC is affordable.	3.4200	100	.98658	.09866
	The manufacturing and processing cost of CLT is affordable.	3.0400	100	1.03397	.10340
Pair 8	The maintenance expenses of RC structures are insignificant.	3.0891	101	.98081	.09759
	The maintenance expenses of CLT structures are insignificant.	2.9901	101	1.06297	.10577
Pair 9	RC structures require additional costs for fire resistance, soundproofing, and interior aesthetics.	3.4851	101	1.12795	.11224
	CLT structures require additional costs for fire resistance, soundproofing, and interior aesthetics.	3.5545	101	1.13556	.11299
Pair 10	Sidelining RC as a building material in the market will boost the economic and employment dynamics in the mainstream construction industry in Pakistan.	3.2178	101	1.10999	.11045
	Introducing CLT as a building material in the market will boost the economic and employment dynamics in the mainstream construction industry in Pakistan.	3.3267	101	1.05933	.10541
Pair 11	RC contains environmentally toxic materials that are detrimental to the climate.	2.9604	101	1.14822	.11425
	CLT contains environmentally toxic materials that are detrimental to the climate.	2.5050	101	1.06418	.10589
Pair 12	The total embodied energy and carbon dioxide emissions of RC are significantly higher.	3.2178	101	1.19670	.11908
	The total embodied energy and carbon dioxide emissions of CLT are significantly higher.	2.4455	101	.83036	.08262
Pair 13	The manufacturing, processing, and transportation of RC are responsible for greenhouse gases and air pollution.	3.4100	100	1.04538	.10454
	Timber plantation can overcome the greenhouse gases emission from the manufacturing, processing, and transportation of CLT as well as help boost up the economy of the country.	3.3100	100	1.21185	.12119
Pair 14	The most common societal perception in Pakistan is that RC structures are quite strong and durable.	3.9406	101	1.08464	.10793
	The most common societal perception in Pakistan is that CLT structures are quite strong and durable.	2.7822	101	1.10999	.11045
Pair 15	Generally, builders and common masses in Pakistan prefer RC structures for public construction.	4.0500	100	1.05768	.10577
	Generally, builders and common masses in Pakistan prefer CLT structures for public construction.	2.5400	100	1.18424	.11842

**Figure 3: Paired Samples Statistics Table**

From the figure, we can see the p-values for each pair. For Pair 1, 8, 9, 10, and 13; the p-value is less than 0.05, which are statistically significant so we reject the null hypothesis and imply that the means of variables are not significantly different. While all other pairs have p-value greater than 0.05 indicating, the means of variables are significantly different. Then we got a Paired samples test and correlations table as output, which displays the standard deviation, standard error mean, confidence interval, and the bivariate Pearson correlation coefficient for all the pairs of variables. We combined both the tables as can be seen in the table below.

**Table 3: Paired Samples Test and Correlations**

Paired Samples Test									
	Paired Differences								Correla-tions
	Mean	Std. Dev.	Std. Error Mean	95% Confidence Interval of the Difference					
				Lower	Upper	t	df	Sig. (2-tailed)	r
<b>Pair 1</b>	0.722	1.393	0.138	0.447	0.997	5.212	100	0	0.034
<b>Pair 2</b>	1.2	1.271	0.127	0.947	1.452	9.439	99	0	0.275
<b>Pair 3</b>	0.363	1.273	0.127	0.109	0.617	2.841	98	0.005	0.120
<b>Pair 4</b>	0.693	1.585	0.157	0.380	1.006	4.392	100	0	0.778
<b>Pair 5</b>	0.504	1.411	0.140	0.226	0.783	3.595	100	0.001	0.566
<b>Pair 6</b>	1.237	1.357	0.135	0.969	1.505	9.162	100	0	0.212
<b>Pair 7</b>	0.38	1.440	0.144	0.094	0.665	2.637	99	0.01	0.870
<b>Pair 8</b>	0.099	1.292	0.128	0.156	0.354	0.77	100	0.443	0.042
<b>Pair 9</b>	0.069	1.416	0.140	0.348	0.210	0.492	100	0.624	0.029
<b>Pair 10</b>	0.108	1.370	0.136	0.379	0.161	0.799	100	0.426	0.042
<b>Pair 11</b>	0.455	1.640	0.163	0.131	0.779	2.79	100	0.006	0.329
<b>Pair 12</b>	0.772	1.448	0.144	0.486	1.058	5.359	100	0	0.905
<b>Pair 13</b>	0.1	1.184	0.118	0.135	0.335	0.844	99	0.401	0.000
<b>Pair 14</b>	1.158	1.488	0.148	0.864	1.452	7.823	100	0	0.424
<b>Pair 15</b>	1.51	1.500	0.150	1.212	1.807	10.06	99	0	0.288

The correlation values ( $r$ ) lesser than 0.05 imply that the pairs are significantly positively correlated. It is an important feature of this test since it measures that the variables are associated with another as they are used for comparison in pre and post-test measures. The test statistic values ( $t$ ) represent the average difference between the pairs. For instance, for the pair 1,  $t_{100} = 5.212$ ,  $p < 0.001$ , there is a significant average difference between the factors of both the variables in the pair. On average, for the pair 1, the acceptance towards RC in terms of the first variable, which was about the production and processing of the building materials, is 0.72 points higher than CLT (95% CI [0.447, 0.997]). It implies that the production and processing of RC is comparatively easier than that of CLT. Likewise, for the pair 7,  $t_{99} = 2.637$ ,  $p > 0.001$ , there is not a significant average difference between the factors of both the variables in the pair. On average, for the pair 7, the mean response for the difference in the manufacturing and processing cost of RC and CLT is recorded as 0.38, with the 95% CI [0.094, 0.665]. It implies that there is not much difference in the costs of both RC and CLT. For pair 12,  $t_{100} = 2.79$ ,  $p < 0.001$ , there is a significant difference between the factors of both the variables in the pair. On

average, for the pair 12, the mean response for the variable i.e., total embodied energy and carbon dioxide emissions, is higher for RC than CLT recorded as 0.772, with the 95% CI [0.486, 1.058]. It implies that according to the responses, RC has higher amounts of total embodied energy and carbon dioxide emissions as compared to CLT. Similarly, we deduced the results for all the pairs by comparing the statistical figures of both the RC and CLT.

### One-Sample T-Test

The output of the One-Sample T-test gave us the One-Sample statistics table as can be seen in the figure below. It displays the basic information related to the selected variables, sample size that is valid and non-missing, mean, standard deviation, and standard error.

One-Sample Statistics				
	N	Mean	Std. Deviation	Std. Error Mean
Do you think the comparative analysis of CLT and RC in Pakistan is enough to make an informed choice for the selection of construction materials?	101	.5941	.49352	.04911
Do you think builders and general masses in Pakistan will easily accept the shift of RC to CLT as a result of evidence-based studies?	99	.3838	.48879	.04913

**Figure 4: One-Sample Statistics Table**

According to the statistics, it can be seen that the mean response of our question number 1 is 0.5941 based on 101 non-missing samples and the mean response of question number 2 is 0.3838 based on 99 non-missing samples. The results imply that according to the professionals in the field of civil engineering, there is enough study on the comparative analysis of CLT and RC in Pakistan to make an informed choice for the selection of the construction materials. However, their response also indicated that the builders and the general masses in Pakistan will not be easily willing to accept the shift of RC based construction industry to CLT based even as a result of evidence-based studies.

The second output of the One-Sample test is the display of the most relevant results of the test such as t statistic, two-tailed p-value, mean difference, and confidence interval for the difference as can be seen in the figure below.

One-Sample Test						
	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Do you think the comparative analysis of CLT and RC in Pakistan is enough to make an informed choice for the selection of construction materials?	12.097	100	.000	.59406	.4966	.6915
Do you think builders and general masses in Pakistan will easily accept the shift of RC to CLT as a result of evidence-based studies?	7.813	98	.000	.38384	.2864	.4813

**Figure 5: One-Sample Test Results**

The p-values for both the variables are  $p < 0.001$  indicating a significant difference between the factors. It indicates that the response of the first question is more inclined towards the positive response as the mean difference is 0.594 (95% CI [0.4966, 0.6915]), while for the second question it is 0.383 (95% CI [0.2864, 0.4813]), more inclined towards negative response.

### Chi-Square Test

We received the table shown below for Chi-Square tests in which the key result is the Pearson Chi-Square.

Chi-Square Tests					
	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	5.083 <sup>a</sup>	1	.024		
Continuity Correction <sup>b</sup>	4.178	1	.041		
Likelihood Ratio	5.225	1	.022		
Fisher's Exact Test				.035	.020
Linear-by-Linear Association	5.032	1	.025		
N of Valid Cases	99				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 15.35.  
b. Computed only for a 2x2 table

Figure 6: Chi-Square Tests

According to the results, the value of the test statistics is 5.083. The footnote for this test suggests the expected cell count hypothesis that the maximum cell count is 5 and this hypothesis was accepted. Since this test was computed for 2x2 Cross-tabulation Table, as can be seen in the figure below, the degree of freedom (df) for this test is 1. The corresponding p-value for Pearson Chi-Square is 0.024, which is less than the chosen significance level (0.05), the null hypothesis is rejected and an association is found between the variables.

**Do you think the comparative analysis of CLT and RC in Pakistan is enough to make an informed choice for the selection of construction materials? \* Do you think builders and general masses in Pakistan will easily accept the shift of RC to CLT as a result of evidence-based studies?**

**Crosstabulation**

Count

		Do you think builders and general masses in Pakistan will easily accept the shift of RC to CLT as a result of evidence-based studies?		
		No	Yes	Total
Do you think the comparative analysis of CLT and RC in Pakistan is enough to make an informed choice for the selection of construction materials?	No	30	10	40
	Yes	31	28	59
Total		61	38	99

Figure 7: Cross-tabulation Table

The results imply that out of 99 non-missing sample size for both the variables, we received 40 negative and 59 positive responses for the question 1. It means that majority think there is enough study to make

an informed choice for the selection of construction materials in Pakistan. Similarly, for the question 2, we received 61 negative responses and 38 positive responses indicating that builders and general masses in Pakistan will not be readily willing to accept the shift of RC to CLT as a result of evidence-based studies.

**Harman’s Single Factor Test**

The principal component analysis for the Harman’s Single Factor Test was performed via the extraction method. The output of the test was the total variance explained in the form of a table shown below.

Table 4: Total Variance Explained for Harman’s Single Factor Test

<b>Total Variance Explained</b>						
<b>Component</b>	<b>Initial Eigenvalues</b>			<b>Extraction Sums of Squared Loadings</b>		
	<b>Total</b>	<b>% of Variance</b>	<b>Cumulative %</b>	<b>Total</b>	<b>% of Variance</b>	<b>Cumulative %</b>
<b>1</b>	9.007	28.147	28.147	9.007	28.147	28.147
<b>2</b>	3.605	11.266	39.413			
<b>3</b>	2.582	8.070	47.483			
<b>4</b>	1.740	5.438	52.921			
<b>5</b>	1.491	4.661	57.582			
<b>6</b>	1.366	4.269	61.851			
<b>7</b>	1.219	3.810	65.660			
<b>8</b>	1.032	3.225	68.885			
<b>9</b>	.978	3.057	71.943			
<b>10</b>	.937	2.929	74.872			
<b>11</b>	.793	2.477	77.349			
<b>12</b>	.732	2.286	79.636			
<b>13</b>	.673	2.102	81.737			
<b>14</b>	.650	2.031	83.768			
<b>15</b>	.605	1.891	85.658			
<b>16</b>	.547	1.711	87.369			
<b>17</b>	.514	1.608	88.977			
<b>18</b>	.480	1.501	90.478			
<b>19</b>	.410	1.280	91.758			
<b>20</b>	.387	1.209	92.967			
<b>21</b>	.331	1.033	94.000			
<b>22</b>	.320	1.000	95.000			
<b>23</b>	.289	.903	95.903			
<b>24</b>	.226	.707	96.610			

<b>25</b>	.216	.676	97.286			
<b>26</b>	.207	.646	97.933			
<b>27</b>	.185	.578	98.511			
<b>28</b>	.150	.468	98.979			
<b>29</b>	.107	.334	99.313			
<b>30</b>	.087	.272	99.585			
<b>31</b>	.075	.233	99.818			
<b>32</b>	.058	.182	100.000			

If the total variance that is extracted by one factor is beyond 50%, it means that there is a common method bias in the study. According to the results, the total variance extracted by one factor is 28.147%, which is less than the suggested threshold of 50%. It implies that there is no issue with the common method bias in this statistical data.

### ***Frequency Table***

We produced a frequency table, as can be seen below, that measures the categorical variables. Since we selected the Compare Variables, we can see all the variables in the table for a comparative analysis.

Table 5: Frequency Table

<b>Variables</b>	<b>Frequency</b>		<b>Percentage %</b>		<b>Mean</b>
	<b>Agree</b>	<b>Disagree</b>	<b>Agree</b>	<b>Disagree</b>	
<b>Reinforced Concrete</b>					
Q1	50	11	49.5	10.9	3.6634
Q2	49	2	48.5	2.0	4.0700
Q3	44	9	43.6	8.9	3.6436
Q4	36	9	35.6	8.9	3.7624
Q5	36	6	35.6	5.9	3.7129
Q6	44	6	43.6	5.9	3.8911
Q7	44	14	44.0	14.0	3.4200
Q8	35	22	34.7	21.8	3.0891
Q9	42	13	41.6	12.9	3.4851
Q10	39	25	38.6	24.8	3.2178

Q11	29	27	28.7	26.7	2.9604
Q12	30	18	29.7	17.8	3.2178
Q13	36	13	36.0	13.0	3.4100
Q14	36	7	35.6	6.9	3.9406
Q15	41	4	41.0	4.0	4.0500
<b>Cross-Laminated Timber</b>					
Q1	24	30	23.8	29.7	2.9406
Q2	30	28	29.7	27.7	2.8812
Q3	37	20	37.4	20.2	3.2727
Q4	20	25	19.8	24.8	3.0693
Q5	32	9	31.7	8.9	3.2079
Q6	20	37	19.8	36.6	2.6535
Q7	30	21	29.7	20.8	3.0495
Q8	27	26	26.7	25.7	2.9901
Q9	32	16	31.7	15.8	3.5545
Q10	41	14	40.6	13.9	3.3267
Q11	11	35	10.9	34.7	2.5050
Q12	10	50	9.9	49.5	2.4455
Q13	28	19	27.7	18.8	3.3069
Q14	19	29	18.8	28.7	2.7822
Q15	19	37	19.0	37.0	2.5400
<b>Additional</b>					
Q1	60	41	59.4	40.6	0.5941
Q2	38	61	38.4	61.6	0.3838

The frequency table displays the frequencies, percentages, and means of all the observations whether missing or non-missing. For the ease of study, we modified the table to distinguish between the different categories and selected only two scales. According to the table, we can determine that in which category

and for which variables, we received more positive or negative response to draw the conclusions for our comparative analysis.

### ***Comparative Analysis of RC and CLT***

By analyzing the results, especially by extracting the mean values from the frequency tables, we concluded our comparative analysis for each of the categories selected for this research study.

#### ***Engineering Properties***

In terms of engineering properties, the positive response was more inclined towards RC with the mean 3.77 as compared to CLT with mean 3.07, suggesting that majority of the respondents believe RC is more viable as its engineering properties are wider and better than CLT.

**Table 6: Comparison of Engineering Properties between RC and CLT**

<b>Material</b>	<b>Mean</b>	<b>Scale</b>
<b>RC</b>	3.77	Neutral < 3.77 < Agree
<b>CLT</b>	3.07	Neutral < 3.07 < Agree

#### ***Economic Impacts***

In terms of economic impacts, the positive response was a little more inclined towards RC with the mean 3.42 as compared to CLT with mean 3.11, suggesting that there is not a significant difference in the costs of both materials.

**Table 7: Comparison of Economic Impacts between RC and CLT**

<b>Material</b>	<b>Mean</b>	<b>Scale</b>
<b>RC</b>	3.42	Neutral < 3.42 < Agree
<b>CLT</b>	3.11	Neutral < 3.11 < Agree

#### ***Environmental Impacts***

In terms of environmental impacts, the negative response was more inclined towards RC with the mean 3.19 as compared to CLT with mean 2.75, suggesting that RC is responsible for negative impacts on environment and climate change.

**Table 8: Comparison of Environmental Impacts between RC and CLT**

<b>Material</b>	<b>Mean</b>	<b>Scale</b>
<b>RC</b>	3.19	Neutral < 3.19 < Agree
<b>CLT</b>	2.75	Disagree < 2.75 < Neutral

#### ***Social Impacts***

In terms of social impacts, the positive response was more inclined towards RC with the mean 3.99 as compared to CLT with mean 2.66, suggesting that majority of the respondents believe RC is a more socially acceptable building material than CLT.

**Table 9: Comparison of Social Impacts between RC and CLT**

Material	Mean	Scale
RC	3.99	Neutral < 3.99 < Agree
CLT	2.66	Disagree < 2.66 < Neutral

## Conclusion

The traditional Pakistani construction industry relies on the reinforced concrete structures. The recent global concerns and studies have established how construction materials have a huge impact on the climate change and environment. Therefore, researchers all over the world are working on introducing sustainable, durable, cost, and energy efficient alternative building materials in the market such as cross-laminated timber. However, many social and economic restraints hinder the shift from RC to CLT. According to the literature review, it is suggested that CLT is a viable alternative for the mainstream RC for construction purposes, as CLT is considerably environment friendly, consumes less energy, is renewable and reusable, requires minimum time, labor, and formwork, thus is also economically viable. The characteristics in which CLT lags behind RC can be modified and improved by using state-of-the-art technologies and modern sciences such as biotechnology and molecular genetics to obtain the desired traits of the wood. The high-rises and residential buildings need additional analytical study to improve the ingredients, quantities, and engineering properties of the building materials. The statistical results of this study can be concluded as:

- According to the research we conducted, in terms of engineering properties, economic, and social impacts, our questionnaire survey response was more inclined towards RC as compared to the CLT considering the resources, practices, and norms of the Pakistani society.
- In terms of environmental impacts, majority people agreed that RC has severe negative impacts on the environment and climate change as compared to the CLT.
- The statistical results also suggested that the preferable choice of the engineers and contractors in Pakistan is using RC as the main construction material.
- The results also suggested that the shift of the Pakistani construction industry from the traditional RC material towards CLT is not well perceived and it will take a long time.
- According to the professionals, the required information and research on the comparisons of different construction materials in literature is enough to make an informed and sustained decision for choosing the right material.

However, there is still much gap in the research that needs to be fulfilled taking in view the case studies of Pakistani construction industry. There is a long way before we can completely understand the pros and cons of both the building materials in all aspects as our economy and socio-dynamics strongly depend on the construction industry.

## Recommendations

In the wake of this research conducted and the conclusions drawn, we offer several recommendations that can improve the construction dynamics of the country. It is evident that the shift in the construction industry from RC to CLT will have affect the environmental, social, and economic conditions of Pakistan. Therefore, our building standards are needed to be modified such that the efforts for moving towards sustainable options is not only limited to public level but also adapted by the private construction firms. The choice of building materials should not only be based on cost but also the environmental impacts such as total embodied energy and carbon dioxide emissions. The energy provisions and regulations drafted by the government for promoting energy-efficient design and construction in Pakistan should be updated according to the latest international standards and developments. The concerned authorities should monitor if those regulations are

being implemented and demand regular energy audits. The government should launch pilot projects while utilizing the energy efficient standards and offer incentives to builders for promoting the use of sustainable building materials such as CLT. Mass awareness, training, and information broadcasting campaigns should be introduced for spreading required and accurate information regarding the impacts of construction materials.

More research is required related to the performance of the different building materials and their impacts on the Pakistani construction industry, environment, and society. It is needed that different experimental tests are performed on these building materials such as CLT and RC to analyze their properties and efficiency practically. It is also important to study the site of the building and devise a building plan that is in coherence with the properties of the building materials. Any research related to these findings is needed to be published and made available for everyone in order to spread awareness and correct information so that builders and contractors can make an informed and sustainable choice.

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## ANNEXURE

### QUESTIONNAIRE

You are invited to participate in this survey on a project “*Comparative Analysis of Cross-Laminated Timber and Reinforced Concrete Structures*” being conducted by the students of BS Civil Engineering Department at University of Lahore, Islamabad Campus. The purpose of this project is to analyze the response of professionals in the construction industry for introducing CLT as an alternative construction material in Pakistan in regards to the growing concerns related to the environmental and economic conditions of the country. Your participation in this survey is voluntary.

**Name (optional):** \_\_\_\_\_ **Age:** \_\_\_\_\_

**Designation:** \_\_\_\_\_ **Company:** \_\_\_\_\_

**Years of Experience:** \_\_\_\_\_ **Date:** \_\_\_\_\_

You can choose your responses from the given options as described in the legend.

<b>Legend</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

### SECTION A

The statements below will shed light on your general knowledge related to the engineering properties, economic, environmental, and social impacts of **Reinforced Concrete (RC)** in Pakistani construction industry.

<b>Engineering Properties</b>		<b>5</b>	<b>4</b>	<b>3</b>	<b>2</b>	<b>1</b>
<b>1</b>	The production and processing of RC as a building material is easier.					
<b>2</b>	RC structures possess greater mechanical properties (compressive, shear and tensile strength).					
<b>3</b>	The strength and stiffness of RC can reduce with time due to corrosion of steel bars, magnitude, and duration of load.					
<b>4</b>	RC offers the ability to advance the architecture and designs of high-rise structures according to the changing trends.					
<b>5</b>	The engineering properties of RC structures are suitable for the landscape of Pakistan.					
<b>Economic Impacts</b>		<b>5</b>	<b>4</b>	<b>3</b>	<b>2</b>	<b>1</b>
<b>1</b>	RC is readily available in Pakistani construction market.					
<b>2</b>	The manufacturing and processing cost of RC is affordable.					
<b>3</b>	The maintenance expenses of RC structures are insignificant.					
<b>4</b>	RC structures require additional costs for fire resistance, soundproofing, and interior aesthetics.					
<b>5</b>	Sidelining RC as a building material in the market will boost the economic and employment dynamics in the mainstream construction industry in Pakistan.					
<b>Environmental and Social Impacts</b>		<b>5</b>	<b>4</b>	<b>3</b>	<b>2</b>	<b>1</b>
<b>1</b>	RC contains environmentally toxic materials that are detrimental to the climate.					
<b>2</b>	The total embodied energy and carbon dioxide emissions of RC are significantly higher.					

3	The manufacturing, processing, and transportation of RC are responsible for greenhouse gases and air pollution.					
4	The most common societal perception in Pakistan is that RC structures are quite strong and durable.					
5	Generally, builders and common masses in Pakistan prefer RC structures for public construction.					

## SECTION B

The statements below will shed light on your general knowledge related to the engineering properties, economic, environmental, and social impacts of **Cross-Laminated Timber (CLT)** in Pakistani construction industry.

<b>Engineering Properties</b>		<b>5</b>	<b>4</b>	<b>3</b>	<b>2</b>	<b>1</b>
1	The production and processing of CLT as a building material is easier.					
2	CLT structures possess greater mechanical properties (compressive, shear and tensile strength).					
3	The strength and stiffness of CLT can reduce with time due to magnitude, and duration of load.					
4	CLT offers the ability to advance the architecture and designs of high-rise structures according to the changing trends.					
5	The engineering properties of CLT structures are suitable for the landscape of Pakistan.					
<b>Economic Impacts</b>		<b>5</b>	<b>4</b>	<b>3</b>	<b>2</b>	<b>1</b>
1	CLT is readily available in Pakistani construction market.					
2	The manufacturing and processing cost of CLT is affordable.					
3	The maintenance expenses of CLT structures are insignificant.					
4	CLT structures require additional costs for fire resistance, soundproofing, and interior aesthetics.					
5	Introducing CLT as a building material in the market will boost the economic and employment dynamics in the mainstream construction industry in Pakistan.					
<b>Environmental and Social Impacts</b>		<b>5</b>	<b>4</b>	<b>3</b>	<b>2</b>	<b>1</b>
1	CLT contains environmentally toxic materials that are detrimental to the climate.					
2	The total embodied energy and carbon dioxide emissions of CLT are significantly higher.					
3	Timber plantation can overcome the greenhouse gases emission from the manufacturing, processing, and transportation of CLT as well as help boost up the economy of the country.					
4	The most common societal perception in Pakistan is that CLT structures are quite strong and durable.					
5	Generally, builders and common masses in Pakistan prefer CLT structures for public construction.					

- ❖ Do you think the comparative analysis of CLT and RC in Pakistan is enough to make an informed choice for the selection of construction materials?

YES	NO

- ❖ Do you think builders and general masses in Pakistan will easily accept the shift of RC to CLT as a result of evidence-based studies?

YES	NO

**Thank you, your participation in highly appreciated!**

# Design Modification and Modal Analysis of Lower Labyrinth Seal of Francis Hydro Turbine for Sand Contaminated water: Khan Khwar power station a case study

(Ref No. ICETEMS-21-035)

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## Abstract

The repetitive erosion occurs in the hydro power plant under water parts that creates major problems in operation of the plant for maintenance engineers. The researchers try to apply various techniques to minimize the erosion of turbine parts by applying hard coating on the turbine blades and painting. Our research focuses on the critical erosion of turbine lower labyrinth seal of high head projects of WAPDA Khan Khwar power station (KKPS), for contaminated water with sand and mud. In 2015 erosion was observed that leads to failure of underwater parts especial in bottom ring and labyrinth seals due to which the units remain on force outage for longer time and cost a loss of 302 Million to WAPDA. The two possible way to reduce the erosion in underwater parts is the inclusion of sand traps to flush out the sand heavy particle out before entering o the power tunnel which is not possible because of high cost of modification and generation loss. The second option to minimize erosion in high head turbine like KKPS is to modify its lower labyrinth seal due to the free space in between bottom ring and labyrinth seal that allow the sand particle to set in the gape and due to the whirl velocity of the runner the particle moves along the circular periphery and erode the bottom ring and seal that cause break down and water leakage from the cone. The seal is modified in term of geometry and material the hardness of the seal material should be lower than the runner material ASTM 306. The ANSYS15 used to carry out six modal analysis for the same material and modified materials. The comparison shows that the modified material erosion is considerably lower than the original material. The vibration and maximum displacement amplitudes based on modal analysis is lower for the replace material in the lower labyrinth seal. 0.02 gm/hr for modified material and 5.2gm/hr of copper aluminum bronze. The actual life before failure calculated based on same geometry but different materials show that modified material has more serviceable life than original materials (10 months for original material and 9 years for modified material) with the same geometry.

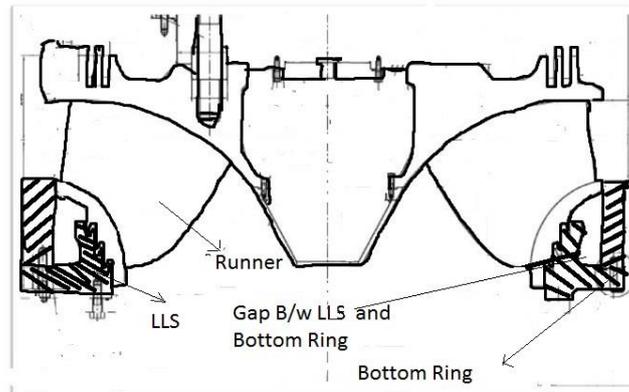
## Keywords

Erosion, Hydro Turbine, Francis turbine, labyrinth seal.

## Introduction

Due arising demand of electricity in Pakistan , the water and power development authority Pakistan started its high head projects in Khyber Pukhtoonkhwa province on emergency bases to cope up with the emerging needs of power in the country. The research resolute on the erosion phenomena in Turbine Francis especially in the lower labyrinth seal(LLS) The free space between the bottom ring and LLS and runner that provide free gape and due to rotation of runner at 500 rpm the contaminated water due centrifugal action erode the bottom ring on circular periphery and labyrinth seal at different point that leads to failure of the system and heavy leakage of pressurize water. The leakage of pressurize water is a threat to the operation and maintenance staff and power house equipment. In Francis turbine the erosion effects LLS, head cover bottom ring , runner blades, and wicket gates while in Pelten turbine the nozzle assembly ,seat ring and tip erosion is the main problem disturbing the whole operation of turbine.

The erosion in 2015 in Khan Khwar power station, the LLS, bottom ring and its connecting studs erosion, leads to the failure and heavy pressurized water leakage occurred. The emergency repair carried out of bottom ring, LLS and connecting studs replaced with new one. However, the same phenomena of repeated erosion in the same way and similar fashion occurred at the same region. The free gap shown in the figure below.



**Figure 1: Francis Turbine assembly of underwater parts**

The feldspar, quartz and rigid particle, that are in excessive in number and quantity in the south Asian countries. The hard erosive abrasion causes the turbine parts erosion. That disturbs its aerofoil and weight that in turn decrease its efficiency at high head and low head power complex [1]. The underwater parts Francis turbine erosion is mainly, the space among the vanes blades and facing surface plate that interchange cross flow and other flow that agitate the velocity profile at the inlet due to which erosion of component occurs. The sediment contaminated water and high pressure and velocity when passes through the hard surface causes erosion [2]. The cavitations phenomena also accelerate the erosion due to a number of physical situation a cyclic cavitations is induced in the turbine parts due erosion occurs which further exacerbate erosion when the deteriorates occur at first point. The erosion can be reduce by different methods including testing of Francis runner using different parameter and variable sediment/particles ranging from 1,5,12,18,28,38 and 48kg/s in the flow. The excessive erosion occurs at the outlet which is the higher pressure area and comparatively high velocity. The erosion caused by sediment contained water minimizes overall work out and mechanical efficiency of turbine increases vibration and even leads to break down in case of excessive erosion. The erosion can be minimizing by opting for optimal design and use of technology including coating of underwater parts. The erosion occurs at the exit of turbine blade where relative velocity is more and higher pressure for the maximum load. The rate of erosion is in proportion to the amount of sediment in water regardless of operating parameter [3]. The erosion can be categorized in three group small, secondary vertex and accelerated erosion of hydraulic machinery. The micro erosion occurs at the point where sands are in fine shape and small size less than  $60 \mu\text{m}$  as compared to high shear force at elevated velocity that occurs at the outer boundary, due to high rotational motion of heavy sand particles that induce indentation in the flow direction that can be compare in fish scale, and it can be observed on guide vanes and turbine blades toward exit in reaction turbine and needle tip of pelton turbine. [4]. The imping angles on the hard surface for steel is a measure of erosion. The rate of erosion increase with decrease in impinge angle for wet area and vice versa and at normal angle of attack the erosion was found to be minimum. [5]. The comparison for disc rotating analysis in pure water without contamination to produce cavitations and the combine effects of sand and cavitations, it was observed that their collective erosion in sand water and cavitations is more than individual erosion [6]. The petro-graphic analyzed that sediment erosion depend on shape, size, hardness and concentration of sand in the water at relative velocity range. The calculated surface material deterioration of operation [7]. The frequency of maintenance and repair is more in power houses located on river having more sediment concentration that erode the turbine under water parts more frequently creating energy loss and unit outage throughout the year and more often in rainy seasons. The erosion also depend on how the units was synchronize and how much load of sand water passed over the runner [6]. The two type of erosion, cavitations erosion is created by the blast or expansion of cavity over the metallic surface whereas the silt erosion occur due to the dynamic

behavior and kinetic energy of sand particle striking against a hard surface of the turbine. The research think that relative velocity of water as sediment velocity whereas other consider characteristic velocity of blades aerofoil to analyze the erosion phenomena through geometrical constrain[7]. The erosion occurs at three different area of trailing and leading edges and the blade surface. The erosion in leading edge is lower than the trailing edge where the relative velocity and pressure is high and the erosion in the middle surface is minimum[8].The erosion corrosion relationship SS316L, Nickel Aluminum Bronze(NAB) and AISI 1020 the experimental analysis shows AS1316<NAB< asi102 [11].

### ***Cavitations***

Cavitations occur due to pressure drop in turbine at leading edges. The deference in pressure create disturbance in characteristic flow and the flow patterns due to which bubbles vapor is formed and when expand near metallic surface causes abrupt change in local pressure that reach to 75MPA. The continue formation and burst of vapour bubbles and localize pressures leads to erosion in hydraulic turbine [12]. Francis turbine cavitations.

- Cavitations at leading edge
- Cavitations at Trailing edge
- Vortex in inter blades
- Swirl formation in draft tube when water exit from trailing edge of the runner.

## **Methodology and Experiment**

The design modification proposed for the failure of existing system with new modified design, new material selection and other parameter using analysis in ANSYS Work bench for modified and original design for comparison.

### ***General analysis of existing system/ data***

The observation carried out after erosion of KKPS in 2015 Francis turbine was dismantled and on inspection a severe erosion was observed in bottom ring LLS along with erosion in runner and wicket gates. The emergency repair of bottom ring carried out where as LLS and studs were replaced with the available spare new one. However the erosion occurred in the similar fashion and at the same circular periphery at a depth of 1.8mm and 3.9mm width and depth respectively at bottom ring and uneven palaces of lower labyrinth seal with erosion of runner and wicket gates after 07 days of repair.

Shown in figure 2.



**Fig:2 Eroded Bottom Ring**

### ***Experimental Plane***

The repeated erosion of KKHP in 2015, it was decided to explore the possible design modification in lower labyrinth seal and bottom ring. Due to sever deterioration, the following is the two possible o modification was recommended to remove the free space/ gap between LLS and bottom ring

- To extend the Bottom ring inner side to fill the gap
- To modify LLS

**Option (i) Modification**

To fill the gap and remove space as shown in the fig(assembly of LLS & bottom ring) the inner side at lower end be extended of bottom ring remove

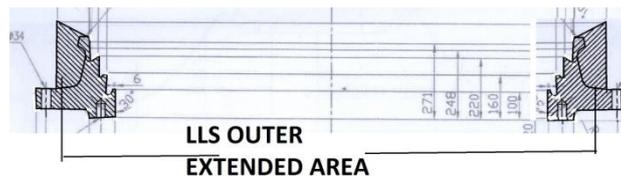


**Fig: 3. Bottom Ring Modified drawing**

The extended portion of bottom ring create problem in future dismantling of runner so the design was set aside.

**Option (ii) Modification**

The modification as shown in the fig.3 the outer edge of LLS at upper side be extended to fill the gap was the optimal way to be consider the outer diameter on the upper side of LLS should be extended as in the figure below to block up the free space in between LLS, the design modification was proposed in LLS, keeping in view both geometrical change and material. The modified material should be of high strength, toughness and ductility however the hardness of new material should be lower than runner material to avoid erosion in turbine blade.



**Fig: 4 Modification in lower labyrinth seal**

**Material for Modified Design**

The Francis runner is costly equipment and the male female part of runner and labyrinth seal that mating each other. The material of labyrinth seal should be selected of lower hardness valve than runner as runner efficiency decrease with erosion. The original LLS “ZCuAl9Fe4Ni4Mn2” aluminum bronze and Runner is marten site stainless steel Grade GB/T-2100 CA, “ZG06Cr16Ni5Mo”.To increase the hardness of LLS with hardness inferior than runner , the hardness of LLS, material stainless steel A306 Grade whose hardness is lower than runner, approximately 200HBW.

**Modal Analysis of both the original and modified design carried out for comparison**

The LLS material is cast aluminum bronze, ZCuAl9Fe4Ni4Mn2 properties is as under.

**Table 1: Properties (Mechanical) of ZCuAl9Fe4Ni4Mn2**

S. No	properties	Value
1	thermal expansion co-efficient	1.20e-005 c <sup>-01</sup>
2	Density	7695 KG M <sup>-3</sup>
3	C <sub>p</sub> , Specific heat	434.0 J KG <sup>-1</sup> C <sup>-1</sup>
4	λ , conductivity thermal	60.50 W M <sup>-1</sup> C <sup>-1</sup>
5	yield strength (Compressive)	2.50e+008
6	ρ , Resistivity	1.70e-007 OHM M

7	Ultimate Tensile strength	4.60e+008
8	Ref Temp	22 *C
9	Yield Strength(Tensile)	2.50e+008

**Model in Pro-E**

The Geometrical model as per original drawing created in Pro-E and saved in required ANSYS format LLMS.

**Creating a Mesh**

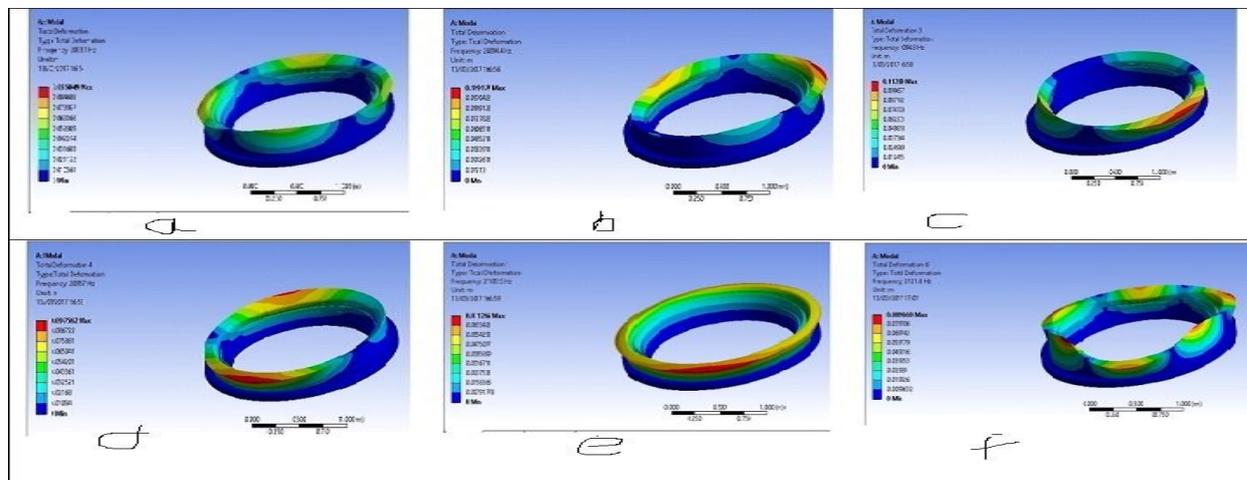
The Pro-E model is imported in ANSYS and created mesh of fine size then engineering data as per table above with six mode of vibration and fixe support point. Geometry imported to ANSYS for creation of mesh and uploading other engineering data to solve for

Modal analysis for Modified design and Stainless Steel material the same is carried out for the modified labyrinth seal with the engineering data as per table 2. Work bench in ANSYS for our modal analysis

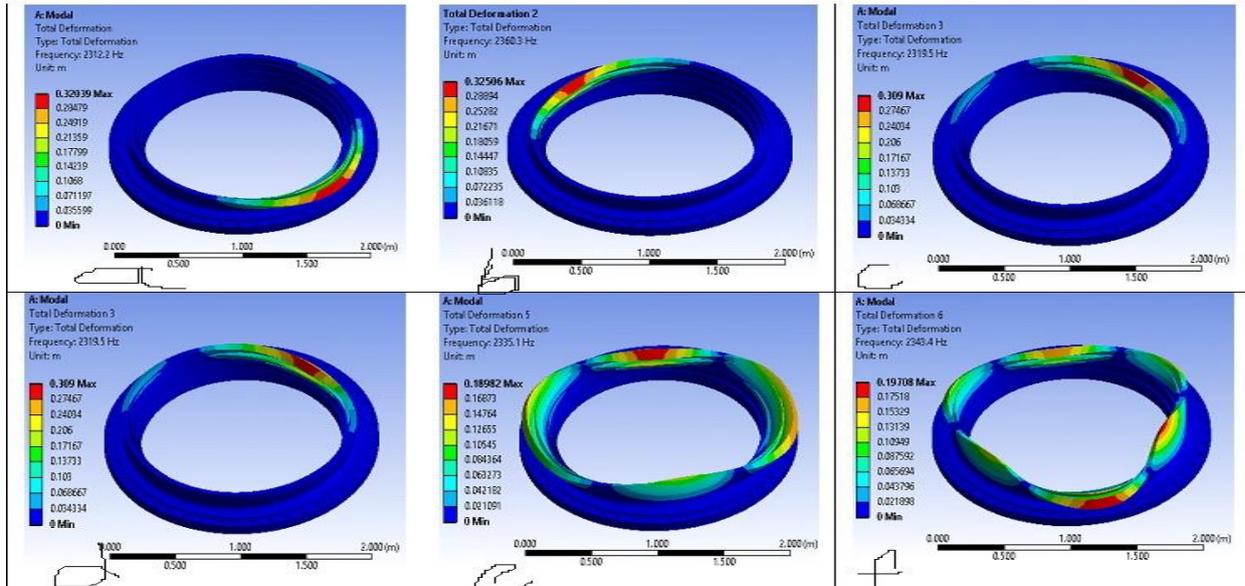
**Table: 2 Stainless steel ASTM A306 Mechanical properties**

Sr No.	properties	Value
1	Coeff-of thermal expansion	1.20E-005 C^-1
2	Density	7695.0 KG M^-3
3	Thermal conductivity	60.5 0W M^-1 C^-1
4	Cp Specific heat	434.0 J KG^-1 C^-1
5	yield strength(Compressive)	2.50E+008
6	Resistivity	1.70E-007 OHM M
7	Ultimate Tensile strength	4.60E+008
8	Yield Strength(Tensile)	2.50E+008
9	Ref Temp	22 *C

**ANSYS Modal analysis**

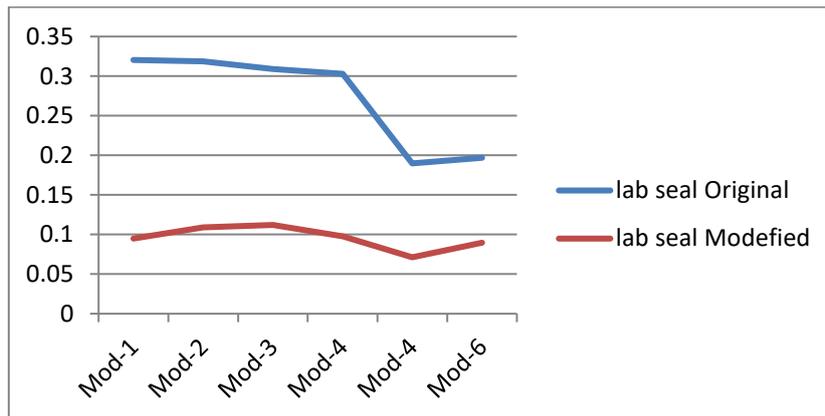


**Fig:5 LLS Original material Modal analysis(5A to 5F)**



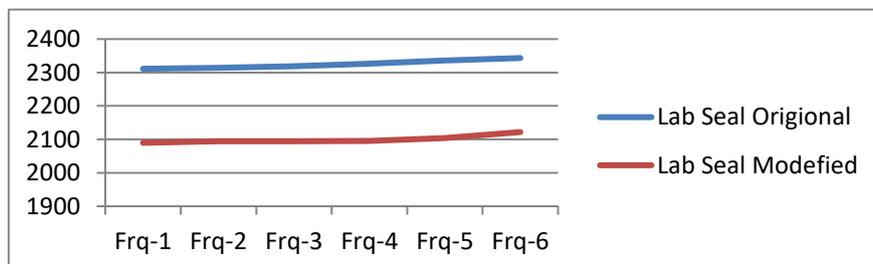
**Fig:6Stainless steel (Modified material) Modal analysis (6a to 6f)**

The analysis on of maximum deformation from ANSYSIS analysis.



**Fig: 7, LLS Original and Modified material deformation comparison**

It is clear from the graph that deformation in modified material is less than original material as stainless steel properties is better than bronze.



**Fig: 8 Graph of LLS Original and Modified comparison based of frequency**

**Comparison and serviceable life calculation**

The comparison from the above result at (fig.4 & 5) predict that the new recommended modified design is safe both in deformation and frequency against the vibration off the system which is allowable up to

(1000 mm /revolution). The design material is hard then the original bronze material and lower than Francis runner stainless steel material, for the reason that the hard entering material in water will not damage runners sides, blades and band instead to labyrinth seal. To evaluate the erosion rate of Copper Aluminum bronze with stainless steel ASTM A306[12] the other geometrical constraint taken from the original manufacturer drawing of KKPS for calculation of volume of material removal before failure.

The new proposed material ASTM A306 for the modified design the erosion rate is very lower than the original design material as of SS A306 erosion is 0.02 and that of bronze is 5.32gm/hr for all parameter and contamination the same contamination as well as geometry [12]. The serviceable life before failure is calculated based on the above erosion data for original material and design for the same geometry without extension or filling the free gape and then for the modified design and material.

Data from original manufacturer drawing of KKPS.

Sand average size 135 $\mu$ , Francis Turbine Diameter: 2.0 meter =Radius R: 1.0 m

Erosion rate of original material of LLS is 5.32 gm/hr and erosion of ASTM A306 Steel is 0.02 gm/hr [20] at reference velocity of water jet 6 m/s., Francis Turbine speed:  $\omega = 500$  RPM (Rated speed of KKPS)

Sand velocity in the water at the outer Trailing edge can be calculated as.

$$V_s = \omega r \quad (1) \quad , \quad \omega \text{ is rpm of Turbine } r \text{ is radius of the Francis turbine.}$$

$$\frac{(\omega r)}{60s} = \frac{500 \cdot 1m}{60} \quad , \quad V_s = 8.34 \frac{m}{s}$$

Propose the velocity as 6.7 m/s at the trailing edge of runner to find serviceable life of LLS for original material and modified material.

The rate of Erosion of A306 SS =0.020gm/h at V=6.5M/S, HVAF Bronze erosion = 5.320 gm/hr at V=6.5 m/s,  $Density = \frac{M \text{ mass}}{V \text{ volume}} - 2$

Bronze density  $\rho = 7695.00 \text{ kg m}^{-3}$  and A306 SS Density:  $\rho = 8000.00 \text{ kg m}^{-3}$

$$\text{Serviceable life} = \frac{\text{Volume to be remove}}{\text{total hours required}}$$

Mass of bronze to be remove = VL1

$$\text{Mass of bronze erosion rate} = 5.5 \frac{gm}{hr}, \quad \text{bronze density} = 7695.00 \frac{kg}{m^3}$$



Fig: 9 LLS Cross section view

Mass of bronze to be remove = VL1

$$\text{Mass of bronze erosion rate} = 5.5 \frac{gm}{hr}, \quad \text{bronze density} = 7695.00 \frac{kg}{m^3}$$

$$\text{Volume } V_1 = \frac{5.50}{7695.0} \\ V_1 = \frac{6.910 \cdot 10^{-3} \text{ Kg}}{m^3/m^2} \quad (3) \quad , \quad \text{The volume to be remove of LLS before failure } e = V_1$$

Area for Erosion from original drawing fig 6, Area1  $A_1 = \pi r_1^2$  (4) & Area2  $A_2 = \pi r_2^2$  (5)

The volume to be remove before LLS failure = VL1, Net calculated Area(Fig 6) =  $A_1 - A_2$

Radius R1 = 1950.0mm, –data KKHPS DRAWING, radius R2 = 1800.00mm

$$\text{Area } A = \pi(R1 - R)^2, \text{ so } A = \pi(1950.00 - 1800.00)^2$$

$$A = 0.0706 \text{ m}^2$$

The total volume removal (erosion) up to failure, Volume V<sub>Lf</sub> = A \* h,

$$h = \text{the height figure 6, } V_{Lf} = 0.0706.00 * 3.500/1000, V_{Lf} = 2.2600 * 10^{-3} \text{ m}^3$$

$$M (\text{mass}) = V_{Lf} * \text{Density, Mass} = 2.260 * 10^{-3} \text{ m}^3 * 7695.00$$

$$\frac{M}{A} = 2.260 * 10^{-3} \text{ m}^3 * \frac{7695.00}{0.0706} \text{ Kg/m}^2$$

$$\frac{\text{Mass}}{\text{Area}} = \frac{6.00 * 10^{-3} \text{ m}^3 * 7695.00}{0.07062}$$

$$\frac{M}{A} = 24.6300 \frac{\text{Kg}}{\text{m}^2} \quad (6)$$

$$\text{Serviceable Life} = \frac{\text{Total Massg (5)}}{\text{Equt(3)}}, \frac{\text{Useful}}{\text{Serviceable}} \text{Life} = 4.9 \text{ Months for BroneLLS}$$

SS A306, Using above equation 1,2,3 and 4 and density of ss A306

$$V_{Lf2} = \frac{0.0200 \frac{\text{mg}}{\text{hr}}}{8000.00 \text{ kg m}^{-3}}, V_{Lf2} = 2.500 * 10^{-5} \text{ m}^3 \quad (6)$$

Area under consideration for Erosion from Fig: 4. Is same as calculated above

$$A = 0.0706 \text{ m}^2, \text{ Mass removed due to erosion of LLS Stainless steel}$$

$$\text{Volume removal before failure, } V_{Lf2} = A * h$$

$$A = \text{net area calculated from equation 3\& 4, } h = \text{the height from the figure4}$$

$$M = \text{density} * \text{volume}, M = p * A * h, \text{ where } Ah = \text{Volume, } p = \text{density}$$

$$M = 2.200 * 10^{-3} * 8000.00 \text{ M} = 17.60 \text{ Kg}$$

$$\frac{M}{A}$$

$$\frac{M}{A} = \frac{17.60}{0.07060}, \frac{\text{Mass}}{A} = \frac{25.6090 \text{ Kg}}{\text{m}^2} \quad (7)$$

$$\text{useful/Serviceable Life} = \frac{\text{Eq 7}}{\text{Eq 6}} \text{ Hrs/Area}$$

$$\text{Serviceable Life} = \frac{25.6090}{2.50 * 10^{-3}} \text{ Hrs/Area}$$

$$\text{Serviceable Life} = 118.56100 \text{ Months}, \text{ Serviceable Life in years} = 9.880 \text{ years}$$

The sand Traps cannot be constructed at the O&M stages due to long shutdown requirement and more budgets and generation loss of power. The sand traps function is to settle down the sand contamination and then regular flushing out through sand traps gate when requires.

The gap between LLS and bottom ring serves as free space for sand particle and water and the whirl of runner at 500rpm the water contaminated particle also rotating along the circular periphery and due to centrifugal action the heavy sand act like abrasive material and erode the bottom ring and labyrinth seal.

The free gap between labyrinth seal and bottom ring is a design flaw and need to be removing in order to avoid the repeated failure of the system and heavy erosion due to centrifugal action of contained water trap in the gap between Bottom ring and LLS. The proposed modification in lower labyrinth seal is feasible both in economically and can be manufacture easily.

The erosion rate of Aluminum Bronze and ASTM A306 detail as

Erosion of ASM A306 =0.020 gm/h at V=6.50M/S [20]

Erosion of HVOF Bronze original Material = 5.320 gm/hr Approximately at V=6.5 m/s

From the useful / serviceable life, rate of erosion and modal analysis it is clear that the modified design is safe to avoid repeated failure of the system and erosion due to the design flaw.

## Future Work

The design modification give clear idea regarding safety and rate of erosion however the following work are still required in future perspective:

- i. To apply hard coating of on the LLS and then carry out further analysis and results and the same can be carried out for SS steel and comparison for sand contaminated water.
- ii. Find and analyze the vortex flow on LLS for different heads ranges from medium to high head and their effects on Francis turbine.

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# Quantitative Analysis of the Effects of Obstructing Direct Line of Sight Communication in 5 GHz Band Using Metal Sheet

(Ref No. ICETEMS-21-036)

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## Abstract

The study is related to the investigation and quantification of the effects of the obstructing materials in the first Fresnel zone of WiFi/WLAN network signals operating in the 5 GHz Band. The Obstruction caused reflection, refraction, diffraction, absorption, and scattering of the signal. The metal obstructions have existed of different gauges and materials in the path of signal propagation. However, some work on the effects of obstruction on wireless signal propagation has already been done. Particularly this research work emphasizes on finding quantitatively the influence of metal sheet of iron obstruction on the signal propagation. The experimental scenario has a Wifi router that transmits the signals and a receiver (laptop) that received the signals and a metal obstruction, blocking the signal propagation. The transmitter-receiver distance is kept at 16m, to fully obstruct the first Fresnel zone by using a circular obstacle made of iron. The metal sheet is placed at the center of the path. The scenarios investigated include the direct line of sight and obstructed line of sight in both indoor and outdoor environments. The same experimental scenario was used and perform the experiment in a virtual environment by TamoGraph software. The results of the indoor and outdoor were compared of the similar experimental setup. The value of signal strength in the outdoor environment was observed to be less than in the indoor environment. This was probably due to the scattering of signals outdoor while multipath convergence in an indoor scenario. The data of TamoGraph software is compared with the practical experiment. The result of the virtual experiment followed the result of the practical experiment but was slightly different due to the difference between the practical and virtual environment. It can be concluded from this research that the signal strength is more effected when the obstacle like metals are present in the first Fresnel zone, so it is necessary to keep the first Fresnel zone free of obstacles. The results have been calculated by placing the iron obstruction between the transmitter and receiver between the LoS path. This can be applied in an indoor environment with higher propagation indoor environment and can avoid unwanted signals by the placement of iron obstruction.

## Keywords

Fresnel zone, Wi-Fi WLAN obstruction, NLoS, Metal Shielding ISM Band 5 GHz.

## Introduction

There are multiple ellipsoidal Fresnel zones between the transmitter and receiver. The order is given in such a way that the nearest region from the central straight path between the transmitter and receiver is called the first Fresnel zone. Among all the Fresnel zones, the first Fresnel zone is very important, it must be free of obstacles as shown in figure 1.

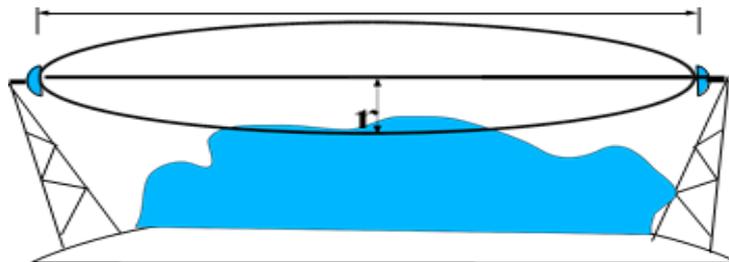


Figure 1. First Fresnel Zone

To calculate the Fresnel zone radius, the following formula is used:

$$r = (0.5\sqrt{\lambda \times d}) \quad (1)$$

Where 'r' is the radius of the first Fresnel zone 'λ' is the wavelength of the transmitted signal, and 'd' is the distance between the transmitter and receiver, as depicted in figure 1. The diameter of the Fresnel zone depends upon the distance between the transmitting and receiving antenna and the frequency of the transmitted wave. Thus reducing the diameter of the Fresnel zone is possible by increasing the frequency, which will decrease the Wavelength of the signal.

Typically, due to the reflection, the electromagnetic waves that reach the receiving antenna can be in or out of phase with the direct Line of Sight signal when there are objects near the Fresnel zone. [2]. The significance of propagation is explained in [3]. The practice involves keeping at least 60% of the first Fresnel zone radius free of obstacles to avoid destructive interference at the receiver [4]. If someone wants high reliability of link then one should determine the line of sight clearance other than the first Fresnel zone that is 2nd, 3rd, and so on [5]. Ideally, an 80% unrestricted Fresnel Zone would not cause any substantial signal loss. Purportedly, keeping the percentage of at least 60 % free will sacrifice some signal strength.

Intentional obstruction of wireless signals enables mitigation of interference from co-frequency, co-channel signals, hence allowing reuse of frequencies in the localized environment. However, in order to obstruct the Fresnel zone, there should be a precise determination of the Fresnel zone size. In this work, we have set up an experiment for the investigation of indoor propagation of 5GHz WLAN signals. We started with the Line of Sight path and then blocked the first Fresnel completely and analyzed the effects on the received signal strength.

Meanwhile, the analysis of the large-scale WIFI deployment becomes complexed. It caused conflict amongst several Ap's in an indoor arrangement. Our methodology used a 5 GHz, ISM band. Due to the 5GHz ISM band less chance of interfering with the 2.4 GHz ISM band devices [6]. There are infinite successive even and odd regions in the 3D ellipsoid. Destructive interference occurs in even regions while constructive interference occurs in odd regions. The even regions are harmful for signal propagation because the signal propagating in these regions reached the receiver out of phase and caused signal strength degradation, so it is better to be blocked. The obstruction placed in the path of signal propagation affects the signal propagation severely, so their effect has to find quantitatively. Sometimes it is necessary to block the co-frequency signal coming from an unwanted source that can affect your desired signal and may also cause a security problem. This technique is used when there are so many co-frequency devices are present within the same building.[1] The obstruction placed in the path of signal propagation affects the signal propagation severely, so their effect has to find quantitatively. Sometimes it is necessary to block the co-frequency signal coming from an unwanted source that can affect your desired signal and may also cause a security problem. This technique is used when there are so many co-frequency devices are present within the same building. The purpose of this research work is to find the effect of metal obstruction on signal degradation quantitatively. The experiment is started firstly of without obstruction scenario for indoor environment, outdoor environment, and simulated environment. Then placed the metal obstruction of gauge 60mm of iron and 25mm of iron to block the first Fresnel zone entirely. The metal obstruction caused the signal propagation. After that, the comparison is done of the same experimental setup in an indoor and outdoor environment. The 5GHz ISM band is used in the experiment because 5GHz devices are recently increased day by day and caused the problem of interference. This research will provide the numerical values of the effect of metals on signal degradation of the 5GHz ISM band. It is viewed from the numerical values that the power of the signals received in the outdoor environment is lesser than in the indoor environment.

## Previous Studies

$r = (0.5\sqrt{\lambda \times d})$  Using a 5 GHz frequency band as a replacement for the 2.4 GHz frequency band is a greater free space reduction, greater sensitivity to moisture, and smog. On the other hand, the Antenna has a significantly greater gain at high frequency. Free space attenuation of one kilometer is 80.41dB for 2.4 GHz and 87.86 dB for 5 GHz [7]. The purpose to design a radio frequency (RF) link is to make

sure the line of sight (LoS) is free from the obstacle between transmitter and receiver. Mostly, some part of the electromagnetic Wavefront propagates on the shortest possible route between transmitting device and receiver. The shortest and straight route on which propagation takes place between the transmitter and receiver is called the line of sight (LoS). According to the viewpoint of receiving antenna, this shortest and direct route comprises the majority of the received signal. Most considerably, the direct line of sight (LoS) route must be free from any type of obstacle that does not affect the strength of the Received signal. Thus, the LoS track and some volume of space perpendicular to this LoS need to be free from hurdles to keep the track clear, hence describing the LoS transmission. Moreover, the necessary proscribe space neighboring to the Line of sight (LoS) track is described through the knowledge of Fresnel zones.

Predominantly, objects along the way of the transmission medium, that is houses, shops, metal substances, or the surface of the prevailing territory such as water, etc can cause reflection of some part of the transmission wavefront. The reflected wavefront will go toward the receiver if they reached coincident with the line of sight wavefront they will result in an increase in the LoS wavefront level or decrease in the LoS wavefront level at the receiving antenna. The level of the combined receiving signal of two wavefronts will be the vector sum of their amplitude and phase of the electric fields if the amplitude of two wavefronts is the same but they are  $180^\circ$  phase-shifted or multiple of one-half wavelength the result of the wavefronts will be zero and no signal will be received by the receiving antenna. On the other hand, if the amplitude of two wavefronts is the same and in the phase that is no phase shift, the result of the wavefronts will be an increase in the received signal level with respect to the signal received from the line of sight path only [3].

Furthermore, when the line of sight is full of obstacles that are there is no wavefront travel directly in the LoS path then the propagation of wavefronts reaching the receiver will occur through diffraction. This will result in a significant loss that is relative to an unobstructed LoS. Therefore, ensuring an unobstructed LoS is necessary for useful communication in microwave associations [8-10]. It is due to the; microwave signals are recognized to be transferred in the direct line. In reality, the route of the microwave signal makes an elliptical curvature, which is defined, through the Fresnel zone [11-13]. In the Fresnel zone structure for LoS connection, the paths of the signals are categorized into various Fresnel zones. In that case, in such a case the designer of the microwave links determined the clearance of a direct path between transmitter and receiver. So, the more important Fresnel zone is the first Fresnel zone where most of the signal strength is around 90% of the concentration of the signal strength [14-16]. However, most of the designers specify the direct path clearance through the first Fresnel zone. Therefore, the link that required high reliability also specifies the path clearance of the higher Fresnel zone. This paper is derived that can be utilized to convert the line of sight percentage from one Fresnel zone to another one. In such a case the height of the given line of sight clearance, the proposed prototype can be utilized to find the alike line of sight percentage clearance in each Fresnel zone. The model of this paper is derived keep in mind the height of the line of sight, the associated parameter of diffraction, and the Fresnel region diameter is stated in the specification.

Meanwhile, mobile phones have been extensively expanding, Wi-Fi distribution has performed an imperative act to relieve smartphone traffic profitably. Thus far, due to the good coverage characteristics and timely market launch of the 802.11b/g 2.4 GHz band is highly crowded. As the need for traffic quickly rises, so it is expected important no of Wireless Fidelity (Wi-Fi) will be installed at 5 GHz ISM band, wherever randomly eighth times additional channels of frequency are available [17]. Additionally, the latest Physical layer modifications in 802.11n/ac encompassing elements such as high order modulation and coding techniques or channel attachment will more increase the capacity of the system. Principally, the Judgment of the capacity will be highly affected by the access point (AP) density of using the 5GHz ISM band channel. However, a maximum of research struggles is far-off dedicated to Wi-Fi role assessment at the agreed access point AP density and the bandwidth of the system [18].

Largely, many industrial estimations were existed to appear the advantage of 802.11n/ac in the 5 GHz ISM band over 802.11b.g, at what time numerous access points are installed in further genuine backgrounds [19–21]. Minimally, many logical efforts on dense CSMA/CA systems in similar backgrounds have been complete [22–23]. Actually, transmission conditions in distinctive enclosed

backgrounds are much dependent on the type of local locations [24]. The key donation of the reading is the primary try to measure the possible capability of collective 5 GHz' ISM band Wireless Fidelity (Wi-Fi) passage/channel by putting into account the densification and wall Loss sensitivity.

## Methology

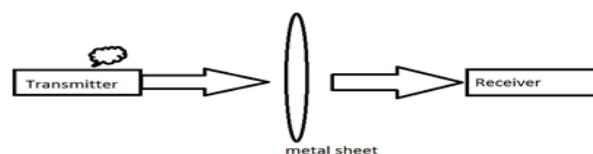
The strength of the signal is affected when the metal obstruction is placed in the first Fresnel zone. The signal strength is degraded due to the property of reflection of metals surfaces and with less power signal is received at the receiver end. As mentioned in the literature review several studies have already been done on this topic, but this study quantifies the signal strength received in the 5GHz band. Without obstruction, then placed metals sheets of 30mm and 60mm. at last compared the indoor, outdoor and simulated environment results. As mentioned in figures 3, 4 and 9, the experimental setup have a Wifi router as a transmitter, operating in a 5GHz band at one end on the height of 0.6 meters from the ground. On the other end, a receiver (laptop) receive is placed at the same height. Placed the metal obstruction in the middle between the transmitter and receiver to block the first Fresnel zone completely and decrease the signal strength of the received signals. The experiment is performed in the indoor and outdoor scenarios and the same scenario is implemented in the TamoGraph software. Our focus was on the strength of the signal received.

## Research Problem

The Research is related to check the effect of metal in the first Fresnel zone indoor and outdoor scenario on the signal strength of WIFI operating in the 5 GHz band. As we know that metals have properties of reflection, refraction, absorption, and diffraction, so they affect the strength of the signal. The signal strength is decreased by placing the metal obstruction in the first Fresnel zone. The amount of signals blocked by the metal of 60mm iron in terms of reflection and less amount of signals is reached to the receiver, therefore the signal strength is less at the receiver side in case of the obstructing material in the first Fresnel zone.

### *Experimental Setup*

The block diagram shows the experimental scenario/Setup of the experiment, the transmitter is a WIFI device and transmits the signal operating in 5GHz and the receiver is usually a laptop with the latest version of Hometown software installed which detect the signal strength. The middle circular shape is a metal sheet through which we have blocked the first Fresnel zone and check the signal degradation through the metal of 60mm iron.



**Figure.2 Experimental Setup Block Diagram**



**Fig 3. Experimental setup practical scenario receiver side**



**Fig 4. Experimental setup practical scenario transmitter side**

**Table 1: Technical details of the equipment used**

Transmitter	Modal specification
LB-Link access point	750Mbps wireless dual-band 11ac router
The transmission power of the 5Ghz band antenna	15 dBm
Reception sensitivity 5GHz	11ac HT80:61dbm
Antenna gain	10dbi

**Table 2: Receiver Specification**

Laptop	Modal specification	Software installed
Dell core i5	4th generation	Homedale

**Table 3: Metal Obstruction Specification**

Type	Gauge
Iron	60mm

In Table, I the specification of the transmitter is shown which is an access point and acted as a transmitter. In Table II the receiver model and specifications have been mentioned. In Table III the details of the metal obstruction are mentioned.

#### ***Homedale Software***

Homedale software is used to monitor the power of the received signal at the receiver. It displays the actual result on the screen of the laptop and works in a real-time environment. dbm unit is used for all the received signal strength.

#### ***Metal Obstructions***

The metal obstruction used in the experiment were gauges of 30mm and 60mm. The metal sheets were used to block the first Fresnel zone completely. During the experiment reflected signals from the windows, door, and wall in the indoor environment results in many phenomena. The diameter of the metal obstructions used is 1 meter.

### **Measurements and Observations**

The uppermost value shows the minimum value of the data. The value in the middle of the box shows the average/mean value. The lowest value shows the maximum value of the data and the data in the right side corner, the upper value shows the 3rd quartile, the middle value shows the 2nd quartile that is the same as the median of the data. The lower value shows the first quartile of the data. We will discuss the median value of each box plot.

The box plots of without obstruction indoor and 60mm iron indoor are given in Fig 5 and Fig 6. We can see that in the case of without obstruction the maximum value is -56dbm and the minimum value is -63dbm in the reading while the average value is -59.44dbm and -60dbm and -58dbm are the values of third quartile and first quartile respectively. In the case of 60mm, obstruction placed in the middle the maximum value is -63dbm, and the minimum value is -71dbm in the reading, while the average value is -66.58dbm and -68dbm, -65dbm are the values of third quartile and first quartile respectively. So the median value is used as a discussion parameter in the research.

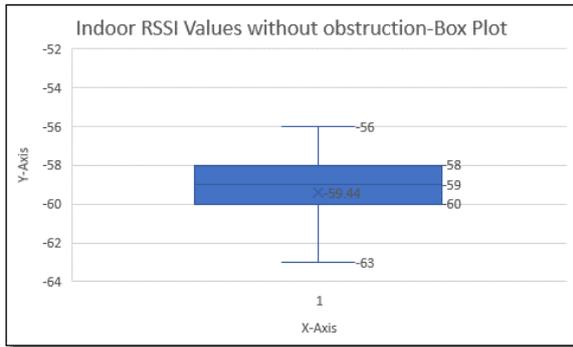


Fig.(a) Box plot of the power received without obstruction in an indoor environment

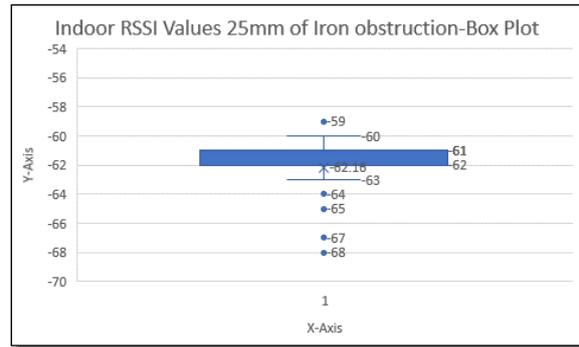


Fig (b). Box plot of the power received using 25mm obstruction in an indoor environment

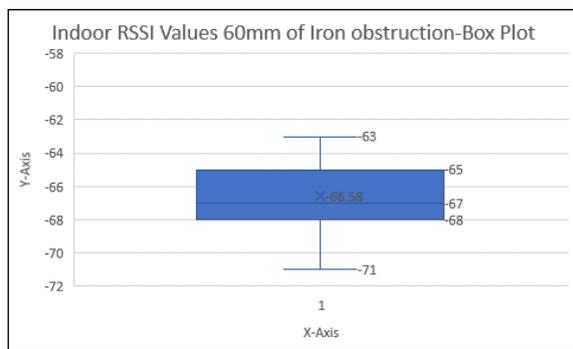


Fig (c). Box plot of the power received using 60mm obstruction in an indoor environment

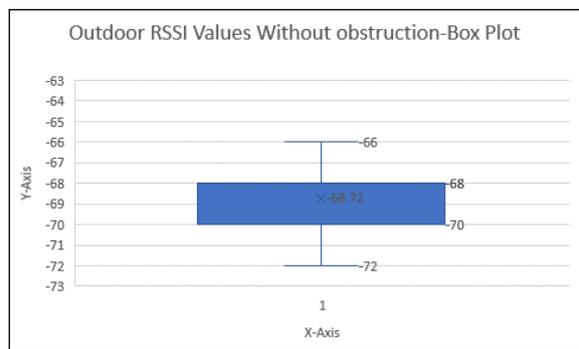


Fig (d). Box plot of the power received without obstruction in an outdoor environment

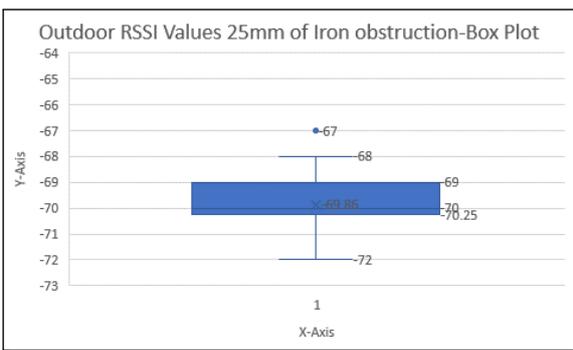


Fig (e). Box plot of the power received using 25mm obstruction in an outdoor environment

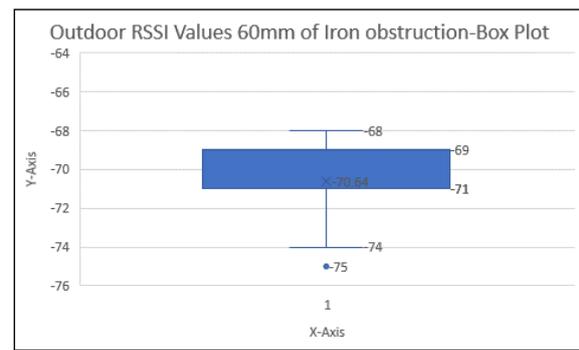


Fig (f). Box plot of the power received using 60mm obstruction in an outdoor environment

using a metal of 25mm and 60mm of iron and WIFI router is used as a transmitter and my personal laptop dell core i-5 installed software Hamedale is used as a receiver. The Hamedale software analyzed and detect the signal strength received by the laptop. And show them on the laptop display. The distance between the transmitter and receiver is 16 meters calculated according to the 5GHz frequency band. According to the 5 GHz band, the area of the first Fresnel zone is 1 meter if the distance between the transmitter and receiver is kept 16 meters. Started with the first Fresnel zone, the first Fresnel zone is unobstructed and the experiment is performed. Then metal sheets of 60mm of the iron gauge are placed at a distance of 8 meters from the transmitter and receiver to block the first Fresnel zone completely. At

last, we used a software called TamoGraph to validate the practical data, so from the result of TamoGraph, we understood that the result is slightly different because of the difference between the virtual environment and practical environment.

## **Analysis and Discussion**

### ***A. COMPARISON OF THE RSSI VALUES BETWEEN WITHOUT OBSTRUCTION AND 60MM OF IRON OBSTRUCTION INDOOR SCENARIO***

The median value of signal strength without obstruction is -59dbm while the 60mm of iron are -67dbm, so there is a decrease of 8dbm in the median values in the signal strength by placing 60mm of iron. The reduction in the value of the median is due to the obstruction placed to block the first Fresnel zone completely. Most of the signals are not reach the receiver and are reflected back by the obstruction placed to block the first Fresnel zone.

### ***B. COMPARISON OF THE RSSI VALUES BETWEEN 25MM AND 60MM OF IRON OBSTRUCTION INDOOR SCENARIO***

The median value of signal strength is 25mm of iron -61dbm while the 60mm of iron are -67dbm, so there is a decrease of 6dbm in the median values in the signal strength by placing 60mm of iron instead of 25mm of iron. The reduction in the value of the median is due to the thickness increased from 25mm to 60mm of iron metal in the first Fresnel zone.

### ***C. COMPARISON OF THE RSSI VALUES BETWEEN WITHOUT OBSTRUCTION AND 60MM OF IRON OBSTRUCTION IN THE OUTDOOR SCENARIO.***

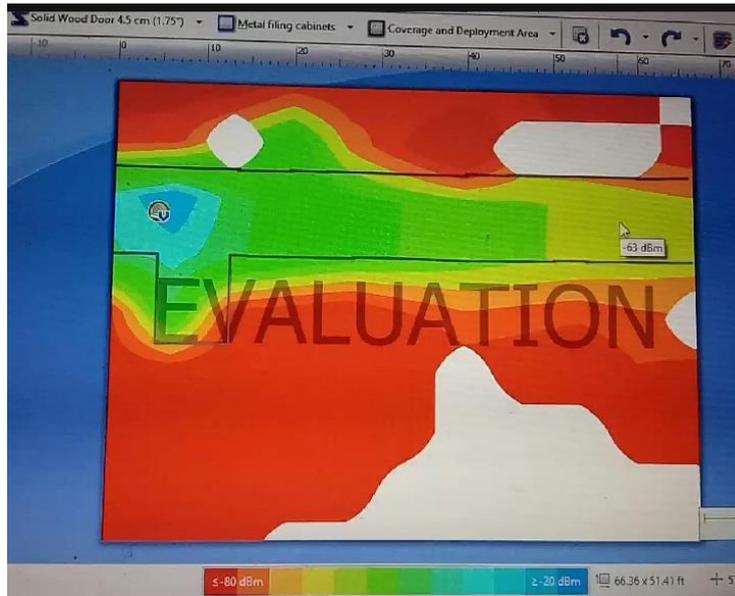
The box plots without obstruction and 60mm iron in outdoor experimental Scenarios are shown in Fig 7 and Fig 8. From the figures, we can observe that the median value is -68dbm in the situation when there is no obstruction put in the first Fresnel zone and the first Fresnel is totally cleared. When the obstruction is placed in the case of an outdoor environment the median value detect by Homedale software and then shown in the box plot is -71dbm. we can see that the median values of signal strength without obstruction is -68dbm and 60mm of iron are -71dbm, so there is a decrease in the signal strength by placing 60mm of iron to block the first Fresnel zone 100%. By comparing the Values, the reduction occurred due to the presence of obstruction. Because when we place the obstruction to block the first Fresnel zone the signals reached to the receiver are also decreased, so less power is detected at the receiver side.

### ***D. COMPARISON OF THE RSSI VALUES BETWEEN 25MM AND 60MM OF IRON OBSTRUCTION OUTDOOR SCENARIO***

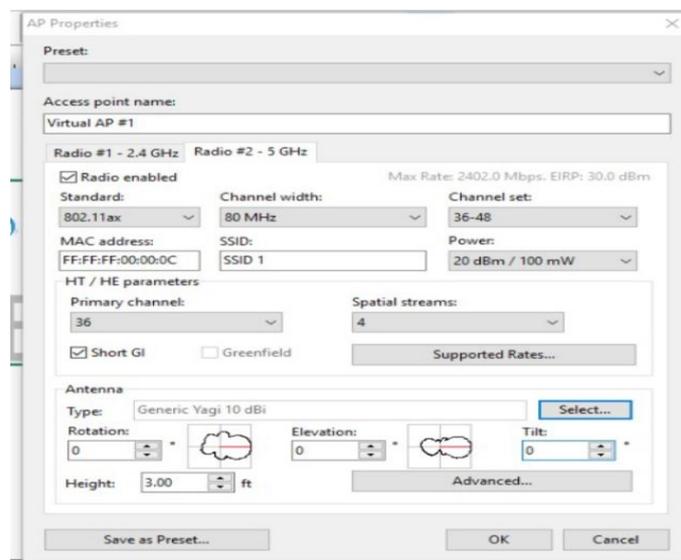
The median value of signal strength is 25mm of iron -66dbm while the 60mm of iron are -71dbm in the outdoor environment, so there is a decrease of 5dbm in the median values in the signal strength by placing 60mm of iron instead of 25mm of iron. The reduction in the value of the median is due to the thickness increased from 25mm to 60mm of iron metal in the first Fresnel zone.

### ***E. COMPARISON OF THE MEDIAN VALUES BETWEEN THE INDOOR AND OUTDOOR SCENARIOS.***

If we compare the values recorded in-door and out-door environments, the out-door values are smaller than the indoor values because in the in-door environment the signals are reflected from the walls, windows, and doors which will reach the receiver and empower the strength of the signal. In the case of an outdoor environment, the signals spread in each direction, and only the signals which are directed towards the receiver are received by the receiver, and the signals which are directed other than the receiver are lost and as a result, the strength of the signal is decreased



**Fig 5. Simulation of the indoor propagation environment through Tomograph Software**



**Fig 6. Access Point specifications**

***F. COMPARISON OF THE RSSI VALUES BETWEEN THE INDOOR SCENARIO OF THE PRACTICAL AND VIRTUAL ENVIRONMENT.***

In the case of an in-door scenario without obstruction, the result of the practical value is compared with the simulated value. The average value of signal strength in an indoor environment without obstruction is -59.44dbm while the average value of the signal strength simulated by TamoGraph software for the same in-door without obstruction is -63dbm. The difference in the results is due to the difference in the simulated and practical scenarios. Certain factors could not be implemented accurately in a simulated environment so there is a more than 3dbm difference that occurred which is not a huge difference.

**Conclusions**

From the research, it can be concluded that placing the obstruction in the first Fresnel zone affects the signal strength. The power of the signal will be high when there is no obstruction between the transmitter and receiver and the signal power are significant decreases by putting the obstruction between them. The signal strength is decreased by placing the metal material in the first Fresnel zone

because the metals sheet will reflect the signals and as a result, the number of signals is decreased to the receiver, therefore the signal strength will also be less at the receiver side. The signal strength received by the receiver will be high when the medium between the transmitter and receiver are empty, empty means a clear line of sight that is receiving the signals without obstruction. The signal strength will be low when the metal of gauge 60 mm of iron obstructs the medium between the transmitter and receiver. Due to the presence of obstruction, a greater amount of reflection will occur which reduced the signal strength at the receiving end.

## Future Work

In the future, the same analysis can be done with the help of non-metal materials, different type of metals, metals of different gauges other than this, metals painted by different paints to check the signal degradation by these materials placed in the first Fresnel zone of transmitter and receiver.

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# Development and Validation of Compressive Strength of Marble Powdered Self-Compacting Concrete Containing Rice Husk Ash Using Artificial Neural Network Technique

(Ref No. ICETEMS-21-093)

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## Abstract

In recent years, numerous investigations about the impacts of filler and binding materials on the properties of self-compacting concrete (SCC) have been carried out. The disposal of waste material is a big issue in a country like Pakistan where the most important component of the construction field is concrete. The purpose of this study is to develop rheological and hardened properties of SCC by utilizing waste and cementitious materials and to check the feasibility by using Artificial Neural Network (ANN) technique for the prediction of compressive strength of Marble Powder based self-compacting concrete containing RHA. Utilizing certain waste materials in our experimental work, total 22 mixes were prepared using Marble Powder (MP) as sand replacement with ratios of 10% and 20% and rice Husk Ash (RHA) used as cement replacement with ratios 0% to 25%. The ANN model is constructed based on back propagation network technique using Levenberg-Marquardt (LM) Algorithm. The various input parameters of neural network effecting the properties of Self compacting concrete are cement content, water, RHA, Marble Powder, Coarse and Fine Aggregates and Super Plasticizers (SP). The output parameter of ANN is Compressive Strength at specific days. The effectiveness of ANN model is assessed by comparing its predicted values with experimental data. Our Results after comparing with experimental values shows that the ANN Model has overall accuracy of +95% for compressive strength of SCC which shows that this Levenberg-Marquardt based ANN model is found out to be good learning algorithm for this study.

## Keywords

Artificial Neural Network (ANN), Levenberg Marquardt (LM) algorithm, Marble Powder (MP), Rice Husk Ash (RHA), Self-Compacting Concrete (SCC).

## Introduction

In this modern world, Concrete is considered the most important component of the civil engineering field. And one of the most important concrete property i.e., durability is key to build reinforced concrete structures with long service life (Bilim, Atiş et al. 2009). Because of the current environmental and economic issues, it is a main task to make modifications on conventional concrete to make it a strong and durable concrete. One such kind is the Self Compacting Concrete (Gill and Siddique 2018).

The main distinction among Self compacting concrete and conventional concrete is just because of mixing proportions of materials. SCC is known as innovative concrete of the era and having property of self-settlement in construction area without vibratory force. SCC settles under its own weight by making its path like fluid (Shi, Wu et al. 2015). SCC is known as innovative because SCC can easily be used in congested areas where concreting is not easy. In SCC, noise pollution reduces and improve the filling capability and enhances construction speed (Nikbin, Beygi et al. 2014).

Due to current climatic and environmental pollution issues, it turns out to be exceptionally important to use waste products in some useful and efficient ways. One such kind is of highly reactive pozzolanic

material i.e., Rice Husk Ash (RHA), is a waste product obtained by burning rice husks in a controlled temperature not more than 700 C (Gill and Siddique 2018).

In Pakistan, Rice Husk produced about 22% of Rice crops' total weight (Memon, Shaikh et al. 2011) and then dumped at different disposal sites. This dump causes environmental and health issues. To avoid this type of effect, many people try to use this ash for different purposes. As MP has high amorphous silica content, it can be availed as Supplementary cementitious materials (SCMs). There have been several researches based on RHA as a cement replacement to check its effects on rheological properties of SCC (Raisi, Amiri et al. 2018).

Marble Powder (MP) is also a wastage of the marble industry. In marble industries, MP waste produced by marble cutting. MP is not being recycled in marble industries (Topcu, Bilir et al. 2009). MP just dump outside the industry as waste material. In Pakistan, MP produced about 300 million tons in different marble industries. Numerous researchers have proposed that SCC containing MP is stronger than reference concrete (Belaidi, Azzouz et al. 2012). Therefore, MP can be utilized as a substitution of filler material in Concrete (Demirel 2010).

Nowadays, the use of soft computing techniques by different researchers are increased. The aim of this study is to develop Self Compacting Concrete by utilizing locally available waste materials and to develop Artificial Neural Network Model to predict the compressive strength of SCC. For this purpose, MATLAB had used. Furthermore, results of ANN were compared with experimental results to check accuracy of Model.

## Experimental Study

### Materials

#### *Binder:*

Ordinary Portland Cement named as “Lucky” with registration code ISO 9001:2000 meeting requirements of ASTM C 150 is used in this experimental procedure. Its properties are mentioned in Table. 1.

**Table 1: Binder Properties**

<b>Physical Properties</b>	<b>Results</b>
Normal Consistency %	27
VICAT Initial settling time (min)	150
VICAT Final settling time (min)	245
Specific Gravity	3.073
Le-Chatelier Expansion (mm)	1.68
Compressive Strength at 7 <sup>th</sup> Day (psi)	3524
Compressive Strength at 28 <sup>th</sup> Day (psi)	5800

#### *Coarse Aggregate*

Coarse aggregates used in this experimental procedure are less than 19mm and meets the requirement of ASTM C33M. Its properties are given in Table No. 2

#### *Fine Aggregate*

Fine aggregates meeting the requirements of ASTM C33 are used in this research having size less than 4.75mm. Its properties are mentioned in Table No. 2

**Table 2: Properties of Coarse and Fine Aggregates**

<b>Properties</b>	<b>CA</b>	<b>FA</b>
Surface Texture	Rough	Smooth
Particle shape	Angular	Rounded
Specific Gravity	2.59	2.63

**Marble Powder**

Marble Powder used as a filler material, a waste material is obtained from mountains or rocks of Taxila, Pakistan. Its properties are given in Table no. 3.

**Rice Husk Ash**

RHA used in this research was obtained after burning rice husk i.e., overing of rice crops at a controlled temperature. RHA have high pozzolanic characteristics and used as a cement replacement in this experimental work. Its properties are mentioned in Table No. 3.

**Table 3: Properties of Marble Powder and Rice Husk Ash**

<b>Physical Properties</b>	<b>MP</b>	<b>RHA</b>
<b>Color</b>	White	Grey
<b>Surface Texture</b>	Smooth	Irregular
<b>Particle shape</b>	Rounded	Irregular
<b>Chemical Composition %</b>		
<b>Silicon Dioxide</b>	83.2%	-
<b>Calcium Oxide</b>	1.6%	-
<b>Aluminum Oxide</b>	0.25%	-
<b>Iron Oxide</b>	0.1%	-

**Water and Admixture**

Tap water is used in this research. Superplasticizer used as a water reducing agent is Viscocrete-3110 (Sika, 2011) to attain high workability. Properties are mentioned in Table No. 4

**Table 4: Properties of Super Plasticizer**

<b>Physical Properties</b>	<b>Results</b>
Color	Yellowish
Form	Liquid
Density (kg/m <sup>3</sup> )	1080
Specific Weight (g/cm <sup>3</sup> )	1.17
Chemical	Aqueous solution of modified polycarboxylates, co-polymers

**Mix Proportions**

Design mix was done based on Self compacting concrete codes by keeping MP on 10% and 20% while RHA mixes from 0% - 25% each in 2.5% interval. Total of 22 design mixes were made and shown in Table No. 5.

**Table 5: Mix Proportions**

<b>Sr. No.</b>	<b>MIX ID</b>	<b>Cement (kg/m3)</b>	<b>RHA (kg/m3)</b>	<b>MP (kg/,3)</b>	<b>FA (kg/m3)</b>	<b>CA (kg/m3)</b>	<b>Water (kg/m3)</b>	<b>SP (% of binder)</b>
0	RFF	455	0	0	702	645	189.6	0.75
1	MP10R0	455	0	70.2	631.8	645	189.6	0.75
2	MP10R2.5	443.625	11.375	70.2	631.8	645	189.6	0.75
3	MP10R5.0	432.25	22.75	70.2	631.8	645	189.6	0.75
4	MP10R7.5	420.875	34.125	70.2	631.8	645	189.6	0.75
5	MP10R10	409.5	45.5	70.2	631.8	645	189.6	0.75
6	MP10R12.5	398.125	56.875	70.2	631.8	645	189.6	0.75
7	MP10R15	386.75	68.25	70.2	631.8	645	189.6	0.75
8	MP10R17.5	375.375	79.625	70.2	631.8	645	189.6	0.75
9	MP10R20	364	91	70.2	631.8	645	189.6	0.75
10	MP10R22.5	352.625	102.375	70.2	631.8	645	189.6	0.75
11	MP10R25	341.25	113.75	70.2	631.8	645	189.6	0.75
12	MP20R0	455	0	140.4	561.6	645	189.6	0.75
13	MP20R2.5	443.625	11.375	140.4	561.6	645	189.6	0.75
14	MP20R5.0	432.25	22.75	140.4	561.6	645	189.6	0.75
15	MP20R7.5	420.875	34.125	140.4	561.6	645	189.6	0.75
16	MP20R10	409.5	45.5	140.4	561.6	645	189.6	0.75
17	MP20R12.5	398.125	56.875	140.4	561.6	645	189.6	0.75
18	MP20R15	386.75	68.25	140.4	561.6	645	189.6	0.75
19	MP20R17.5	375.375	79.625	140.4	561.6	645	189.6	0.75
20	MP20R20	364	91	140.4	561.6	645	189.6	0.75
21	MP20R22.5	352.625	102.375	140.4	561.6	645	189.6	0.75
22	MP20R25	341.25	113.75	140.4	561.6	645	189.6	0.75

***Preparation and testing of samples***

Cubes of sizes 100x100x100mm (4x4x4 in.) were casted for compressive strength testing. After that, Cubes were demolded and placed in tap water for curing purposes.

***Concrete Tests******Fresh Concrete***

Slump Flow, V-Funnel and L-Box Test are performed on fresh concrete to investigate the filling and passing ability of SCC.

***Hardened Concrete***

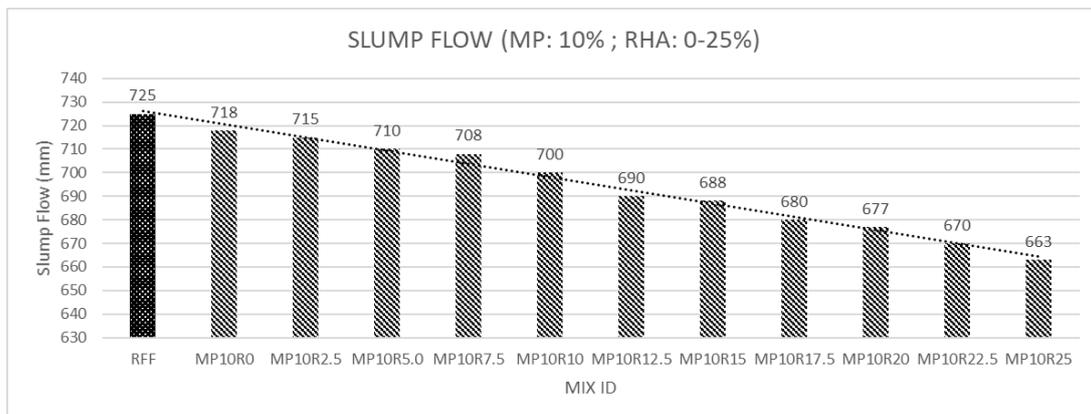
Compressive strength test is performed on cubes after completion of curing time. Three specimens of each mix were tested to obtain good results.

## Experimental Results

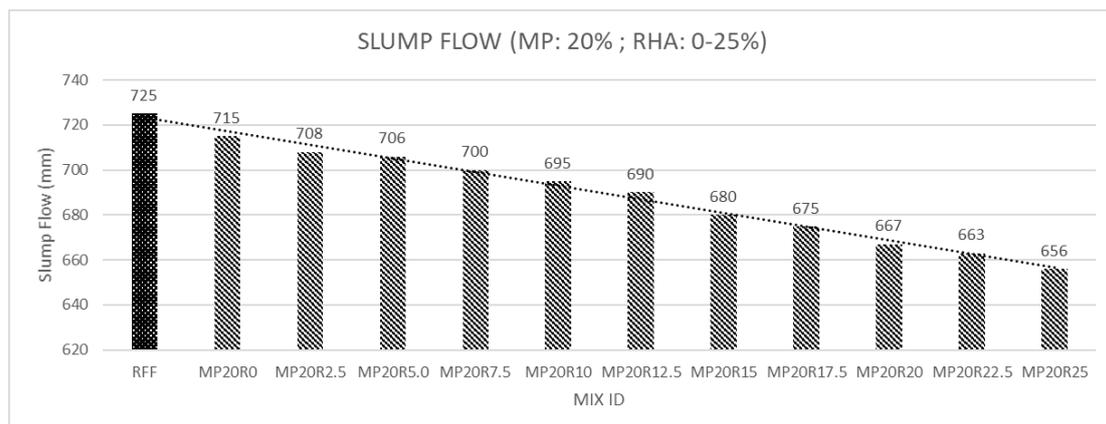
### Fresh Properties

#### Slump Flow Test

Slump flow test is performed to check the workability of Concrete. Results obtained after experimentation fall in the range given by EFNARC i.e., 650 mm to 800 mm. Results are shown in Fig. 1 and Fig. 2.



**Figure 1: Slump Flow Test Results (MP 10%, RHA 0-25%)**



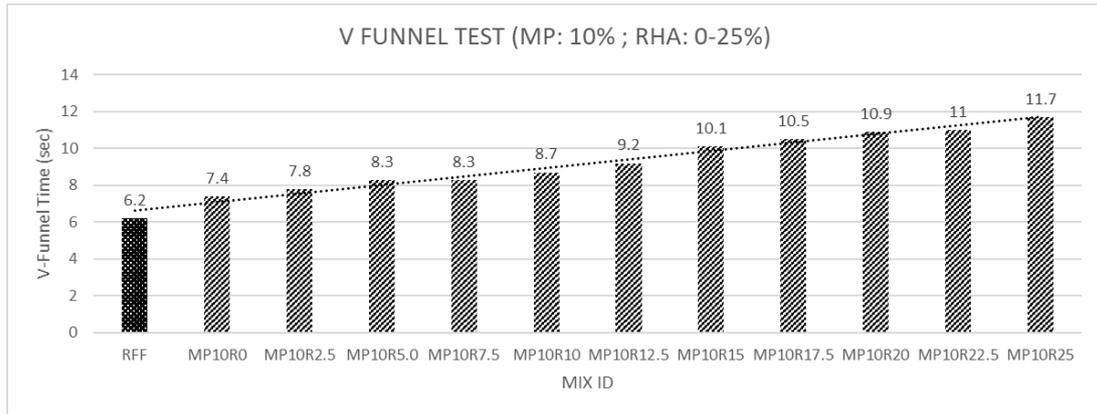
**Figure 2: Slump Flow Test Results (MP 20%, RHA 0-25%)**

#### V-Funnel Test

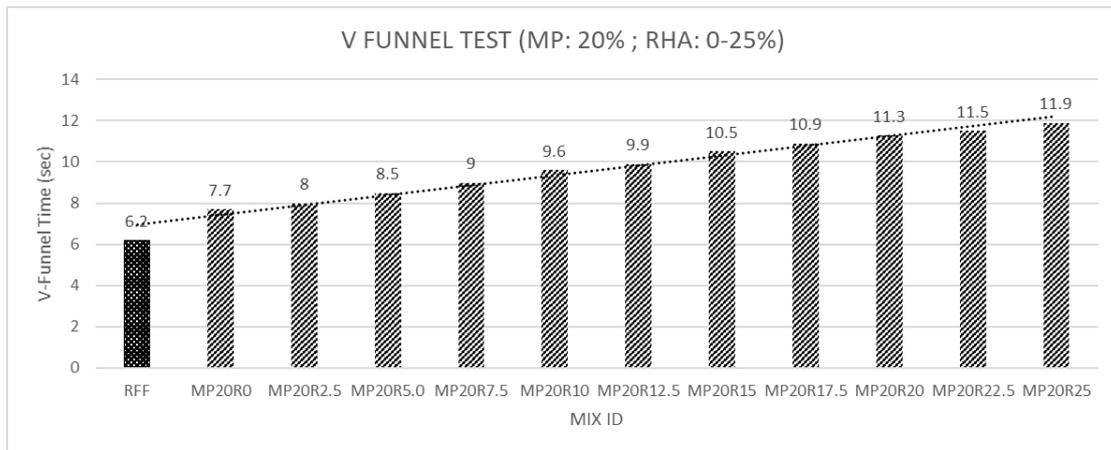
V-funnel test is considered a second workability test performed on fresh concrete to check the flow ability of SCC. Results obtained after experimentation fall in the range given by EFNARC i.e., 6-12 sec. Results are shown in Fig. 3 and Fig. 4.

#### L-Box Test

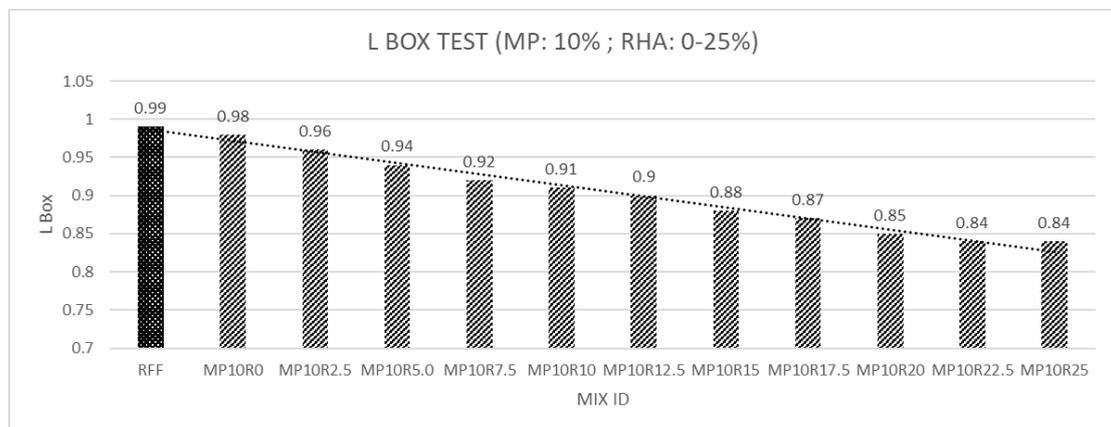
L-Box test is used to check the passing ability and blockage ratio ( $h_2/h_1$ ) of SCC and considered as a third workability test. Blockage ratio obtained from L-Box test lies within acceptable range given by EFNARC i.e., 0.8-1.0. Results are shown in Fig. 5 and Fig. 6.



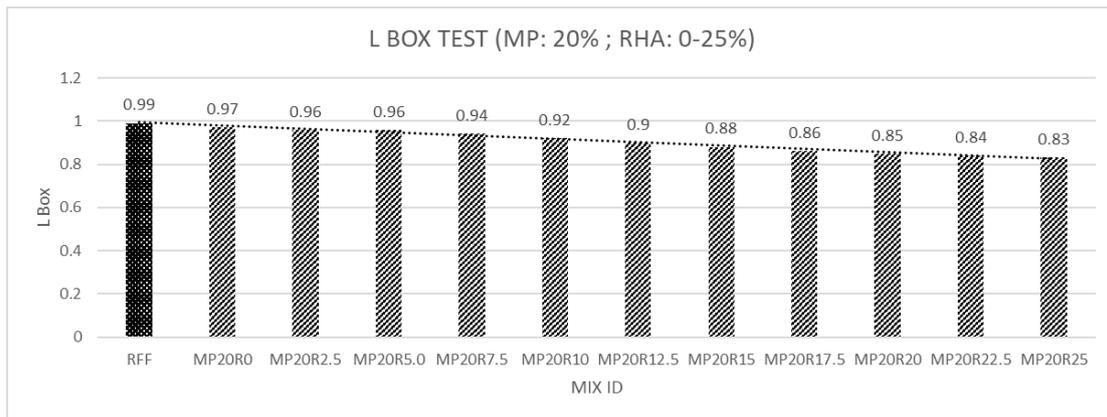
**Figure 3: V-Funnel Test Results (MP 10%, RHA 0-25%)**



**Figure 4: V-Funnel Test Results (MP 20%, RHA 0-25%)**



**Figure 5: L-Box Test Results (MP 10%, RHA 0-25%)**

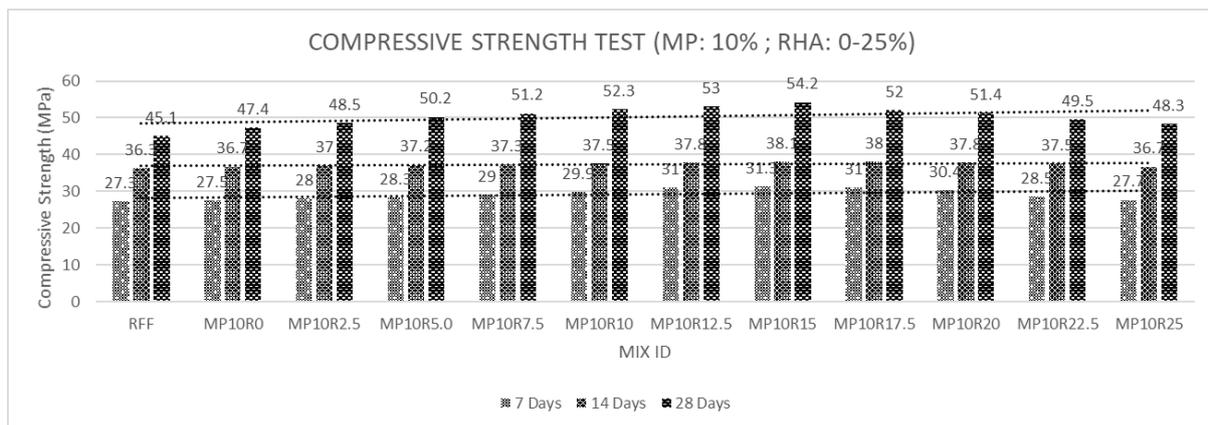


**Figure 6: L-Box Test Results (MP 20%, RHA 0-25%)**

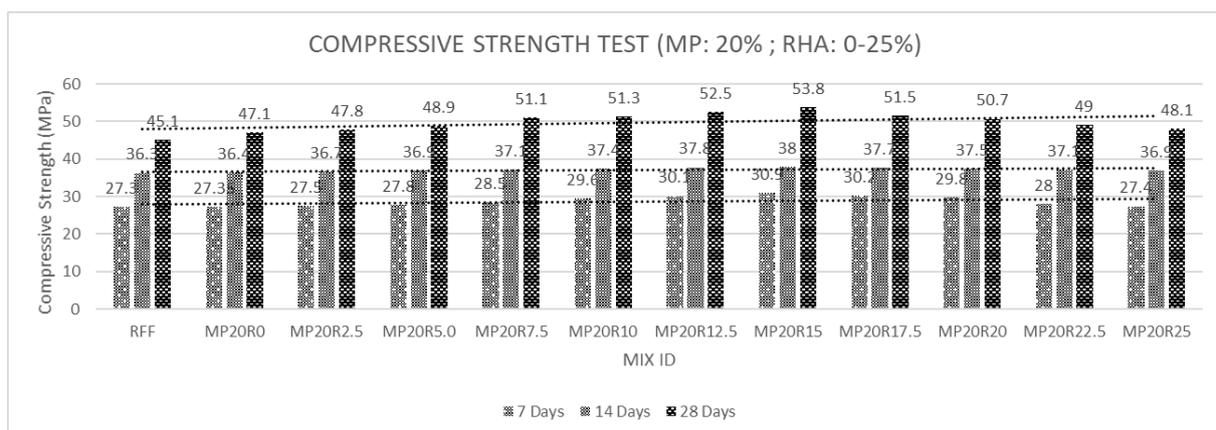
## Hardened (Mechanical) Properties

### Compressive Strength Test

Compression Strength test was performed on hardened concrete after 7, 14 and 28 days to check the compressive strength. Results are shown in Fig. 7 and Fig. 8.



**Figure 7: Compressive Strength Test Results (MP 10%, RHA 0-25%)**



**Figure 8: Compressive Strength Test Results (MP 20%, RHA 0-25%)**

It is noted that, compressive strength at 28 days increases about 20% when using mix No. 7 i.e., MP 20%, RHA of 15% used as cement replacement. But after adding more than 15% RHA, Compressive strength value decreases w.r.t reference sample.

### Artificial Neural Network for the prediction of experimental results

In simple words, an artificial neural network (ANN) is a mathematical or computational model that is motivated by the human brain and its huge biological Neural Network. It can learn from experiences to develop its performance. Same as human brain, Artificial Neural Network obtains information through learning. It consists of different functions and weights which acts as artificial neurons and are linked to each other like a network. They are mostly used in artificial intelligence tasks related complex problems. (Nikoo, Torabian Moghadam et al. 2015).

Generally, an ANN model comprises of different layers, input and output consists of input and output data. Between these layers, there are one or more hidden layers depending upon the model. It includes neurons which has activation functions, linear or nonlinear such as sigmoid etc. and are connected by weights to determine the output. (Bilim, Atiş et al. 2009).

ANN consists of three different steps of training, validation and Test. In training step, model trains itself by repeating and adjusting weights to get the needing output. The errors of the validation step are checked thoroughly during the training step (Khademi and Jamal 2016).

In this study, input layer consists of 7 variables/parameters and one output paramant. The input parameters/variables are cement, rice husk ash, marble powder, coarse and fine aggregates, water content, and super plasticizer. Compressive strength of the concrete at 7, 14 and 28 days was selected as model outputs. It was developed and performed on MATLAB as shown in Figure. 9.

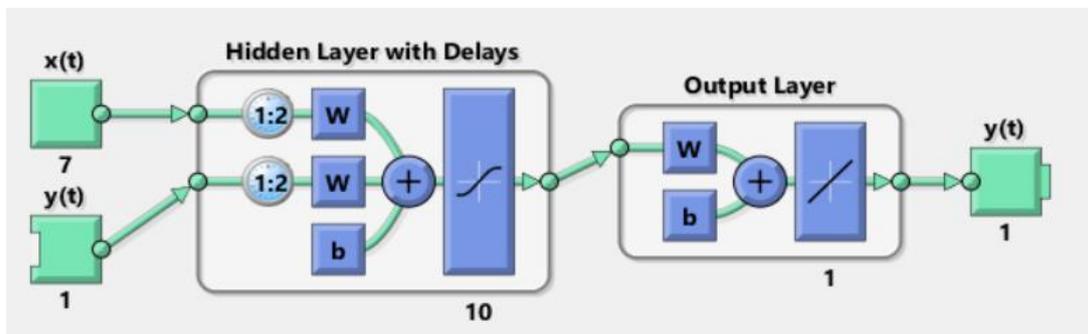


Figure 9: Structure of ANN Model used in MATLAB.

The model was based on back propagation network technique using Levenberg-Marquardt (LM) Algorithm. In the training, one hidden layer is made and its size selected is ten. The data set is divided into three categories of training which is taken as 60% of total data, Validation is taken as 20% and testing which is also 20% of total dataset. Results are shown in Fig. 10 to Fig. 12.

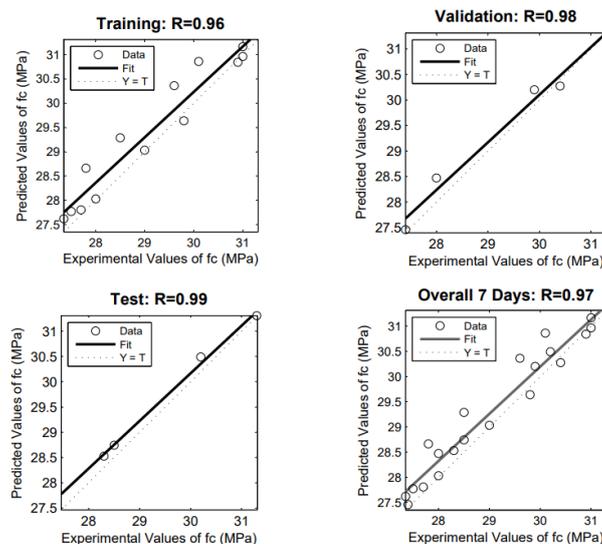
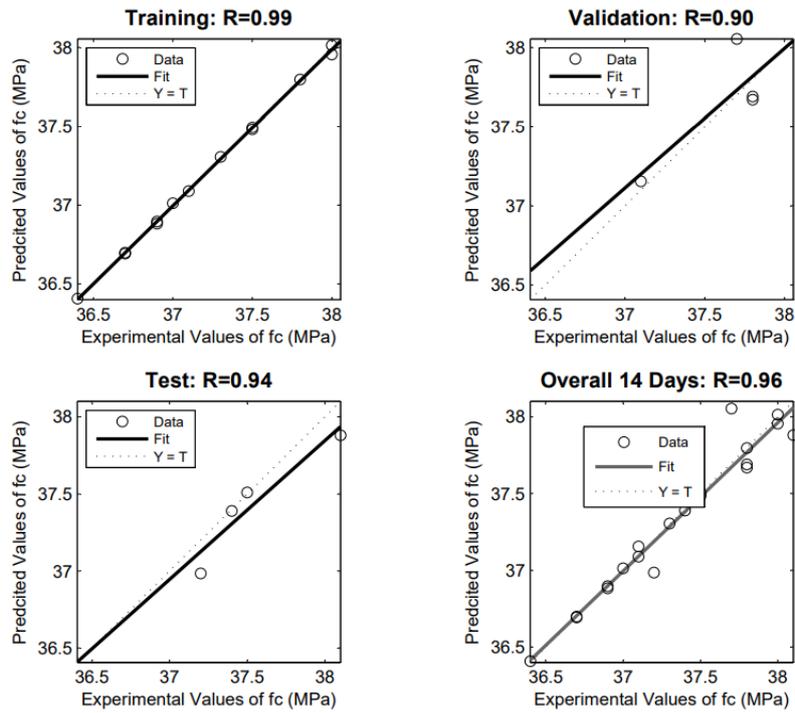
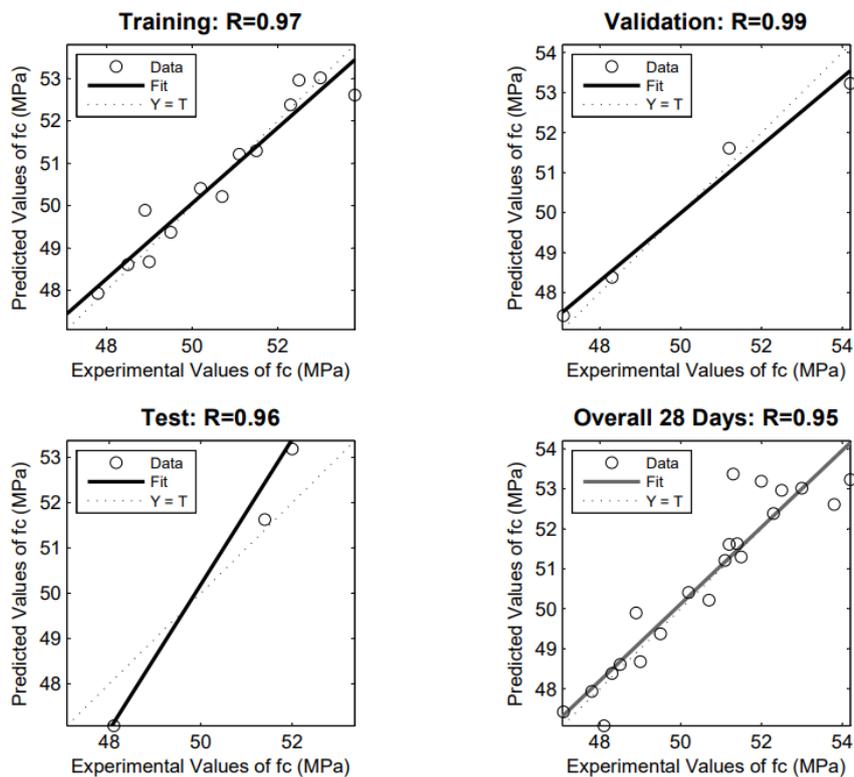


Figure 10: ANN Results at 7 Days



**Figure 11: ANN results at 14 Days**



**Figure 12: ANN Results at 28 Days**

Figures. 10 – 12 shows results of Artificial neural network model at 7, 14 and 28 days with an overall accuracy of 95 – 97% which shows that this Levenberg-Marquardt based ANN model is found out good learning algorithm for marble based self-compacting concrete.

## Conclusions

The following conclusions were made as a result to this research study:

- i. It is concluded that SCC can successfully be developed with fixed content of Marble powder and Rice husk ash up to 25% as per EFNARC guidelines.
- ii. In investigating fresh properties of SCC, it is proved that Slump flow values decreased, and L-Box and V-Funnel results increased meaning that flow and passing ability decreases with increasing the content of RHA but fell within the acceptable range given by EFNARC.
- iii. Compressive Strength of SCC increased up to addition of 15% RHA, however, strength loss was observed beyond 15% addition of RHA.
- iv. The ANN Model predicted the compressive strength of Marble Powdered Self compacting concrete with an overall Accuracy of +95% which showed that Levenberg-Marquardt based ANN model is found out good learning algorithm for this study. As a result, instead of expensive experimental investigation, an ANN model can be used to estimate the compressive strength of concrete with high accuracy.

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# Investigation of the Effect of Varying Gradations on the Marshall Properties of Hot Mix Asphalt

(Ref No. ICETEMS-21-110)

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## Abstract

Aggregate is one amongst the most important components of hot mix asphalt, contributing ninety to ninety-five percent of asphalt mix by weight or eighty to ninety percent by volume. Aggregates thus not solely influence the engineering properties of hot mix asphalt but conjointly its overall performance. Gradation, one amongst the crucial properties of aggregate blend was considered in this study to evaluate its effect on Marshall properties of hot mix asphalt. Along with Attock Refinery Limited 60/70 penetration grade binder, four completely different gradation blends were utilized for preparation of hot mix asphalt via Marshall method of mix design. Optimum binder contents were determined at four percent air voids against which all other volumetric and strength parameters were determined. It was concluded that the asphalt mix design properties vary significantly with variation in gradation blends. The requirement of optimum binder content was lower when the gradation blend was coarser and greater when the gradation blend was finer due to their surface areas. Fine gradation bituminous mixes showed higher values of voids in mineral aggregate, voids filled with asphalt and deformation compared to coarse gradation bituminous mixes. Moreover, bituminous mixes with strong interlocking of aggregate particles showed better stability.

## Keywords

Gradation, Marshall Mix Design, Hot Mix Asphalt, Marshall Parameters

## Introduction

Hot mix asphalt (HMA) is primarily composed of binder and aggregates. The binder plays the role of an adhesive agent and causes aggregate particles to stick together in a single unit mass. After fasten by the binder, mineral aggregates behave like a stone skeleton and contribute toughness and durability to the structure. The response of flexible pavements relays on the individual attributes of these integrants as well as on their combine behavior in the system [Asim, 2013].

It's important to choose compatible aggregate source, aggregate gradation, bitumen grade and its proportion for the design of asphalt mix in order to fulfill the needs of a certain paving project. Almost all of the important properties of an asphalt mix like volumetric and strength parameters are affected by variations in gradation limits and bitumen content [Banerji et al.,2014].

Gradation is likely the most essential attribute of a bituminous mix, since it influences all its important properties, including stiffness, stability, durability, permeability, workability, fatigue resistance, friction resistance, and moisture resistance [Roberts et al., 196]. This demand designers to choose best gradation blend at the stage of mix design in order to minimize such distresses and hence to develop more sustainable pavements [Qadir et al., 2018]. Therefore, an attempt has been made in this study to analyze that how variations in gradation of aggregates affect the essential mix design properties by considering four distinct wearing course gradations namely; Pakistan's National Highway Authority Class-A and Class-B, Superpave and Asphalt Institute along with 60/70 penetration grade binder.

## Literature Review

HMA is primarily consists up binder, aggregates, fillers, air voids and sometimes additives. The aggregate comprises paving mixtures of about ninety five percent by mass or between eighty and ninety percent by volume and thus significantly affects the resulting engineering properties of HMA. The typical range of coarse aggregate in bituminous mixtures for sustaining heavy loads is from thirty-five to sixty-five percent for a Nominal Maximum Aggregate Size (NMAS) of 19 mm [Polaczyk et al., 2019, ASTM, 2003].

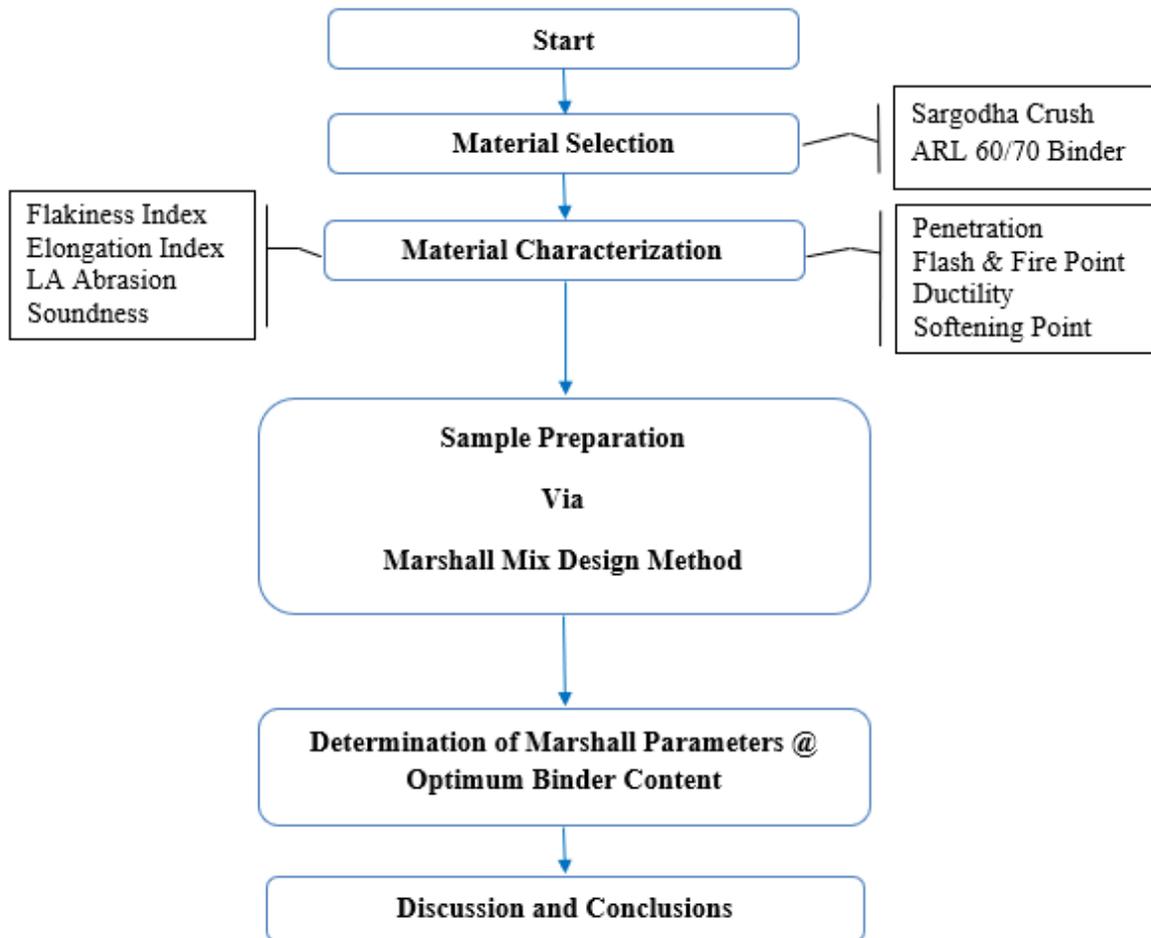
The effect of variation in aggregate gradation (fine, medium, coarse) and type (limestone, dolomite and basalt) on the properties of Marshall mix was studied. From the point of view of stability and hardness, coarse-graded bitumen mixtures showed the most satisfactory results compared to other graded bitumen mixtures [Sobhan, 1987, Afaf, 2014]. The effect of Maximum Aggregate Size (MAS) of 19 mm on the Marshall properties of HMA was investigated and it was found that 19 mm MAS could be used in HMA as it results in appropriate values of mix design parameters [Budiati, 2013].

The effect of aggregate gradation on the crushing potential of thin layers revealed a link between the fine fraction content, the maximum nominal size of the aggregate and the crushing performance of asphalt concrete mixtures. Mixtures manufactured with a low content of fine aggregate and a small nominal maximum volume showed extra improvements and hence reflected the significance of considering aggregate gradation in the design of asphalt concrete mixes [Garcia-Gil, 2019]. The effect of aggregate gradation (upper and lower boundary) and type (limestone and granite) along with stress methods on the physical properties and modulus of elasticity of asphalt mixtures was determined. The results declared that the upper limit granite asphalt mixtures compacted with rotary compressor achieved the best results of Marshall stability and resistance to stress and cracking [Al-ammari et al., 2019].

Study of the effect of gradation blends on the stability of HMA mixtures indicated that gradation control the void structure of the HMA. The maximum stability was obtained in case of open-graded blend having 2.36 mm aggregate size and five percent bitumen content [Kalaitzaki et al., 2015]. Bituminous mixtures with coarser gradation blends offer significant resistance to permanent deformation [Lira et al., 2021, Hussan et al., 2019].

## Research Methodology

The overall research methodology of the current study is presented by a flow chart in figure 1. This first step of research methodology was the selection and collection of aggregate and binder. Sargodha source of aggregate and Attock Refinery Limited 60/70 (ARL 60/70) penetration grade binder were considered for this study. After checking the appropriateness of these materials, four different wearing course gradation blends namely, Pakistan's National Highway Authority Class-A and Class-B (NHA-A and NHA-B), Superpave and Asphalt Institute (table 1) were selected to be used for developing bituminous mixtures via Marshall mix design method. Three replicates of each specimen were prepared for each gradation blend against each percentage of bitumen content (3.5, 4 and 4.5%). In order to simulate heavy traffic condition, each specimen was compacted with seventy-five hammer blows on each side. Optimum Binder Content (OBC), Marshall stability, flow and volumetric properties of all gradation bituminous mixtures were determined, results were analyzed, discussed and conclusions were drawn.



**Figure 1: Research Methodology**

**Table 1: Aggregate Gradations**

Combined Grading (Asphalt Wearing Course)						
Inch	mm	NHA-A % Passing	NHA-B % Passing	Superpave % Passing	Asphalt Institute % Passing	
1	25	100	--	--	--	
¾	19	95.0	100	100	100	
½	12.5	76.0	82.0	94.0	95.0	
3/8	9.5	63.0	70.0	87.0	82.0	
#4	4.75	42.5	50.0	65.0	59.0	
#8	2.36	29.0	30.0	37.0	43.0	
#50	0.30	8.5	10.0	9.0	13.0	
#100	0.15	6.0	7.0	7.0	8.5	
#200	0.075	5.0	5.0	5.0	6.0	

## Materials and Testing

The following sections briefly describe the overall testing program of the study.

### *Aggregate Properties*

The aggregates for this research study were acquired from Sargodha hills. In order to check the appropriateness of the aggregates, laboratory tests; including gradation, flakiness and elongation index, Los angles abrasion and soundness were conducted on it [ASTM, D 4791, AASHTO, T 96, AASHTO, T 104]. The results of these tests are summarized in table 2.

**Table 2: Physical Properties of Aggregate**

Type of Test	Results	Specifications	Standard
Flakiness Index (%)	12	$\leq 15$	ASTM D 4791
Elongation Index (%)	5	$\leq 15$	ASTM D 4791
Los Angeles Abrasion (%)	26	$\leq 30$	AASHTO T 96
Soundness Value (%)	3.37	12	AASHTO T 104

### *Binder Properties*

Attock Refinery Limited (ARL) 60/70 penetration grade bitumen was used in this study throughout. For evaluating the appropriateness of the acquired binder; penetration, flash and fire point, ductility and softening point tests were conducted on it [AASHTO, T 49, AASHTO, T 48, AASHTO, T 51, AASHTO, T 53]. The results of these tests are summarized in table 3.

**Table 3: Physical Properties of ARL 60/70 Bitumen**

Type of Test	Results	Specifications	Standard
Penetration Test (0.1 mm)	64	60-70	AASHTO T49
Flash & Fire Point Test ( $^{\circ}$ C)	328 & 362	$\geq 232$	AASHTO T48
Ductility Test (cm)	129	$\geq 100$	AASHTO T51
Softening Point Test ( $^{\circ}$ C)	49.7	46-56	AASHTO T53

### *Marshall Mix Design*

Marshall mix design method was utilized for the preparation of HMA [ASTM, D 6927]. Three replicates of each specimen were made at three different binder content percentages (3.5, 4.0 and 4.5 %). Each specimen was compacted by delivering seventy-five blows to it on every side, which simulates heavy loading condition. Care was taken to keep maintain  $145 \pm 5$   $^{\circ}$ C temperature during the compaction process as it is the ideal specified compaction temperature. The average value of three replicates of every specimen were considered for more accurate results. Plots between percentage of bitumen content and air voids were drawn in order to calculate the optimum values of binder content against four percent air voids for all gradations bituminous mixtures. The optimum values of all other Marshall parameters were then determined at optimum binder content. The results of the mix design are summarized herein table 4.

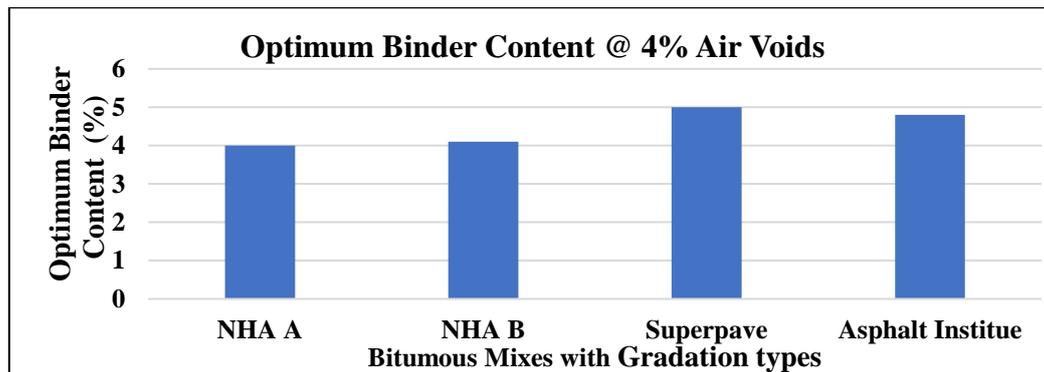
**Table 4: Results of Marshall Mix Design**

Bituminous Mixes with Gradation Types	OBC (%)	VA (%)	VMA (%)	VFA (%)	Stability (N)	Flow (0.25mm)
NHA-A	4.0	4.0	12.15	66.08	13386	12.03
NHA-B	4.1	4.0	12.95	65.16	12700	12.6
Superpave	5.0	4.0	14.70	69.18	13965	13.5
Asphalt Institute	4.8	4.0	14.52	67.73	15151	13.1

## Results and Discussion

### *Optimum Binder Content*

Optimum Binder Content (OBC) is the amount of binder that balances the volumetric and strength properties of asphalt concrete mixtures for each gradation blend of aggregates. From figure 2, it can be inferred that NHA-A and NHA-B gradations have less OBC values than Superpave and Asphalt Institute gradations because NHA-A and NHA-B gradation blends contain coarser particles, which have low surface area and hence require less bitumen content for lubrication. While the Superpave and Asphalt Institute gradation blends contain relatively finer particles, which have greater surface area and hence need more bitumen content for lubrication.



**Figure 2: Optimum Binder Content of all Gradations Bituminous Mixes**

### *Voids in Mineral Aggregate*

Voids in Mineral Aggregate (VMA) is the total void space between the aggregate particles in a compacted asphalt concrete, including air voids and asphalt not absorbed by the aggregates. According to figure 3, it was found that NHA-A and NHA-B gradation blends have minimum values of VMA in comparison to the VMA values of other gradations bituminous mixes. This can be referred to the coarser nature of the NHA-A and NHA-B gradation blends which decreased the interaction of aggregate particles with each other and hence resulted in low VMA. The NHA-A and NHA-B gradation bituminous mixtures did not fulfill the VMA criteria of Asphalt Institute (13 %), while the VMA values of other gradations bituminous mixes fulfilled the Asphalt Institute criteria.

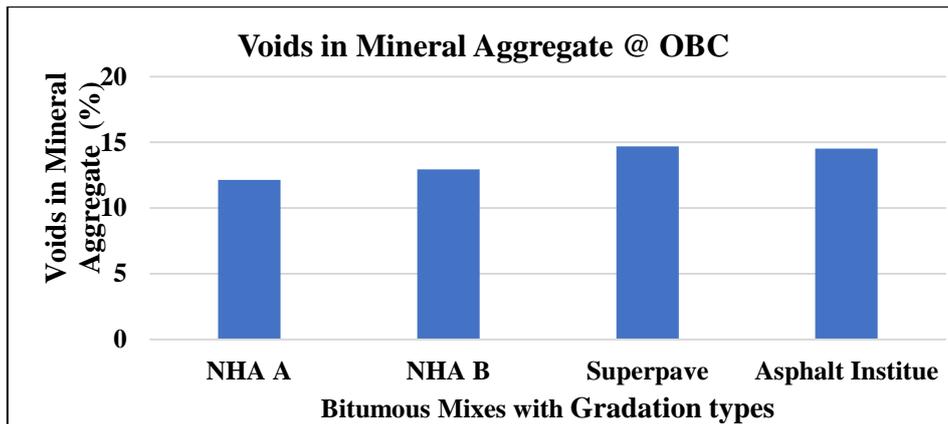


Figure 3: Voids in Mineral Aggregate of all Gradations Bituminous Mixes

#### *Voids Filled with Asphalt*

Voids Filled with Asphalt (VFA) is the percentage of the voids in mineral aggregates that incorporate asphalt and not the absorbed asphalt. From figure 4, it was found that Superpave gradation possess the highest value of VFA as compared to the VFA values of other gradations bituminous mixes. This can be due to the fact that Superpave gradation blend has the highest percentage of voids which require higher bitumen content in order to fill up these gaps and hence resulted in high value of VFA. However, the VFA results of other gradations bituminous mixes showed confirmation to the criteria of Asphalt Institute (65 %- 75 %).

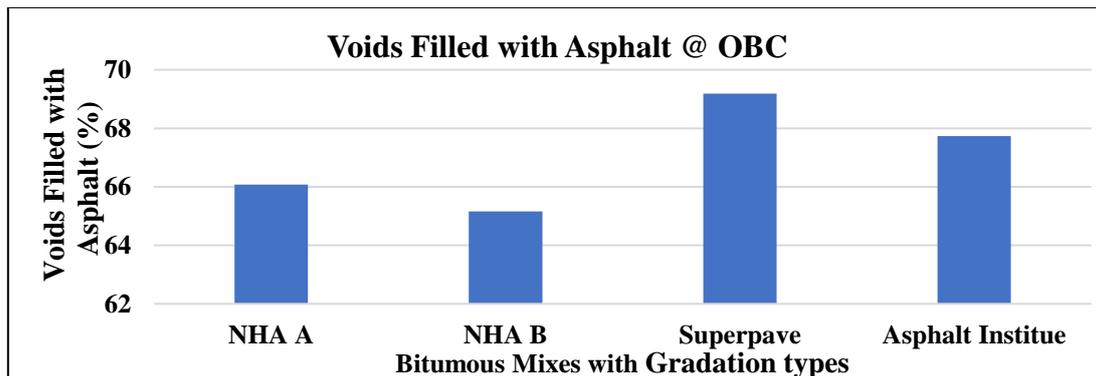


Figure 4: Voids Filled with Asphalt of all Gradations Bituminous Mixes

#### *Marshall Stability*

Marshall Stability is the maximum load sustained by the asphaltic material applied at a constant rate of 50.8 mm/minute. From the figure 5, it can be inferred that Asphalt Institute and Superpave gradations bituminous mixes possess the highest value of stability as compared to NHA-A and NHA-B gradations bituminous mixes. This can be due to the fact that the gradation blends of Asphalt Institute and Superpave contain greater proportions of fine aggregates, which has increased interlocking among aggregate particles and hence made them more stable. However, the stability results of all gradations bituminous mixes showed confirmation to the criteria of Asphalt Institute (8006 N).

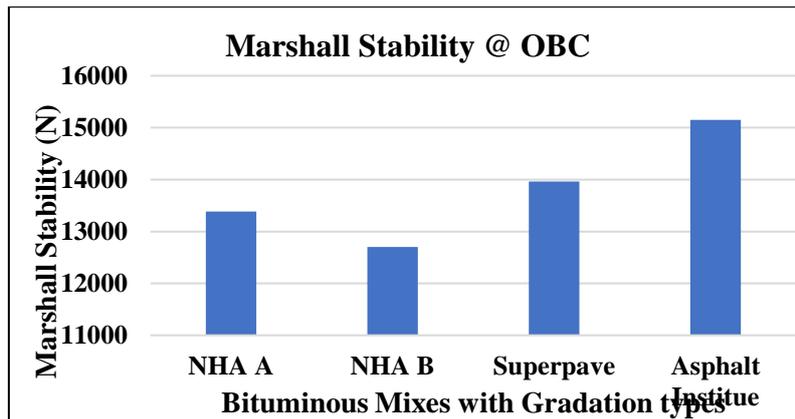


Figure 5: Marshall Stability of all Gradations Bituminous Mixes

### Marshall Flow

Marshall Flow is the value of deformation against maximum load. From the figure 6, it can be observed that Superpave and Asphalt Institute gradations bituminous mixes possess highest values of flow as compared to NHA-A and NHA-B gradations bituminous mixes. This might be due to fact that bituminous mixes with high OBC and more fine particles in gradation blend, flow/deform more and vice versa. The flow values of all gradations bituminous mixes showed confirmation to the prescribed limits of Asphalt Institute criteria (8 mm – 14mm).

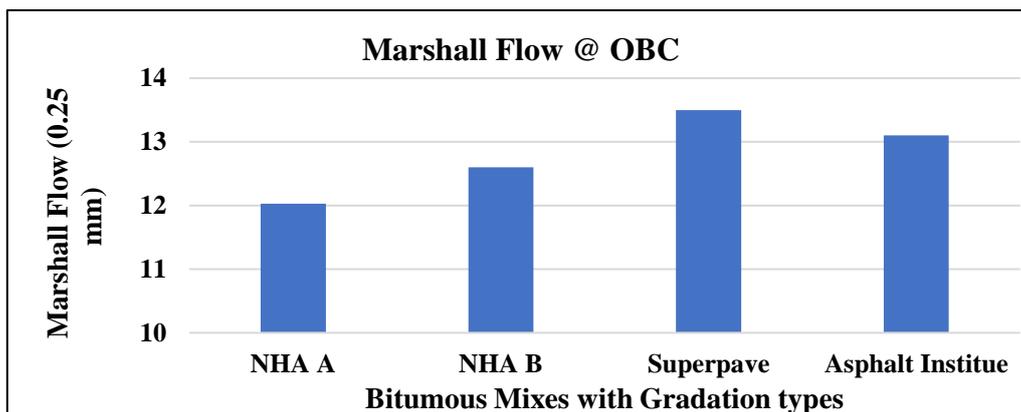


Figure 6: Marshall Flow of all Gradations Bituminous Mixes

### Conclusion

The laboratory test results of this study, lead to the following conclusions:

1. The requirements for optimum binder content were lower when the gradation blend was coarser and higher when the gradation blend was finer due to their surface areas.
2. Fine gradations bituminous mixes showed higher value of voids in the mineral aggregate due to greater number of interactions between aggregate particles.
3. Fine gradations bituminous mixes contain large number of voids and thus showed high value for voids filled with asphalt compared to coarse gradations bituminous mixes.
4. Better stability was achieved by bituminous mixes having strong interlocking of aggregate particles within the gradation blend.
5. Bituminous mixes with high optimal binder content and high proportion of fine aggregate showed high flow values.

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# Mathematical Modelling and Analysis of Harmonic Filter to Reduce Total Harmonic Distortion due to Nonlinear Load

(Ref No. ICETEMS-21-113)

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## Abstract

With the advancement in technology, power electronics has become vital part of power sector. Almost every electrical device is now based on power electronics due to its tremendous advantages. But their major drawback is normally overlooked i.e. these devices offer some major power quality issues and effects supply side of power system. Among these power quality issues, harmonics are most crucial ones caused mainly due to nonlinear load and need urgent mitigation. This research is conducted to overcome this issue i.e. to reduce total harmonic distortion (caused due to nonlinear load). This research mainly comprises of mathematical modeling and simulation of shunt active power filter to reduce total harmonic distortion and to improve power quality. In this research, an application of mathematics is being adopted in field of electrical engineering, shunt active power filter is designed based on synchronous reference frame (SRF-Theory) and harmonic analysis is conducted with help of Fourier and Fast Fourier transform that reduced total harmonic distortion up to 3.81% in accordance with standard harmonic limit provided by IEEE-519 standard that allows 5% total harmonic distortion. Finally, proposed research established highly improved total harmonic distortion, reduced stress on supply side, lower losses and has improved power quality.

## Keywords

Harmonics, Active filter, FFT, THD, Power Quality.

## Introduction

In early years, when power sector mainly relied on conventional sources for power generation, the load was almost resistive and linear in nature [1] such as incandescent lamps, motors, generators, and heating elements, etc. The domestic load was mainly comprised of and was driven by linear elements of power system such as step-down transformers and motors etc. similarly, the industrial sector was also driven and control through linear systems [2] but there is always a need for some advancement in governing and controlling of the power sector, therefore, certain advancements were made. One of those advancements is the addition of renewable energy sources that mainly involves power electronics [3]. The energy system is progressing, becoming smarter and efficient, with the incorporation of alternative power resources and power electronic technologies, but it is also presenting serious challenges that have a huge impact on energy quality [3]. Some major problems in power quality include voltage sag, swell, flicker, harmonic distortions, short and long-term voltage variations, and surges, etc. presented in Fig.1. Among these power quality issues, harmonics are the most crucial ones, caused mainly due to nonlinear loads [4], and are highly affecting the power quality. The term power quality is very wide and has many definitions. According to the definition of the institute of electrical and electronics engineering (IEEE), power quality is “The ability of power system to provide pure noise-free sinusoidal waveshape and stable system if voltage and frequency are concerned” [2].

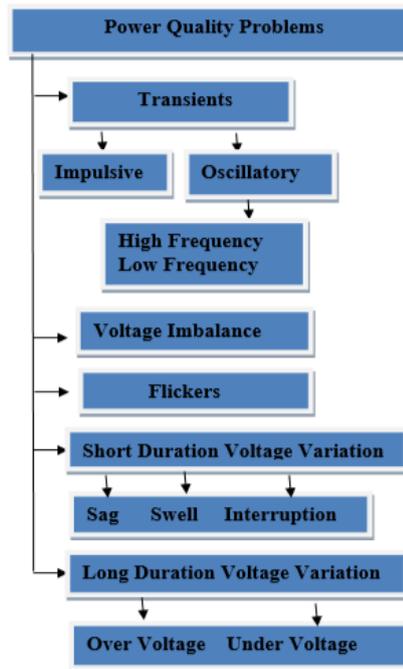


Figure 1: Power Quality Problems

Although problems with power quality are generally hidden from the plant data networks, they have fairly apparent implications: unit downtimes, lower throughput manufacturing failures/waste, faulty gear, and utility penalties. The effect of power quality incidents on all industrial plants has substantial cost implications. With the digitization of facilities and the deployment of increasingly nonlinear loads, energy quality problems simply increase. Several manufacturing plants neglect the need for regulating power quality because of the complexities of identification, assessment, and solution of challenges relating to power quality, particularly fluctuations, oscillations, or imbalances. Furthermore, sensing and tracking of these issues of power quality are not the core of a regular network system.

Assurance of power quality is as important as the power supply for utility, but it is affecting by harmonics caused mainly due to nonlinear load [5]. The nonlinear loads inject harmonics back into the supply system for which the utility has to increase its generation and equipment size to feed the same load so, to overcome this problem, harmonic mitigation is very important [4]-[5]. There are several methods available for harmonic mitigation among those methods, using filters is one of the reliable solutions [6].

This study entails the development of a shunt active power filter for the sake of harmonic mitigation. In this research harmonic analysis of nonlinear load is conducted with the help of Fourier analysis and Fast Fourier transform which may lead to a very high percentage of total harmonic distortion. To reduce this percentage a shunt active power filter is designed based on mathematical modeling that significantly reduces the total harmonic distortion, improves power quality, and limits the percentage total harmonic distortion as provided by IEEE-519 standard. The paper comprises various sections, section I starts with the introduction of power quality and harmonic issues, followed by the literature review presenting causes and effects of harmonics. Section II presents Mathematical modeling and detailed equation analysis of various power quality parameters, Section III provides the harmonic analysis of nonlinear load without filtration through simulation results, followed by designing of shunt active power filter to reduce total harmonic distortion using Simulink/MATLAB software in section IV and the section V of the paper concludes the research results.

## Mathematical Modeling

### Harmonics

Harmonics can simply be defined as “The multiples of fundamental frequency”. These are the values of voltages and currents that appear on a value other than that of fundamental value and distort the purity of the sinusoidal wave. Harmonics are mainly caused due to nonlinear loads and causes additional stresses on the power system as due to harmonics the supply system gets disturbed and the utilities have to increase their generation and equipment size to feed the same load [7]. Fig 2. presents the effect of the addition of a harmonic component to a fundamental value that clearly shown disturbance and impurity in a sine wave of voltages.

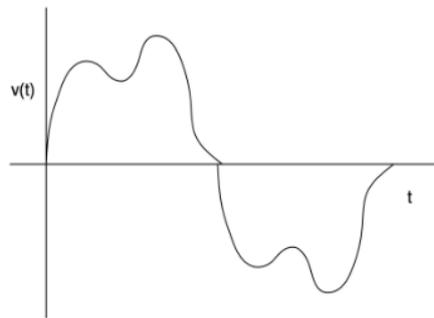


Figure 2: Non-sinusoidal Waveform due to Harmonics

### Types of Harmonics

There are several types of harmonics out of which the two fundamental types of harmonics are even harmonics and odd harmonics, among them, odd harmonics are considered to be the most dangerous ones and need urgent mitigation. On the other hand, even harmonics are not considered to be much important and do not affect the power system due to symmetry in their waveshape [7].

As the name implies odd harmonics are the odd multiples of fundamental components i.e., 3rd, 5th, and 7th harmonic, etc. and the even harmonics are the even multiples of fundamental components like 2nd, 4th and 6th harmonic, etc. other types of harmonics are inter-harmonics, sub-harmonics, and non-integer harmonics. Sub harmonics are the harmonics whose value is less than that of fundamental frequency [8]. These are sometimes also known as negative harmonics, normally produced due to signal amplification through loudspeakers and are seen in electric traction [8]. Inter harmonics are those multiples of harmonics that are non-integer in nature and are normally seen in arcing phenomena, but these types of harmonics readily get finish when the arc stabilizes [9]. That's why their effect is not considered to be significant in power system analysis. Fig 3. presents the effect of the addition of odd harmonics to the fundamental component that indicates the non-sinusoidal nature of waveshape.

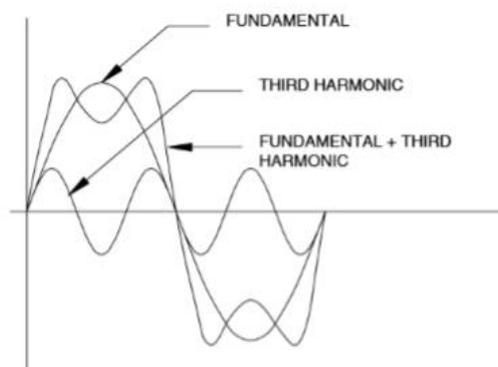


Figure 3: Addition of harmonic to fundamental component

In a single-phase system, there is no need for harmonic sequences but in the case of a three-phase system harmonic components are divided into positive sequence [9], negative sequence, and zero sequence harmonics based on fundamental mathematical equations provided as follows.

$$i_{a1} = I_{a1} \sin \omega t \quad (1)$$

$$i_{b1} = I_{b1} \sin (\omega t - 120^\circ) \quad (2)$$

$$i_{c1} = I_{c1} \sin (\omega t - 240^\circ) \quad (3)$$

The 3rd harmonic component is considered to be zero-sequence harmonics according to standard equations.

$$i_{a3} = I_{a3} \sin (3\omega t) \quad (4)$$

$$i_{b3} = I_{b3} \sin 3(\omega t - 120^\circ) = I_{b3} \sin (\omega t - 120^\circ) \quad (5)$$

$$i_{c3} = I_{c3} \sin 3(\omega t - 240^\circ) = I_{c3} \sin (\omega t - 240^\circ) \quad (6)$$

The 5th harmonic is said to be negative sequence harmonics according to standard equations.

$$i_{a5} = I_{a5} \sin (5\omega t) \quad (7)$$

$$i_{b5} = I_{b5} \sin 5(\omega t - 120^\circ) = I_{b5} \sin (\omega t - 240^\circ) \quad (8)$$

$$i_{c5} = I_{c5} \sin 5(\omega t - 240^\circ) = I_{c5} \sin (\omega t - 120^\circ) \quad (9)$$

And 7<sup>th</sup> harmonic is considered to be positive sequence harmonic according to standard equations.

$$i_{a7} = I_{a7} \sin (7\omega t) \quad (10)$$

$$i_{b7} = I_{b7} \sin 7(\omega t - 120^\circ) = I_{b7} \sin (\omega t - 120^\circ) \quad (11)$$

$$i_{c7} = I_{c7} \sin 7(\omega t - 240^\circ) = I_{c7} \sin (\omega t - 240^\circ) \quad (12)$$

Division of harmonic components in positive, negative & zero sequence is initial step of designing filter [9].

### ***Harmonic mitigation Strategies***

Line reactors, D-STATCOM, various control methods, and filters are harmonic reduction options available. Filters are classified into two types: active and passive filters. This study involves development of a shunt active filter for harmonic mitigation using Fourier analysis [10].

#### ***Active Power Filters***

The Active power filter works in such a way that it injects or supplies currents of same rating with a reverse phase to cancel harmonic currents of power system. There are three main types of active filter out of which shunt active power filter is being chosen in this research due to its reliable features mentioned below as compared to series active power filter [11].

#### ***Shunt Active power Filter***

In series active power filter, the source side impedance is normally much higher than that of the impedance of diode rectifier due to which current fed into the starting point and the diode rectifier by the series active filters for compensating outflows and thus series of active filters are not able to fully negate the harmonics and create difficulties with the enlargement of the dc ripple and the ac peak current. A shunt active power filter is used to prevent these problems [1]. It also has the advantage of having compensatory current in addition to the small basic active current element for balancing failures and sustaining power supply along with the dc capacitor [12].

## **Methodology**

Three main components of this research model include grid, load, and filter presented in Fig 4. The selected load for this research is nonlinear resistive and selected filter for research is shunt active power filter. Load is made nonlinear by using power electronic devices [12]. Designing of shunt active power filter based on mathematical modeling and harmonic analysis is conducted with the help of Fourier Transform [1]. Initially nonlinear resistive load is connected to grid and harmonic analysis is done on Simulink/MATLAB software presented in fig.5 with the help of Fourier analysis according to the equations given as follows [12].

$$x(t) = a_0 + \sum (a_n \cos(n\omega_0 t) + b_n \sin(n\omega_0 t)) \quad (13)$$

A periodic current  $i(t)$  with a zero DC value can be represented by

$$a_n(k) = 2N_k \sum_{j=k-(N-1)T_s}^{kT_s} i(jT_s) \cos(n\omega_f jT_s) \quad (14)$$

$$b_n(k) = 2N_k \sum_{j=k-(N-1)T_s}^{kT_s} i(jT_s) \sin(n\omega_f jT_s) \quad (15)$$

here  $\omega_f$  is fundamental frequency. With numerical implementation of Fourier series, coefficients become,

$$a_n(k) = a_n(k-1) + 2N[i(kT_s) + i((k-N)T_s)] \cos(n\omega_f kT_s) \quad (16)$$

$$b_n(k) = b_n(k-1) + 2N[i(kT_s) + i((k-N)T_s)] \sin(n\omega_f kT_s) \quad (17)$$

here  $T_s$  is sampling period and  $N$  is an integer. Or recursively  $N = \frac{T_f}{2T_s}$ .

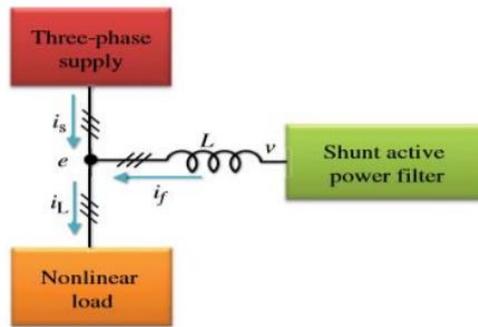


Figure 4: Shunt active power filter with supply and load

It can be seen through Fourier analysis of nonlinear resistive load that it produces a total harmonic distortion of about 30.70% that is a significant amount and need an urgent solution [1]. Based on the block architecture shown in Fig.6, a shunt active power filter is built to reduce harmonics after FFT-based harmonic analysis of a nonlinear resistive load. The filter is made up of three major parts: a power circuit, a control circuit, and a harmonic current extraction mechanism [1]. The synchronous reference frame (SRF-Theory) is employed as a harmonic current extraction approach in this filter design [10].

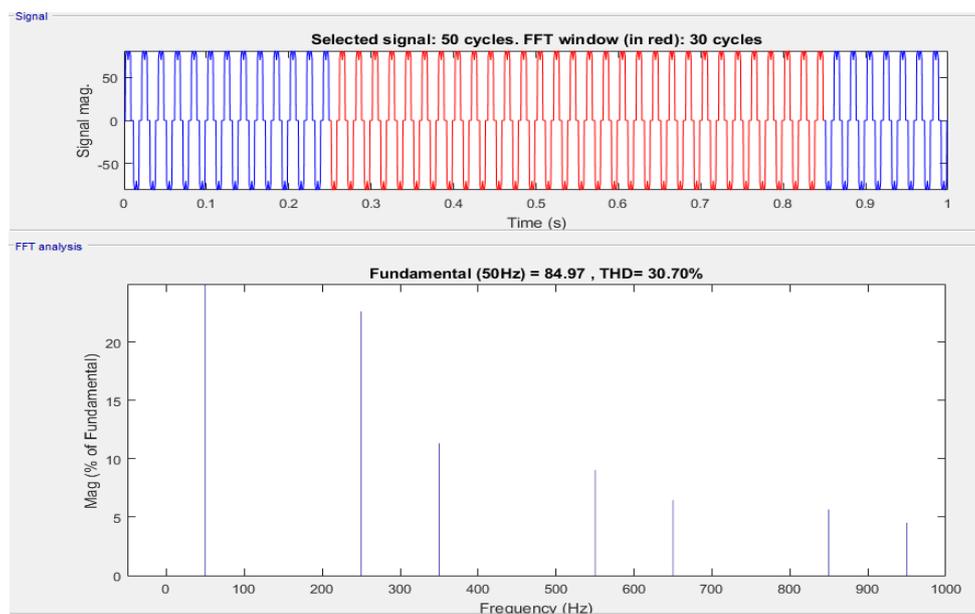


Figure 5: FFT of harmonics Produced due to Nonlinear Load.

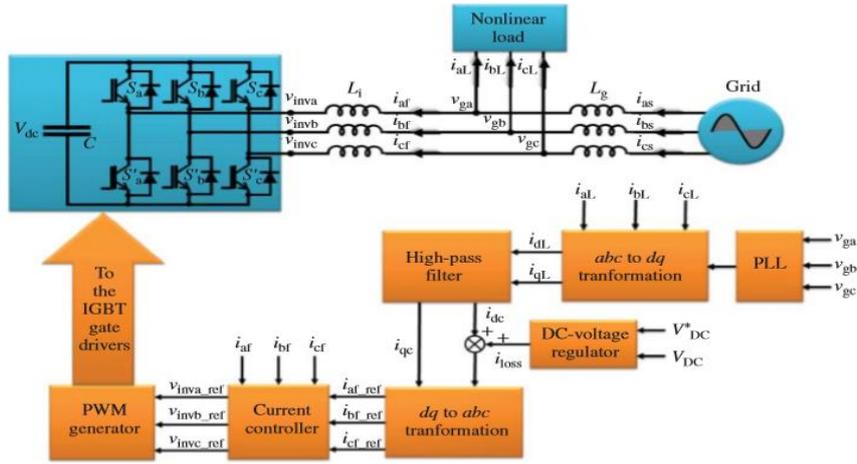


Figure 6: Block diagram of shunt active power filter

### SRF-Theory

SRF frame theory was utilized to create filter's harmonic current extractor approach. As title implies basic idea is to create frame that spins at synchronized pace as shown in Fig.7. The SRF Theory is based on identifying system's instantaneous power in synchronized referenced frame. The load currents are converted from abc static frame to d-q synchronized revolving frame using following transformations [1]

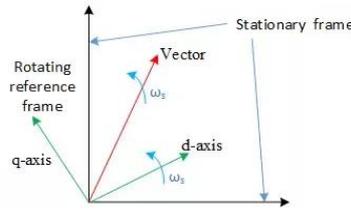


Figure 7: Block diagram of SRF-Theory.

Mathematically if we explain this theory then,

$$\begin{pmatrix} i_d \\ i_q \end{pmatrix} = \frac{2}{3} \begin{pmatrix} \sin\theta & \sin(\theta - \frac{2\pi}{3}) & \sin(\theta + \frac{2\pi}{3}) \\ \cos\theta & \cos(\theta - \frac{2\pi}{3}) & \cos(\theta + \frac{2\pi}{3}) \end{pmatrix} \begin{pmatrix} i_a \\ i_b \\ i_c \end{pmatrix} \quad (18)$$

where  $\theta$  is rotational angle of d-q coordinates,  $\omega$  is angular frequency of power source [1]. The active and reactive power elements of current are represented by d and q components & can be divided into two parts:

$$i_d = i_d' + i_d'' \quad (19)$$

$$i_q = i_q' + i_q'' \quad (20)$$

where  $i_d'$  and  $i_q'$  are fundamental current components, while  $i_d''$  and  $i_q''$  are harmonics components [1].

### Power Circuit for Filter

Power circuit consists of grid that supply current, a nonlinear load that generate harmonics and voltage control system [10].

### Control Circuit for Filter

The control circuit for filter starts with phase-locked loop (PLL) which generates an output signal with phase related to phase of input voltage. Here voltages are given as input to PPL, after that abc to dq transformation based on SRF-Theory is done from where we get currents as an output [11]. By using high pass filter, unwanted part is filtered out, dc voltages get regulated through a regulator and reverse conversion i.e. from dq to abc is performed to get reference currents for controller, output moves to PWM generator and through IGBT gate drivers control circuit is connected to power circuit of filter [12].

### Results and Discussion

In this research, a Shunt active power filter is designed in Simulink/MATLAB for nonlinear resistive load. Harmonic analysis of a nonlinear load is performed using Fourier analysis and Fast Fourier transform, which results in very high percentage of harmonic distortion. To minimize this proportion, a shunt active power filter is created, which considerably minimizes total harmonic distortion, enhances power quality, and restricts the percentage total harmonic distortion as specified by the IEEE-519 standard. After designing filter, harmonic analysis is conducted again and significant reduction in harmonic percentage is being noticed, presented in Fig. 8 and tabulated in Table II.

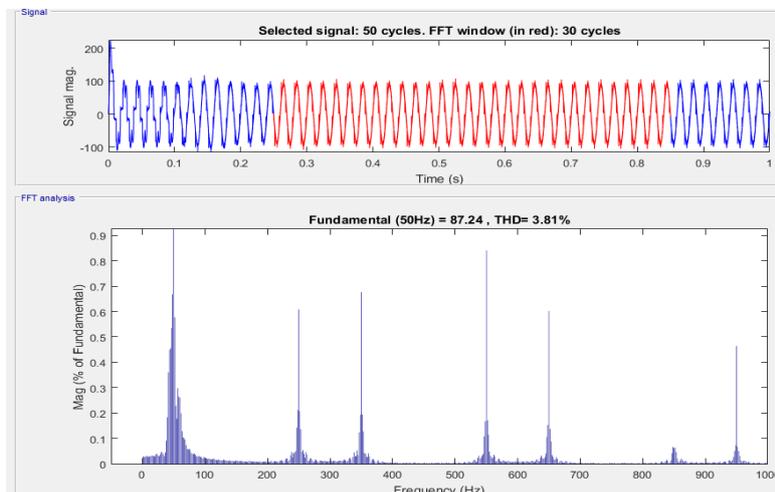


Figure 8: FFT Analysis of Nonlinear Load after Filtration

Table 2: Comparison of THD (%)

Ser.No	Nature of Load	Before Filtration	After Filtration
1	Nonlinear Resistive Load	30.70%	3.81%

Table II shows a significant reduction in THD by using a shunt active power filter. Nonlinear load generated significant number of harmonics which distorted supply and consequently reduced power quality. To overcome this situation, a shunt active power filter is being designed that significantly reduced total harmonic distortion, brought percentage harmonics within provided IEEE-519 standard values and improved the power quality to noticeable values.

### Conclusion

Importance of power quality is increasing day by day with increase in usage of power electronic devices. In this research one of the power quality issue i.e. harmonic and its effects have been discussed. The nonlinear loads are main cause of injecting harmonics and effecting power quality so, a nonlinear resistive load was use for analysis, its harmonic analysis was conducted through Fourier analysis. A shunt active power filter was designed that reduces the harmonic percentage for which the waveforms

were captured and the final numbers were tabulated for comparison. The results clearly indicate the significant reduction in total harmonic distortion (THD %) and has consequently improved the power quality.

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# Catalytic Conversion of Used Cooking Oil (UCO) into High-Grade Chemicals

(Ref No. ICETEMS-21-123)

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## Abstract

The development of renewable energy sources will decrease our dependency on the usage of fossil fuels; in addition, safeguard the green environment from the harmful effects of the produced greenhouse gases. In this study, we investigated the catalytic conversion of used cooking oil (UCO) to examine the proposed metal oxide catalysts (CaO, TiO<sub>2</sub>, CaO/TiO<sub>2</sub> (hybrid)) characterizations and yield of produced products (high grade chemicals). It also aims to compare the performance of the metal oxide catalysts and to find the optimum process conditions. The catalysts were characterized before and after the use by XRD and XRF and the produced products were evaluated by GC-MS. The reaction parameters; heat rate, reaction temperature, reaction time, catalyst load) effects were also investigated for the selectivity of the products. The experimental results showed that 4 wt. % catalyst, 10 °C /min heat rate, 500°C reaction temperature, and 120 m reaction time give the best result for hybrid (CaO-TiO<sub>2</sub>) catalyst, The obtained maximum biofuel yield was 63%, 68%, and 79% for TiO<sub>2</sub>, CaO, and CaO/TiO<sub>2</sub>, respectively. It was also observed that the hybrid catalyst showed better activity on repeated recycle turns illustrating that it is a potential choice for the conversion of UCO into high grade chemicals.

## Keywords

Used Cooking Oil, Metal Oxide Catalysts, Catalytic Cracking, Biofuel.

## Introduction

The main reason for the rapid depletion of natural energy sources is due to the increase in population growth and rapid industrialization around the world (Pimentel and Pimentel, 2006). Over 80% of conventional energy source, such as coal, natural gas, petroleum, and other fossil fuel extraction, are hazardous to the environment and nonrenewable in nature (Sun et al., 2018). Conventional fossil fuels have been used for hundreds of years around the world (Tan et al., 2015). Fossil fuel energy use is predicted to reach 934 million tonnes annually (Kulkarni and Dalai, 2006). According to the World Energy Council, if no additional oil wells were discovered, fossil oil will be depleted in less than ten decades (Sharma and Singh, 2009). Environmental contamination and limited fossil fuel supplies are two major causes driving the quest for alternative energy sources (Dorian et al., 2006). The topic of generating alternative fuels, particularly biofuel obtained from vegetable oil through catalytic cracking, has been a focus of research during the course of recent many years, (Kantikaneni et al., 1995). Bio-fuel produced from vegetable oil not only provides a renewable energy source, but it also has environmental benefits (lower toxic gas emissions and greenhouse gas emissions) (Ooi et al., 2004). Soybean, rapeseed, canola, and palm oils are the most common biofuel feedstocks. Many biofuel industries have developed up all over the world in recent decades, but most of them aren't operational all year due to a lack of inexpensive vegetable oils to utilize as a feedstock for biofuel manufacturing. Over than 95% of the feedstock used in the manufacturing of biofuel comes from edible oils, which are widely produced in many places of the world and have qualities that make biofuel produced from these oils ideal for use as a diesel fuel alternative Borugadda and Goud, 2012). Utilization of edible oil to obtain biofuel is not viable due to a large demand of such oils for food use, and they are now significantly more expensive to usage, so obviously, the benefit of utilization of non-edible vegetable oils as feedstock as compared

to edible oils is much greater (Shu et al., 2010). It has been recommended that lower-cost feedstocks such as used cooking oil (UCO), crude vegetable oils, and animal fats, be employed. Among these feedstocks, UCO has been the subject of research because of its cheaper and large availability (Zhang et al., 2003). As a result, biofuel produced from UCO is not only cost effective but also environment friendly (Wen et al., 2010). In the current study, biofuel was produced by utilizing a catalytic cracking procedure in which UCO was chosen as a feedstock because it contains a high level of free fatty acid, and have the potential of low-cost production, which can be reduced by 60–90% (Talebian-Kiakalaieh et al., 2013) depend upon methods of production. In addition, the activities of several catalysts (CaO, TiO<sub>2</sub>, and CaO/TiO<sub>2</sub>) under different process conditions were investigated in this work for comparison purposes. The goal was to identify the optimal catalyst and appropriate conditions for catalytic cracking.

## Materials and Methods

### Used Cooking Oil (UCO)

UCO was collected from the Sadar Bazar, Peshawar, (KP), Pakistan. Table 1 lists the physical and chemical properties of the UCO. Calcium oxide (CaO) and titanium dioxide (TiO<sub>2</sub>) catalysts were bought from Sigma, Europe. While in the hydride case (CaO/TiO<sub>2</sub>), the proportions of CaO and TiO<sub>2</sub> was 1:1 (50%) wt. % respectively.

### Catalytic Cracking of UCO

A home-built experimental setup was used in the process, as illustrated in Figure 1. The filtered oil (20 g) was introduced to the round bottom flask (known as a batch reactor) containing the weighted catalyst. Uniform mixing (500 rpm) and heating (10 – 20 °C/min) to the batch reactor was provided by a magnetic plate to achieve the desired temperatures of 400, 425, 450, 475, and 500 °C. Vapors generated during the heating process were condensed and collected as a liquid in a conical flask. Some of the generated gases exited the reactor through a tiny opening near the condenser. The required amount of catalyst based on the UCO feed was; 2, 4, 6, 8, and 10 % CaO and TiO<sub>2</sub>, respectively, whereas in the hydride case (CaO/TiO<sub>2</sub>) the proportion of CaO and TiO<sub>2</sub> was 1:1 (50%) wt.%.

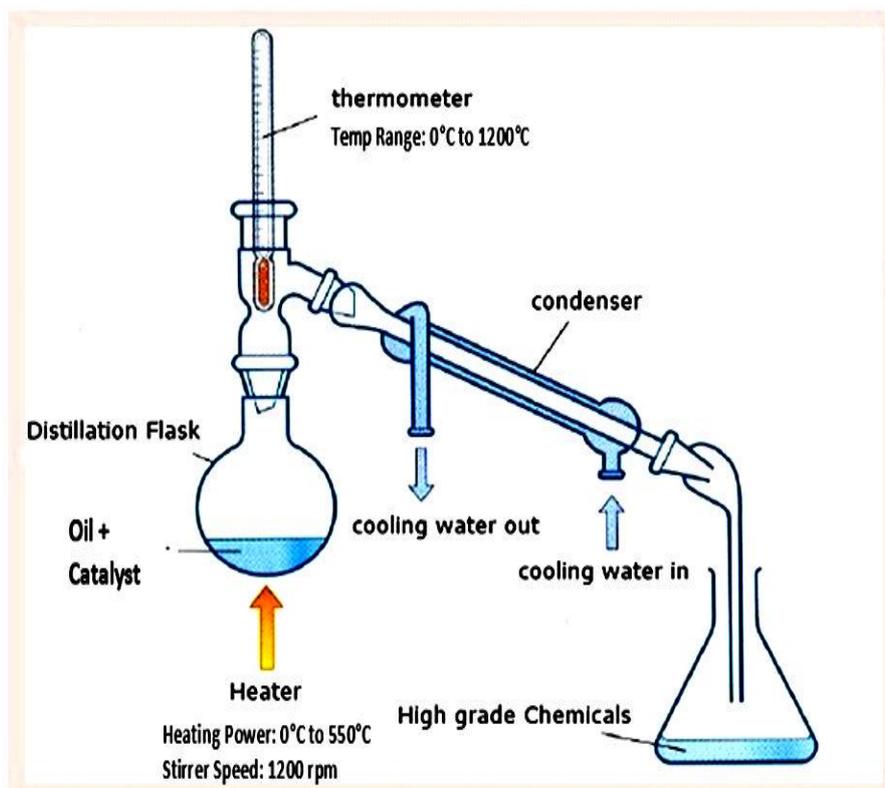


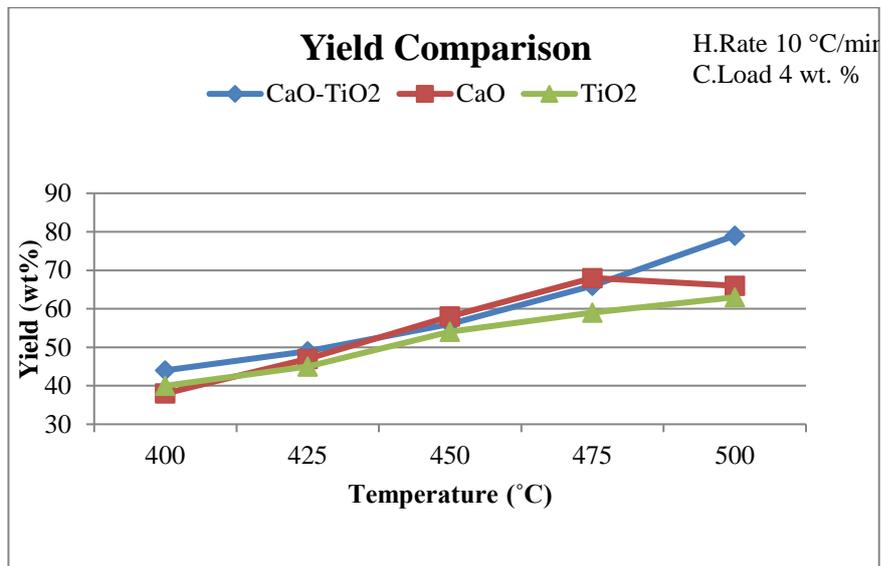
Figure 1: Experimental setup

**Table 1: Physicochemical properties of used cooking oil (UCO)**

Physicochemical properties	
Density (g/cm <sup>3</sup> ) @25 °C	0.96
Flash point (°C)	298
Calorific value in MJ/Kg	38.9
Kinematic viscosity in mm <sup>2</sup> /s @25 °C	43.74

## Result and Discussion

In experimental work, the process parameters (residence duration, reaction temperature, catalyst load, and heating rate) were adjusted several times to find the best conditions and optimal catalyst for the process. The results showed that for each of these three catalysts, 4 wt. % catalysts, 10°C/min heat rate, and 120 m reaction time yielded the best results, however, maximum yields were obtained at different temperatures for each catalyst. Experiments were done by varying the temperature between 400 and 500°C while keeping the other parameters the same as described above. The obtained maximum biofuel yield was 63% for TiO<sub>2</sub> and 79 % for CaO/TiO<sub>2</sub> at 500°C, respectively, and 68 % for CaO at 475°C, as shown in Figure 2. At 500 °C, the largest conversion for CaO/TiO<sub>2</sub> was reported, whereas the least was observed at the temperature above the 500°C. This could be due to structural damage or active site deactivation as a result of increased temperatures. At a greater temperature, the oil might also be transformed into uncondensed gaseous products (Ahmed., 2010).

**Figure 2: Comparison on the Basis of Yield**

### *Catalyst activity*

The following factors were investigated which affect the catalytic cracking process

### *Effect of Catalyst Loading*

The selection of catalyst plays a vital role in the process of catalytic cracking due to their influence in production yield and component selectivity for biofuel. The catalyst's efficiency in this process is determined by various parameters, including pore size, active site, surface area, and pore volume (Wako

et al., 2018). The effect of catalyst loading on biofuel yield was investigated using catalyst loadings of 2, 4, 6, 8, and 10% by weight shown in Figure 5. At 10 and 20°C/min, the production of biofuel rose from 74 to 79 wt% and 72 to 76 wt%, respectively, with just an increment in catalyst loading from 2 to 4 wt%. It is obvious that a larger catalyst concentration will provide a greater number of active sites which will increase the reaction rate it can be observed up to a specific catalyst loading, and after that, the catalyst loading no longer acts as a limiting factor. As shown in Figure 5, raising the catalyst load over 4 wt. % up to 10wt. % results in a decrease in biofuel yield. It's because of increasing catalyst loading led the catalyst's active sites to agglomerate, reducing catalyst activity. As a result, a substantial amount of residual coke was collected on the active sites of the catalyst, leading it to deactivate. This coke diminishes the catalyst's surface area, decreasing the active site.

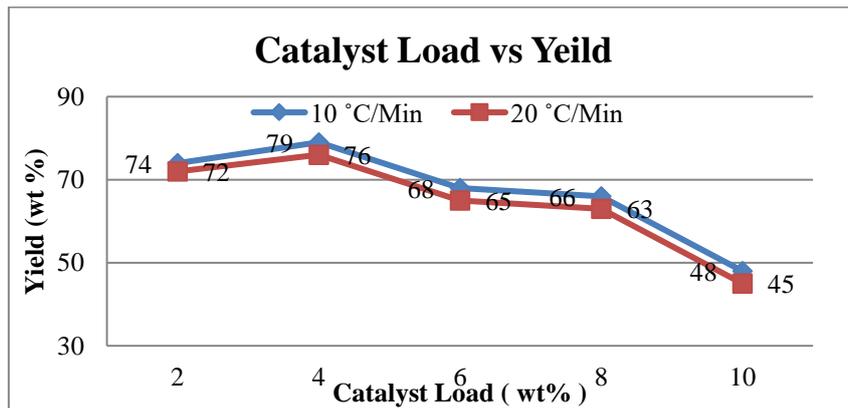


Figure 5: Catalyst Load vs Yield

#### Effect of Reaction Temperature

The temperature had a considerable impact on the process of catalytic cracking (Song et al., 2014). The experiments were carried out at five different temperatures ranging from 400 to 500°C to see how temperature affect the biofuel yield as shown in Figure 6. The maximum yield collected at 475°C and 500°C on the heating rate of 20°C/min and 10°C/min respectively above these points a decrease in yield was observed. The increase in the yield was due to an increase in active sites as discussed above while the decrease may be due to secondary cracking which indorses gas production at high temperatures (Taufiqurrahmi and Bhatia, 2011)

There was no linearity between yield and cracking temperature for the catalyst CaO/TiO<sub>2</sub>. This shows the variation in the catalytic characteristics of metal oxides were due to adsorbing on unsaturated metal sites and/or oxygen atoms, followed by hydrogen and/or oxygen addition or removal (Ahmed., 2010). As a result, a process temperature of 500°C was found to be appropriate, providing 79% biofuel in 120 min.

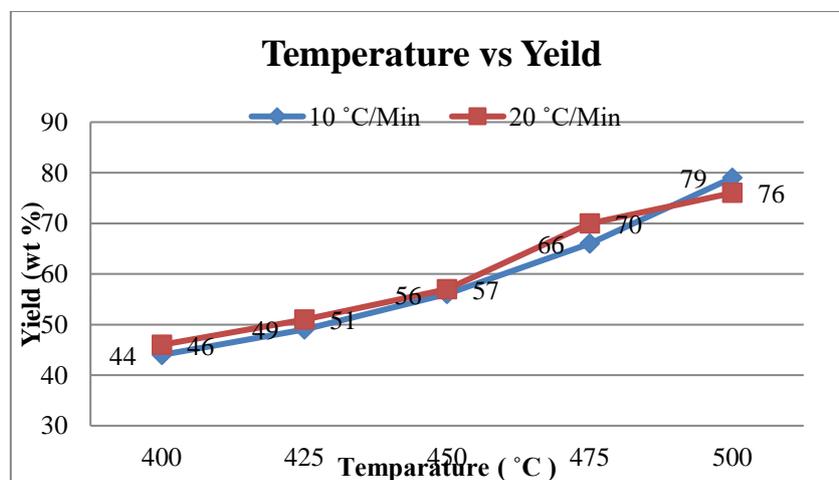


Figure 6: Temperature vs Yield

### Effect of Residence Time

The effects of residence time on biofuel yield were studied at 60, 90, 120, 150, and 180 minutes. By rising the residence period from 60 to 120 minutes, the output of biofuel increases from 26 to 79 wt. % at 10°C/min and from 24 to 76 wt. % at 20°C/min, as a result, increasing the residence period from 60 to 120 minutes enhances biofuel yield. However, increasing the residence period to 180 minutes had no influence and resulted in a little decrease in biofuel generation. This may be because of biofuel transformation to side products as a result of the biofuel's prolonged contact time with the reaction medium (Li et al., 2016). However, Figure 7, shows that 120 minutes of residence time was thought to be the optimal time for gaining high biofuel yields

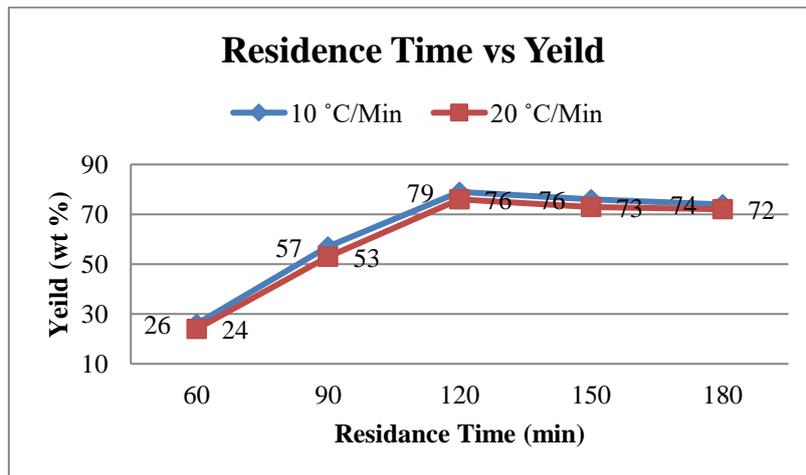


Figure 7: Residence Time vs Yield

### Effect of Heating Rate

Heating rate play an important role in the conversion of UCO into biofuel. The cracking procedure was carried out at a different heating rate of 10 and 20 °C/min. The Highest biofuel yields of 79 wt% (10 °C/min) and 76 wt% (20 °C/min) were observed at 500°C, as illustrated in the graph Figure 8. There was even a slight difference in biofuel yield comparing heating rates of 10 and 20 °C/min, with the reaction performed at 10 °C/min yielding the highest biofuel yield. The conversion of UCO to biofuel was maximized when heated at a lower rate of 10 °C/min since the UCO held within a specific temperature range for a longer period of time. With a higher heating rate (20 °C/min), however, the low conversion is because of gas yield (Nazzal, 2002). As a whole, the greater yield value of biofuel (79 wt. %) was attained at a heating rate of 10 °C/min.

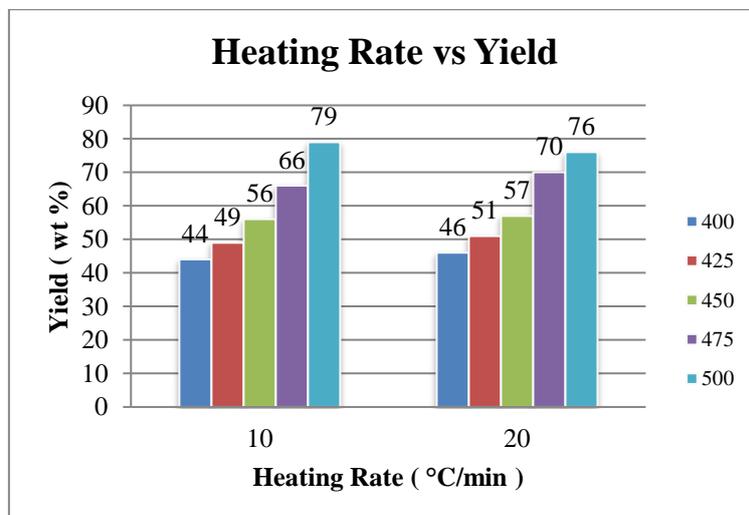


Figure 8: Heating Rate vs Yield

### ***Analysis of produced biodiesel***

The biofuel produced primarily contained hydrocarbon and oxygenate molecules such as ester, ketone, and acid. The hydrocarbons with a total concentration of 73.3 %, ranged from C<sub>6</sub> to C<sub>22</sub>, indicating that the majority of the fatty acids in UCO were converted to hydrocarbons through cracking over the (CaO/TiO<sub>2</sub>) catalyst. Moreover, a ketone concentration of over 2% was produced. The formation of hydrocarbon and ketone is a good sign since it means that some of the oxygen in UCO has been removed through a series of reactions including deoxygenation. However, the biofuel generated still contained 23.4 % acid and esters, indicating that future refinement will be necessary to convert more acid/ester to produce the highest proportion of hydrocarbon.

### **Conclusion**

In this investigation, several catalysts such as CaO, TiO<sub>2</sub>, and a hybrid case (CaO-TiO<sub>2</sub>) were employed to catalytically crack UCO to produce biofuel. The conversion of UCO was done successfully to biofuel. The hybrid catalyst (CaO-TiO<sub>2</sub>) was shown to have the best potential among the tested catalysts, with the highest yield. Catalytic cracking produced 79 wt% biofuels at the optimum processing parameters of 500°C reaction temperature, 120 min residence time, a heating rate of 10°C/min, and catalyst loading of 4 wt%. The combination of CaO and TiO<sub>2</sub> improved biofuel production.

This is because of the conversion of Ti and Ca into respective ions within calcium lattice that can improve stability while maintaining an acceptable rate of catalytic activity. The results also suggest that while hydrocarbons can be recovered at high temperatures, above 500°C can generate secondary cracking. During catalytic cracking, the calorific value, flashpoint, density, and kinematic viscosity of UCO were enhanced from 38.9 to 39.8 MJ/kg, 298.5 to 99°C, 0.96 g/cm<sup>3</sup> to 0.88 g/cm<sup>3</sup>, and 43.74 mm<sup>2</sup>/s to 3.67mm<sup>2</sup>/s respectively. It was also discovered that the hybrid catalyst performed better on repetitive recycle turns, indicating that it could be a viable option for converting UCO into high-grade compounds.

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# Selection of Suitable City and Its Optimized Location for the Installation of Grid Connected PV System

(Ref No. ICETEMS-21-135)

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## Abstract

Electrical energy provided by existing hydro and thermal power plants is being limited as the population and industrialization of metropolitan regions has increased, resulting in high energy costs and energy instability. As a result, the global spread of Photovoltaic (PV) based micro-grids have increased while taking use of free solar insolation throughout the day. However, weather circumstances have a significant impact on its fluctuation and unpredictability. This work aims to find suitable city and its optimized location for the installation of Grid connected PV system in Pakistan. The weather data collected from different cities of Pakistan are used to calculate average irradiance of sun, maximum temperature and minimum temperature. Based on collected data, the suitable city for the installation of Grid connected PV system is selected through the Simulink model. After the selection of suitable city for the installation of micro-grid, the GIS (Geographical information system) is used to find out the area of that specific city in which maximum PV energy will be obtained.

## Keywords

Photovoltaic system, micro-grid, optimum location, PV-grid system.

## Introduction

Global studies show that the world's total installed solar capacity has been steadily increasing [1]. Political intervention, societal unacceptability, and financial hurdles are all preventing broad usage of these resources. Furthermore, there is a consensus in the literature that Pakistan's technological understanding of solar PV is at best inadequate [2]. Despite having a large potential for renewable energy resources, particularly solar energy, Pakistan is experiencing a serious energy crisis of power shortage for many years. During peak summer months, power shortage goes higher as the difference between demand and supply of energy might be as large as 6000 MW. This has resulted in daily power outages ranging from 6 to 12 hours. To prevent from this power shortage, consumers have built alternative energy sources such as fossil fuel generators and solar power plants to mitigate the impact of these power interruptions or load shedding [3].

The purpose of this essay is to examine the deployment of solar photovoltaic in several towns of Pakistan where blackouts of 6 to 7 hours are typical. Six major towns of Pakistan i.e Karachi, Islamabad, Lahore, Multan, Quetta, and Peshawar are selected, all of which are in distinct climatic and geographical regions. The Climates-to-Travel database used to import weather data i.e sun irradiance and temperature for these major towns. According to irradiance data, Karachi has the highest average daily worldwide contamination on a smooth surface of 5 kWh/ m<sup>2</sup>, while Lahore has the lowest estimate of 4.5 kWh/ m<sup>2</sup>. So, Karachi was chosen for the investigation of the planned 400 kW electric power project because of its strongest energy capacity and proximity to a large population.

The solar irradiance for different months is observed for all major cities from the Climate-to-Travel database. Then modeling work is established through MATLAB simulation by putting the values of sun irradiance and temperature. According to the findings, solar PV system implementation would demonstrate the most appropriate city for grid-connected PV system installation and 0.6-0.7t CO<sub>2</sub> reductions in GHG emissions in different areas of Pakistan under current climatic circumstances [4]. After the selection of suitable town for the installation of Grid connected PV system, find the most appropriate place in that city for its installation.

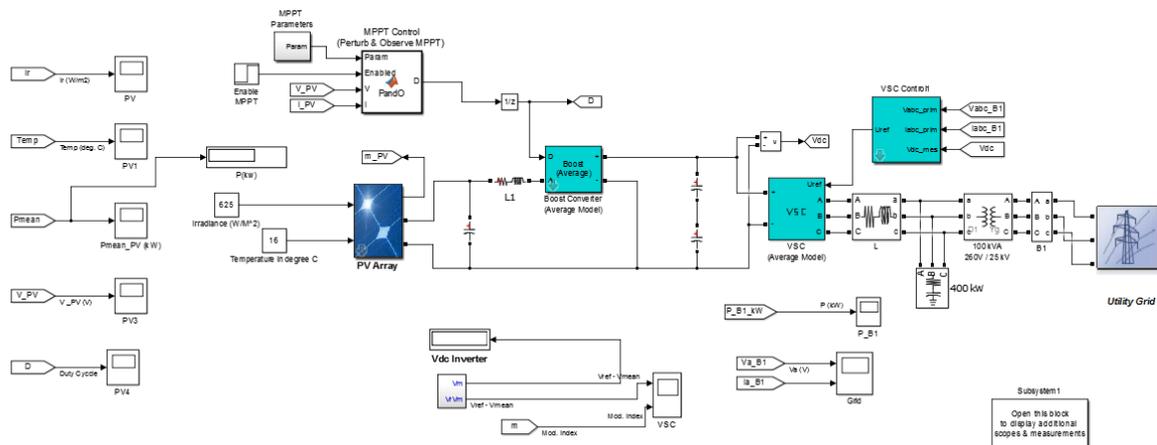
## Methodology

The purpose of this essay is to examine the deployment of solar photovoltaic in several towns of Pakistan where blackouts of 6 to 7 hours are typical. Six major towns of Pakistan i.e Karachi, Islamabad, Lahore, Multan, Quetta, and Peshawar are selected, all of which are in distinct climatic and geographical regions. For the selection of a suitable city of Pakistan, a typical grid-connected PV system is used. The network comprises of a PV array that creates a peak in MW based on sun irradiance, temperature and a DC/DC converter that also serves as a power optimizer whose control features includes Maximum Power Point Tracking (MPPT) [5]. This converter is regulated by the regulator, and the P&O technique is used to optimise results. These P&O methods monitor the solar cell's progress toward its maximum power supply. The goal of the P&O is to generate maximum power transmission [6].

The power that fed from PV system and the utility to the distribution network is considered for eight major cities Karachi, Lahore, Islamabad, Hyderabad, Peshawar and Quetta. Electricity generated is well utilized when there is sunny time period from PV arrays [7]. However, at night or when there are clouds the additional batteries are being utilized for meeting needs of electricity. As there is interconnection with grid then, grid is utilized for supplying electricity and acts as storage or battery whenever, PV array is not liable. Power that is obtained from the PV system for these cities is collect for winter, spring and summer season. From the values of power of different cities, predict the most suitable city for the installation of PV system. After the selection of desires city, which is best for the installation of PV system, need an appropriate place for that city for the installation of Grid Connected PV system. In order to determine the best place for installation of PV systems in that city, traditional methods that represent only three-dimensional artifacts to construct digital surface models are inefficient. So, GIS technology proposed to address this problem. GIS is a tool for meeting stewardship, sustainability, and cost-cutting goals [8].

## Simulink Model

The detailed analysis of grid connected PV system has been simulated in MATLAB as shown in figure 3 using the technique of P&O. Average modeling of PV with Grid is represented by equivalent VSC which produces AC voltage over one cycle of that switching frequency. In such model the harmonics are not developed although the dynamics produced by interaction of control and power system remains preserved [9]. The P&O technique and MPPT algorithm has been implemented in MPPT control block [10]. The main work presented in this research paper to show that in which city implementation of PV micro grid is better through Simulink model by changing the value of temperature and sun irradiance according to the different cities [11].



**Figure 1 Simulink Model of Grid Connected PV System**

From the above presented Simulink model, put the values of average sun irradiance and temperature values for different cities of Pakistan and find out the value of power obtained from PV system.

## Result and Discussion

### *Analysis during summer carried out for solar power project site selection:*

The analysis of solar power generation has done in different cities of Pakistan that are Karachi, Lahore, Hyderabad, Islamabad, Jacobabad, Quetta and Peshawar during summer as shown in table 1. The analysis has been divided in two temperature conditions, maximum (sun radiation peak hours) and minimum (down sun radiation hours).

**Table 1: Analysis during summer at maximum temperature**

City	Solar radiance (kWh/m <sup>2</sup> )	in Max temp	Power from PV
<b>May-August (Analysis during summer)</b>			
Islamabad	3.4	35	202
Jacobabad	4.45	42.7	267
Hyderabad	4	38.7	261
Karachi	5	37.75	305
Quetta	6	34.2	284
Peshawar	3.5	35	210
Lahore	4.5	37.5	215

The values that taken during summer season at maximum temperature shows that Karachi is the suitable city for the installation of PV system. While Islamabad is the least suitable city for the installation of PV system.

**Table 2: Analysis during summer at minimum temperature**

City	Solar irradiance (kWh/m <sup>2</sup> )	Min temp	Power from PV
<b>May-August (Analysis during summer)</b>			
Islamabad	3.4	23	129
Jacobabad	4.45	27.7	283
Hyderabad	4	27.2	270
Karachi	5	26.7	212
Quetta	6	16.5	250
Peshawar	3.5	23	130
Lahore	4.5	25	215

The values that taken during summer season at minimum temperature shows that Jacobabad is the suitable city for the installation of PV system. While Islamabad is the least suitable city for the installation of PV system.

### *Analysis during winter carried out for solar power project site selection*

The analysis of solar power generation has done in different cities of Pakistan that are Karachi, Lahore, Hyderabad, Islamabad, Jacobabad, Quetta and Peshawar during winter as shown in table 1. The analysis

has been divided in two temperature conditions, maximum (sun radiation peak hours) and minimum (down sun radiation hours).

**Table 3: Analysis during winter at maximum temperature**

City	Solar radiance in (kWh/m2)	Max temp	Power from PV
<b>November-February (Analysis during winter)</b>			
Islamabad	3.4	20.5	222
Jacobabad	4.45	25.7	214
Hyderabad	4	27.7	249
Karachi	5	27.25	270
Quetta	6	14	223
Peshawar	3.5	21	139
Lahore	4.5	23	213

The values that taken during winter season at maximum temperature shows that Karachi is the suitable city for the installation of PV system. While Peshawar is the least suitable city for the installation of PV system.

**Table 4: Analysis during winter at minimum temperature**

City	Solar radiance in (kWh/m2)	Min temp	Power from pv
<b>November-February (Analysis during winter)</b>			
Islamabad	3.4	7	152
Jacobabad	4.45	8.2	207
Hyderabad	4	13.7	206
Karachi	5	13.2	216
Quetta	6	-2	Can't install
Peshawar	3.5	6.2	179
Lahore	4.5	6.25	210

The values that taken during winter season at minimum temperature shows that Karachi is the suitable city for the installation of PV system. While Islamabad is the least suitable city for the installation of PV system.

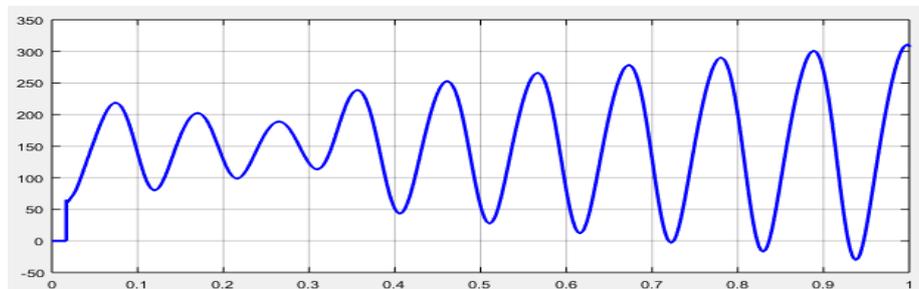
***Analysis during spring carried out for solar power project site selection***

The analysis of solar power generation has done in different cities of Pakistan that are Karachi, Lahore, Hyderabad, Islamabad, Jacobabad, Quetta and Peshawar during spring as shown in table 1. The analysis has been divided in two temperature conditions, maximum (sun radiation peak hours) and minimum (down sun radiation hours).

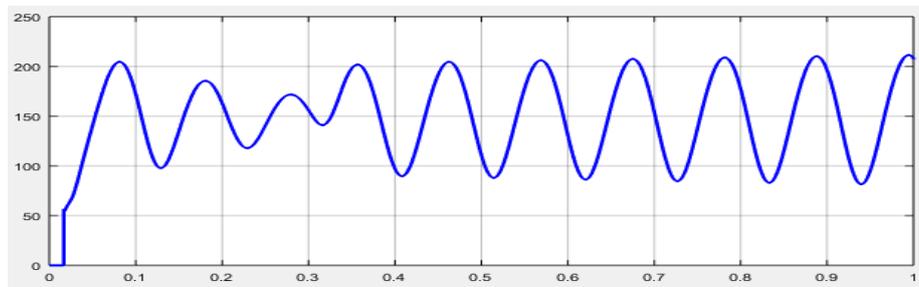
**Table 5: Analysis during spring at maximum temperature (sun radiation peak hour)**

City	Solar radiance in (kWh/m <sup>2</sup> )	Max temp	Power from PV
<b>March, April-September, October (Analysis during Spring)</b>			
<b>Islamabad</b>	3.4	29	209
<b>Jacobabad</b>	4.45	36.2	262
<b>Hyderabad</b>	4	36.7	267
<b>Karachi</b>	5	32.7	309
<b>Quetta</b>	6	25.2	222
<b>Peshawar</b>	3.5	30	208
<b>Lahore</b>	4.5	31	268

The values that taken during spring season at maximum temperature shows that Karachi is the suitable city for the installation of PV system. While Peshawar is the least suitable city for the installation of PV system.



**Figure 2: Power generation in spring maximum temperature in Karachi**



**Figure 3: Power generation during spring at maximum temperature in Peshawar**

The graph shows the city that is most and least suitable for the installation of PV system during spring season at max temperature.

**Table 6: Analysis during spring at minimum temperature**

City	Solar radiance in (kWh/m <sup>2</sup> )	Min temp	Power from PV
<b>March, April-September, October (Analysis during Spring)</b>			
<b>Islamabad</b>	3.4	15	160
<b>Jacobabad</b>	4.45	19.5	83
<b>Hyderabad</b>	4	22.2	212
<b>Karachi</b>	5	21.7	240
<b>Quetta</b>	6	6.5	235
<b>Peshawar</b>	3.5	16.5	158
<b>Lahore</b>	4.5	17	207

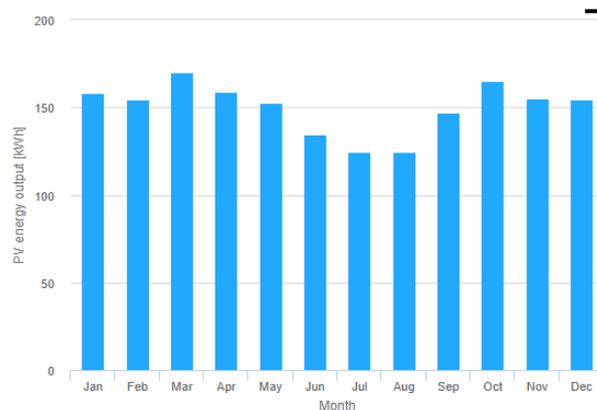
The values that taken during spring season at minimum temperature shows that Karachi is the suitable city for the installation of PV system. While Jacobabad is the least suitable city for the installation of PV system.

From the table and graph, observe that Karachi and the Hyderabad are the most suitable cities for the installation of PV system as sun irradiance and temperature is maximum in these cities during summer, winter and spring season. From these two cities, select the suitable place in which maximum energy from solar is obtained through PV system. So, let's find the suitable area of Karachi city in which we get max energy from solar PV system. Table 10 shows the different areas of Karachi which shows its yearly PV energy production values.

**Table 7: Yearly PV energy production and in-plane irradiation of different areas of Karachi**

Karachi Towns	Yearly PV energy production [kWh]:	Yearly in-plane irradiation [kWh/m <sup>2</sup> ]
<b>New Karachi town</b>	1749	2331
<b>North Nazimabad Town</b>	1765	2348
<b>Gulberg Town</b>	1760	2345
<b>Lyari town</b>	1799	2360
<b>Malir</b>	1764	2337
<b>Landhi</b>	1764	2334
<b>Bin Qassim Town</b>	1753	2330

From the values of above table, conclude that Lyari town is the best suitable area in Karachi to install the PV microgrid system as the sun radiation is maximum in this area. By inserting the values of longitude and latitude of Karachi, observed its monthly irradiance over the 12 months of that city and then obtained the PV energy production values in different areas of Karachi as shown in figure 5



**Figure 4: Monthly PV energy output for of Lyari area of Karachi city**

By selecting the city Karachi for the installation of PV system, select the main area of Karachi that are Lyari, new Karachi town, north Nizamabad Town, Gulberg Town, Malir, Landhi, Bin Qassim Town. Observe the value of sun irradiance in that respective area of Karachi through Geographical information. Results shows that Lyari town is the suitable place for the installation of PV grid connected system.

## Conclusion

The analysis of Grid connected PV system in different cities of Pakistan shows that the maximum energy can be extracted from Karachi and Hyderabad. While Peshawar and Islamabad are the least suitable cities for the selection of PV micro grid structures. Therefore, it is suggested that Karachi is the suitable place to install PV micro grid system because sun radiations are maximum in this city. After the selection of suitable city, find the suitable area of that city through geographical information system. From the different values of sun irradiance in multiple areas of Karachi, it concludes that Lyari town is the most suitable area in Karachi for the installation of Grid Connected PV system.

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# Modeling of DC to DC Converter Using Interleaved Topology with Voltage Multiplier Cell for High Voltage Gain Ratio

(Ref No. ICETEMS-21-154)

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Affiliation Missing

## Abstract

Dc-dc boost converter is very popular topic from the last two decades due to the world needs energy sources with lack of pollution and bad effectives to the environment. In order to accomplish a high pushing force (voltage) from solar energy, many researchers designed various types of topologies in dc-dc converters with the purpose to attain high voltage gain ratio and efficiency. But still in the current topologies have some problems, such as low efficiency, voltage ripples, and reducing the voltage stress and input current. To overcome this issue we will design a novel topology by using interleaved topology with multiplier cells. The central idea of our approach is achieving high efficiency, low power dissipation and reducing voltage stress. This paper would like to make a clear picture on the general law and framework for the next generation non-isolated high step-up DC/DC converters.

## Keywords

High Voltage Gain, DC-DC Converter, Renewable Energy, Voltage Stress, Coupled Inductors, Interleaved, Multiplier Cell, IBMC.

## Introduction

The attention of Renewable energy has been increasing with going up concerns about reduction of fossil fuels, energy crises, affection of the world warming and growing need for more environmentally friendly energy sources. The mid distinct types of Renewable energy sources like solar PV and Fuel Cell has a pleasant energy sources due to acceptable cost and increasing efficiency of the automations.

Most unlimited power sources like photo voltaic and vitality unit have low yield voltage and require arrangement association or a voltage support converter to give enough yield voltage are described in [1]. The idea of the sun power utilizes in solar panel change over sun radiations into electrical energy by utilizing photovoltaic (PV) impact are presented in [2]. In [4,5] continuous power supplies, E automobiles, aeronautics flying power systems, and u-girds, employ energy storage elements are explained and investigated in [4, 5]. The real DC to DC converters were made in the mid 1960s when semiconductor switches had ended up being available, as these converters are typically used in equipment for various applications. This is a novel research area, which has a lot of applications in the field of industry, telecommunications, biomedical, Satellites, transportation, appliances, military, renewable energy, utility, physics and photonics [1, 2, 3, and 4]. The power conversion process is done by DC-DC boost converters for the above mentioned applications [5]. The conversion ability of the boost converter is from milli-watts to kilo-watts ranges [6]. There are a ton of issues in the basic dc-dc boost converters, such as power loss voltage ripples and low efficiency. Researchers and electrical engineering are trying to fix and solves these issues.

Power electronics plays a very key role in Renewable energy especially in the reducing of energy consumption, improvement efficiency and the increasing voltage gain ratio of electric systems. Power converters are key subsystems in applications where power circuits interface sustainable power sources with loads, just as vitality stockpiling units, for example batteries. DC-DC Boost converter is a power electronics device which is mostly made of transistor; Diode, inductor and capacitor the boosting ability depend on these elements. In DC-DC boost converter inductors and capacitors are act as storage elements while transistors and diodes work as switching elements [7]. For transistor switching a constant signal is needed such as a PWM signal, the PWM signal is a consistent exchanging recurrence, altering the on and off length of the switch. The PWM signal is additionally utilizing for controlling the switching, the duty cycle  $K$  as the proportion of the on time span to the switching  $T$  duration. Usually

renewable energy source and DC batteries applied as an input voltage source for converters. The boost convert boost low I/P voltage to required O/P voltage. Step-up output voltage of the converter based on user applications and I/P source.

The traditional circuit having low voltage transformation ratio as to reverse recovery downside, the excessive output voltage in order for high obligation cycle thus leading the switch to remain on for long time interval. The voltage multiplier cells have massive size and additional power losses. Switch inductor topology is applied for low I/P voltage sources due to drawing high I/P current. Switch C topology has high transient current. Attractive coupled L topology has inductance spillage issue.

The basic interleaved technique regarding to boost converter have been introduced to conquer these issues. It has a whole a lot of advantages over these mentioned topologies. The basic interleaved technique regarding was being to reduce I ripples and boom the energy density. Interleaved procedures have zero reverse-recovery of O/P diodes and low obligation cycle as contrast with basic convertor [1]. Two- stage DC to DC interleaved boost converter reduces ripples in I/P current and boosts the I/P voltage to specific level however not up to a ideal level. Two phase interleaved converter circuit story were described in [2, 3] providing output voltage of 120. So as to cut back power misfortunes on switches and upgrade effectiveness auxiliary inductor is associated b/w the 2 switches of the 2 parallel inductors to modify ON the switches at zero voltage with 94% effectiveness [4]. Another two stage interleaved boost converter with power factor corrected to produce voltage doublers feature with higher than 50% of duty cycle, 1.3 KW power and output voltage of 400V is appropriate for universal line [5]. A modular interleaved converter with both voltage Doublers and forward vitality conveying circuit give high effectiveness of 95.8% with high output voltage [6]. The ripples cancellation network were explain in regarding transient response [7]. A high G, DC to DC converter with CL and voltage lift method gives high yield voltage up to 240V with frequency of 50 KHz [8]. The three stages interleaved step-up converter with CL and voltage extension capacitor provide high G and low switch losses were developed in [9]. A 3 stages CL boost converter with clamping capacitor is employed to clamp the switched voltage of interleaved converter additionally the spillage energy are amassed in single clamp capacitor which release to the yield to give high effectiveness [10]. Four cells interleaved boost converter achieves less power losses and low ripples current by the use of 25% duty cycle for each cell and by ON and OFF the switches gives low output voltage ripples but have low gain not greater than two [11].

In summary a wealth of attempt is devoted on different directions of the fundamental boost converter but still there is changeling to improve the efficiency and control the input current as well pushing forces stress. To overcome these issues we will design a novel interleaved boost converter, integrate couple inductor interleaved topology with voltage multiple cell using a novel method in order to achieve low power dissipation, having all the benefits of interleaved boost converter yet have satisfactory gain.

### **DC- DC Converter**

Converter is the device which changes properties of I/P voltage at the O/P. DC-DC converters is utilized when the available power supply is DC and the load requirement is also DC. The DC-DC converter actually converts and also boosts a variable low DC voltage into a constant or uninterruptable high voltage. Basically, DC-DC converters concept were developed after Second World War for communication purpose from choppers. First of all, type A chopper was converted into buck converter in 1940, while after that boost converter was developed from type B chopper. The buck boost converter was introduced after boost and buck converter. 1980 and 1990 was golden period of converters in which hundreds of DC-DC converters were introduced such as soft switching converters, CUK converter and SEPIC converters. After that more than 600 hundred DC-DC converters were introduced for different purposes from these converters. The traditional DC to DC boost converter consists of Input voltage source, Transistor (MOSFET), Diode, Inductor, Capacitor, Pulse width modulation (PWM) signal generator, Output filter components (capacitors) and Load. The schematic figure of basic DC to DC boost converter is given below in Figure 2.1

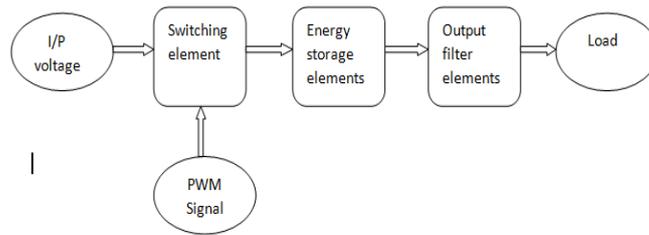


Figure2.1. Block diagram of the basic boost converter.

### 1) Isolated and Non-Isolated Dc-Dc Converters

DC-DC converters have two types that are Isolated and Non-Isolated DC-DC converters. The isolated converters do not gift an electric contact between the I/P and the O/P circuits while non-isolated have direct contact between the info and yield circuit.

Isolated converters offer the advantages over the non-isolated; the absence of direct electric contact, a safety condition is produced for both the input and the output circuit such like isolation forestalls I/P voltage from transmitting to the O/P in case of interior failure. Isolated converters can offer different grounding configurations: Negative or positive ground, or even floating ground. In isolated Voltage transients on the I/P are not transferred to the O/P Isolated converters are widely used in communications where loads are highly sensitive [8, 9]

Nevertheless, isolated converters gift drawbacks of massive size. Usually, these converters use bulky transformers and extra components that non-isolated converters. Thus, volume, mass, cost, and power losses in some cases of isolated converters are larger than the case of non-isolated converter. Non-isolated DC to DC converters offer the merits of lower cost, and high power density.

### 2) Interleaved Boost Converter

Interleaved boost converter is a type of DC to DC boost converter in which two are more than two boost converter are associated in corresponding to step up the I/P voltage to at desired high O/P. The major benefit of the interleaved boost converter are to reduces I/P current waves, O/P voltage waves and power losses across transistor switches which improve the efficiency of the converter.

The voltage stress across the switches and diode is equivalent to the output voltage, which make this topology not suitable for high yield voltage gain.

#### 2.1) Reverse Recovery Time

When diode is in forward bias and certainly turned to reverse bias then reverse current goes high for short interval of time because of forward current and shrikes of depletion region after that current goes to normal reverse value this short time interval is called reverse recovery time. And interleaved boost converter have less reverse recovery problem.

### 3) Applications Of Dc-Dc Boost Converter

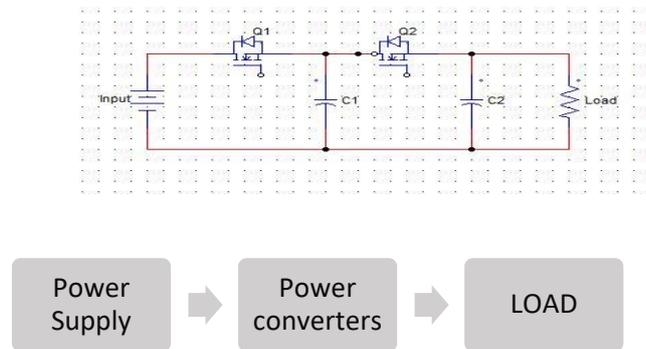
This is a novel research area, which has a lot of applications in industry(High power or DC power supply, Motor drives, Robotics),telecom, biomedical(Implantable devices, X-ray), transportation, appliances, military(Radar, Pulse Laser), renewable energy(Photovoltaic, Micro grade), Distributed Power system, utility(Power factor correction, High voltage direct current (HVDC), physics, Avionic space, and photonics. Thus it has power conversion applications for those devices whose operating voltage from milliwatts to kilowatts ranges.

## Background

In this section, discussing the Power Electronics Converters and their types and basic concept of DC-DC converter and also examine the exacting technique that have been utilized for boosting of a PV O/P voltage, limiting ripple in the current drawn from the PV. To improve the presentation of the interleaved boost converter is summarized at the end of section. This paper work is concerning DC-DC boost

converter, which is expounded to the field of power electronics. Power electronics is the study of converting, processing, controlling and conditioning of electric power through semiconductor devices. So power electronics convert current and voltage into such a form that meets the power requirements of the tip user. Practically, there is always a mismatch of power between power supply and load at the tip user's side. Thus the power converters ought to use to overcome this mismatch issue between power supply and load for proper operation.

The power supply and load mismatch fixing problem is shown in below 3.1 block diagram.



Block diagram 3.1: Interconnection between power supply and load.

### 1) Mechanism of Dc-Dc Boost Converters

The basic obstruction of improving the efficiency of the fundamental DC-DC converters in high boost applications is way out PWM duty ratio, conduction losses emanating from high rated power devices and reverse recovery related loss of the output diode. In view of these limitations, many work have been carried out to explore various topologies with potentials of improving the limitations of basic topologies like static gain, power devices voltage stress, power density and efficiency. There are varies types of DC voltage boosting techniques, which are utilize in DC-DC converters.

### 2) Switched Capacitor/Switched Inductor Techniques

These techniques [18] allow to achieving high voltage gain from classical converters. The method uses capacitor/ inductor charge transference to boost the input voltage. The SC converter structure and the SC cell viewed In Fig 3.2(a) and Fig 3.2(b).

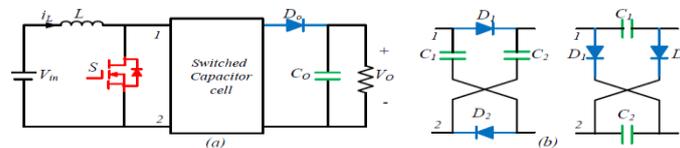


Fig 3.2 (a) Switched capacitor Converter structure and (b) Switched capacitor cell topologies

The switched capacitor circuit can provide a boost function of the I/P voltage depend on the C charge transference, when inserted in classical boost converters [18]. When switch is turn-off in the converter, the diodes act in the cell is forward bias. Therefore, the two capacitors in the switch cell are charged in parallel to the converter VIN. During the SW turn-on conduction, the diodes work as reverse blocking, and the capacitors are discharged in series. Switched capacitor cell can improve the voltage gain and reduced the device Vstress.

### 3) Switched Capacitor Charge Pump

Charge pumps circuit operates based on capacitor charge transference and do not contain inductors [19]. The basic switched capacitor structure is given in below figure.

It has several advantages like cheap, small in size, fast dynamic response, easy to integrate and have high power density. The main drawbacks are inrush current, output voltage regulation is less and discrete. It is normally used in mobile displays, energy harvesting and for high gain applications. Diagram 3.3: Switched capacitor charge pump basic schematic circuit

#### 4) Switched Inductor

Switched inductor technique has high boosting ability. It is suitable for low voltages and cannot be usable for high power applications. The switched inductor cell is made from 2 inductors instead of capacitors and 2-3 diodes [18]. Incorporation of switched inductor cell within the classical converters provides a means of increasing the voltage gain, however, static gains of ten times or higher isn't feasible without higher duty ratio. In furthermore, the device V stress is the same as the converter output voltage resulting in dominant conduction losses and severe reverse recovery issues limiting its use to low power applications.

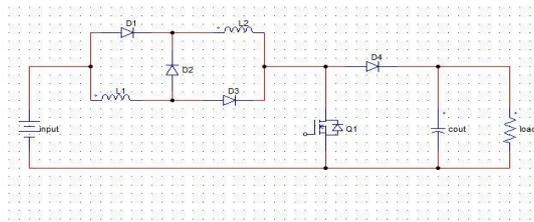


Figure 3.4: Switched inductor schematic ckt.

#### 5) Three level boost converter

Fig 2.5 shows the three level converters [21], and the circuit has an advantage of voltage stress distribution among the power devices.

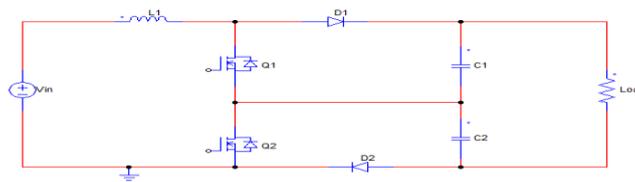


Figure 3.5: Three level boost converter

The device VS is half of converter Vo. Moreover, topology permits significant reduction in inductor volume. The fundamental downside of this topology is that the G is the equivalent to conventional boost converter as such it is not adequate in several advanced applications require higher conversion ratio of ten times or higher and also the diodes reverse recovery losses is another worry.

#### 6) Voltage Multiplier Cell

It is well efficient, low cost and very simple alternative technique to defeat the confinements of traditional boost and buck-boost DC-DC converters for superior and high change proportion applications is by utilization of voltage multiplier cells [20]. The inclusion of the voltage multiplier cell is to cut back the issues of mass, volume and losses related with the high voltage power transformers. Figure 3.6 views the fundamental schematic circuit figure of voltage multiplier cell. The voltage multiplier cell can be installed into traditional converters like buck, lift and buck-boost to execute high advance down or high advance up converters [20].

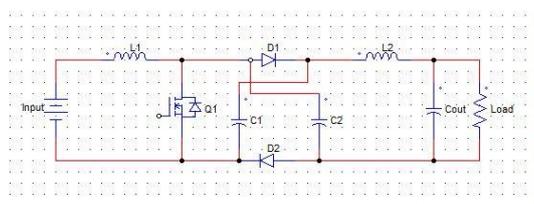


Figure 3.6: Voltage multiplier schematic circuit.

## 7) Magnetic Coupling

In numerous applications, it is wanted to include a magnetic element into the exchanging DC-DC converter to acquire series of step-up wide range V transformation proportion. Another preferred position is that the transformer based converter makes the power switch voltage stress far less than the  $V_o$ . Including multiple secondary winding offers a means of obtaining multiple DC outputs. Various high advances up topologies utilizing using magnetic means were reported in the literature [22, 23]. Besides, the volume, weight and losses of the transformer are the limiting factors of producing compact and effective converter. The leakage inductance is the main drawback of this technique.

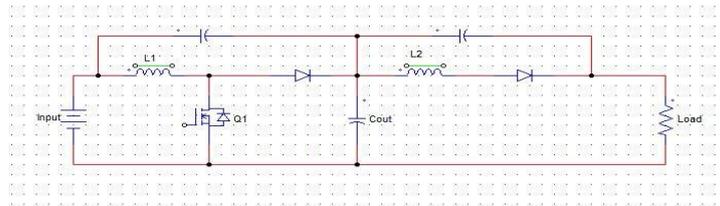


Diagram 3.7: Magnetically CL schematic circuit.

## IV. MODELING FOR PROPOSED CONVERTER (IBVC)

In the given idea we illustrate a non-isolated interleaved boost converter with voltage multiplier cell as shown in Fig. 4.1. In the current idea we try to improve gain of the CKT and making more effective the said CKT.

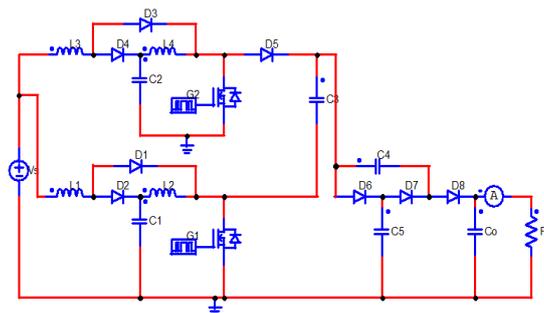


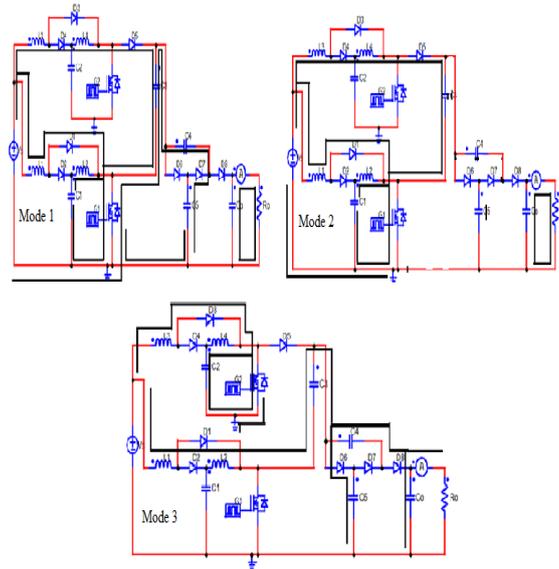
Figure 4.1 Novel Interleaved Boost Converter having Voltage Multiplier Cell

Table 4.1 Devices with its values

Devices	Values
L1=L3	260*10 <sup>-6</sup> H
L2=L4	125*10 <sup>-6</sup> H
C1=C2	2200 uF
C3	100uF
C4=C5	100uF
Co	470 uF
Ro	100 Ohm

### a) Steady state analysis for novel approach

During the operating process, we suppose that all modules or components are best which having (100% efficiency), Consider the source of input  $V_g$  is a pure dc, and all energy elements having comparative small voltage ripple at SW frequency ( $f_s$ ).



**Figure 4.2 Modes 1, 2 & 3**

During mode 1, in the boost converter present at the bottom of the interleaved part when switch S1 is switched ON, diode D1 becomes forward biased and diode D2 is reversed biased by the capacitor voltage  $V_{C1}$  hence, inductor L1 is charged by input voltage source  $V_s$  and L2 comes in parallel with capacitor C1 thereby, L2 is charged with energy present in capacitor C1. Voltage equations of inductors L1 and L2 are given as follows. The Voltages of the inductors are given below,

$$V_{L1} = V_S \quad (1)$$

$$V_{L2} = V_{C1} \quad (2)$$

Using the idea Kirchhoff Voltage law, during the when S2 is in Off state at the same time D5 providing charges to the capacitor C3 while D4 and L3, L4 giving easiest path for the flowing of input current and in the situation D3 and D4 have opposite polarity means diode three is in blocking position while the device four allowing the current. Mathematically we conclude such as

$$V_S = V_{L3} + V_{C2} \quad (3)$$

So voltage across L3 is expressed as:

$$V_{L3} = V_S - V_{C2} \quad (4)$$

While voltage across L4 can be expressed by using Kirchhoff Voltage law:

$$V_{C2} = V_{L4} + V_{C3} \quad (5)$$

So  $V_{L4}$  is expressed as:

$$V_{L4} = V_{C2} - V_{C3} \quad (6)$$

In this mode, capacitor VC5 is charged to a VO of interleaved boost converter

Considering operation of mode 2, the below mathematical formulations illustrates that first device is in on position due to the OFF situation of S1 and second device not allow flow. Moreover, the flow of current from the source  $V_s$  that provides and supplied energy or power to output side using the path of first magnetic energy storage device. The mathematical equation are developed viewing the ON and OFF positions of the various energy storage devices (diode, inductor, capacitor) on the bases of KVL, We get,

$$V_S = V_{L1} + V_{C1} \quad (7)$$

So  $V_{L1}$  is expressed as:

$$V_{L1} = V_S - V_{C1} \quad (8)$$

For  $V_{L2}$ , Using KVL, We get,

$$V_{C1} = V_{L2} + (V_{C4} - V_{C3}) \quad (9)$$

So  $V_{L1}$  is expressed as:

$$V_{L2} = V_{C1} - (V_{C4} - V_{C3}) \quad (10)$$

.The Voltage equations of inductors L3 and L4 are given as follows.

$$V_{L3} = V_S \quad (11)$$

$$V_{L2} = V_{C2} \quad (12)$$

Now By applying Volt-Second balance model for the magnetic energy storage elements separately.

**For L1,**

$$V_S DT + (1 - D)T(V_S - V_{C1}) = 0 \quad (13)$$

**For L2,**

$$V_{C1} DT + (1 - D)T(V_{C1} - (V_{C4} - V_{C3})) = 0 \quad (14)$$

**For L3,**

$$(V_S - V_{C2})DT + (1 - D)TV_S = 0 \quad (15)$$

**For L4,**

$$(V_{C2} - V_{C3})DT + (1 - D)TV_{C2} = 0 \quad (16)$$

After long mathematical calculation for the novel approach the model for voltage gain:

$$\frac{V_O}{V_S} = \frac{N+2}{(1-D)^2} \quad (17)$$

Where, N shows the amount of cell which are using in the basic interleaved structure.

## V. SIMULATION RESULTS & DISCUSSION

The proposed converter is designed in PSIM software having input supply of 12V while the cycle ratio is 0.5. As, a result the VO is improved and enhanced by 16, The L1 and L3 are fixed value 260 uH and value of inductors L2 and L4 are chosen as 125 uH. Similarly, the electric energy storage element C1 and C2 are fixed as 2200 uF, Also, the transitional capacitor C3 as 100 uF, capacitors C4 and C5 as 100 uF and output capacitor Co as 470 uF.

a) Simulation of interleaved boost converter with voltage with multiplier cell (IBVC).

The IBVC is simulated in the PSIM software having the following parameters presented in the Table 1.

**Table 5.1 Parameter with its values**

Parameters	Values
I/P V	12 V
L1=L3	260*10 <sup>-6</sup> H
L2=L4	125*10 <sup>-6</sup> H
C1=C2	2200 uF
C3	100uF
C4=C5	100uF
Co	470 uF
Ro	100 Ohm
D	50%
Voltage stress	49 V
Vo	220 V

### *Input Current and Voltage*

The Figure 4.1 illustrates the input current and input voltage through PSIM program. The input current is produced from the source and then divided into both parts according to modes variation. The overall input current is viewed in fig 5.1(a), while input voltage is viewed in fig 5.2(b).

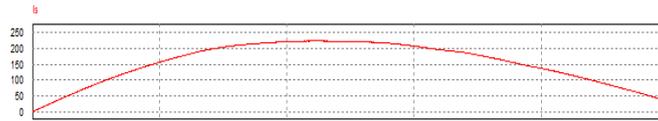


Fig 5.1(a) I/P Current

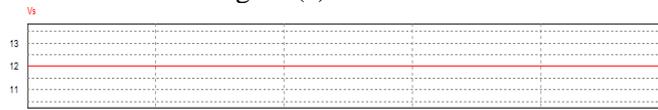


Fig 5.1(b) I/P Voltage

### Output Current and Voltage

The O/P current and O/P voltage using PSIM is viewed in Fig. 5.2a and 5.2b respectively. O/P current is reduced to 2.25A and the O/P voltage is increased nearly to 220 V. It is show that a high DC voltage gain is obtained (220/12 V) that prove the idea.

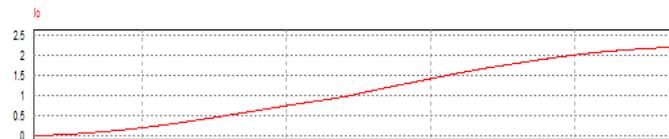


Fig 5.2(a) O/P Current

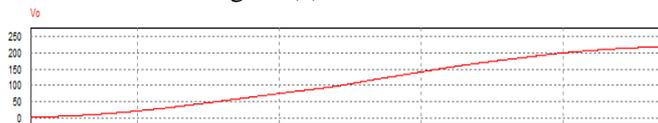


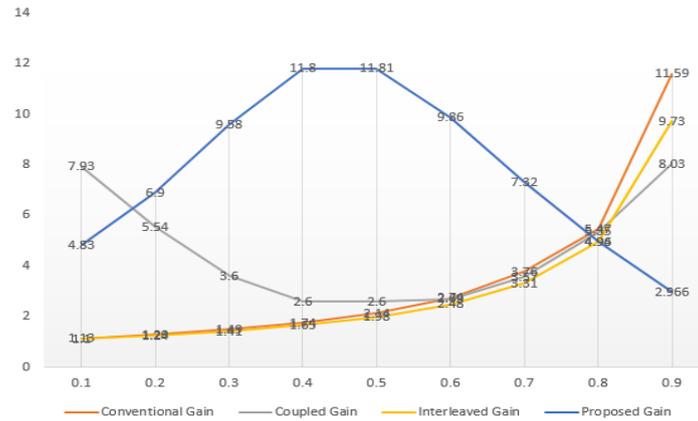
Fig 5.2(b) O/P Voltage

### Voltage Gain and Duty Cycle Comparisons

Figure 5.3 gives a comparison among the four topologies in the ideal case at various duty cycles. It is to be noted that from this figure that for low duty cycle, G of conventional and interleaved topology is extremely low compare to coupled proposed topology while coupled topology shows its highest G. In spite of the fact that, at intermediate duty cycle, interleaved topology shows its lowest value while proposed topology displays its highest G. At high duty cycle, conventional and coupled topology shows their highest voltage gains. While interleaved and proposed topology decrease their G by increasing duty cycle.

Table 5.2 Voltage Gain Vs Duty Cycle

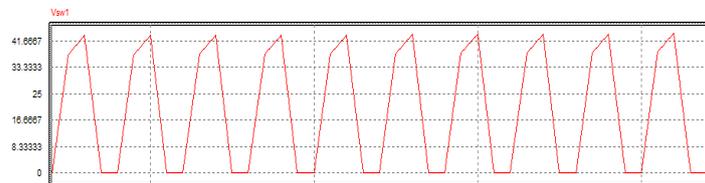
Duty Cycle	Conventional Gain	Coupled Gain	Interleaved Gain	Proposed Gain
0.1	1.13	7.93	1.1	4.83
0.2	1.29	5.54	1.24	6.9
0.3	1.49	3.6	1.41	9.58
0.4	1.74	2.6	1.65	11.8
0.5	2.14	2.6	1.98	11.81
0.6	2.74	2.69	2.48	9.86
0.7	3.76	3.57	3.31	7.32
0.8	5.47	5.35	4.96	4.94
0.9	11.59	8.03	9.73	2.966



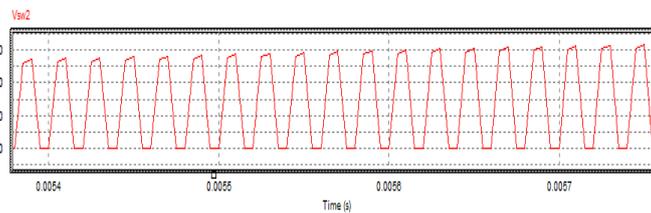
**Figure 5.3 Voltage Gain versus Duty Cycle**

### *Voltage Stress on Switch*

The basic benefits of this technique are to decrease the  $V_{stress}$  on each component comparing with conventional and interleaved boost converters. The  $V_{stress}$  on a SW1 is equal to 42 V and on SW2 is 52 V as viewed in Fig 5.4 through PSIM.



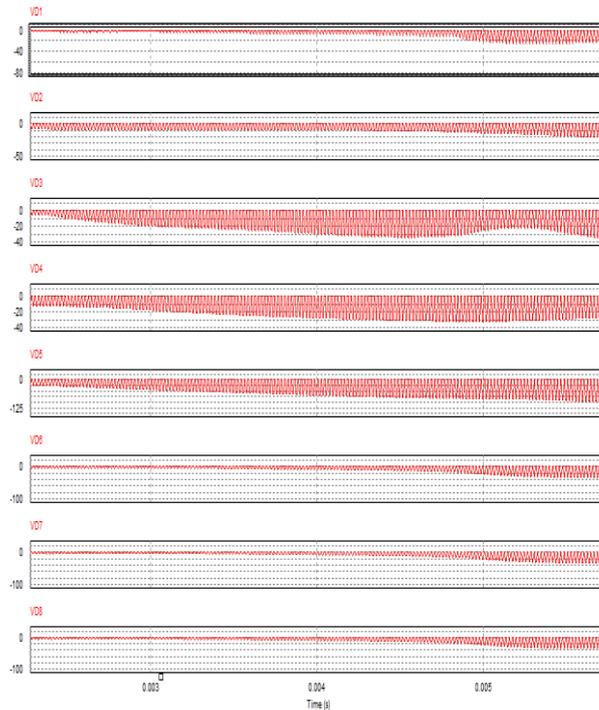
**Fig 5.4(a) Vstress on Switch SW1**



**Fig5.4 (b) VStress on Switch SW2**

### *Voltage Stress Across Diodes*

The 5.5 diagram provides the information and briefly knowledge about the voltages drop of all diodes which are present at the novel approach. Consequently, the first and second elements having same V stresses across D1 and D2 respectively, while VD3 is the  $V_{stress}$  across D3, VD4 and VD5 are the different voltages having different values and at last VD6, V D7 and VD8 are same voltages across D6, D7 and D8 respectively.



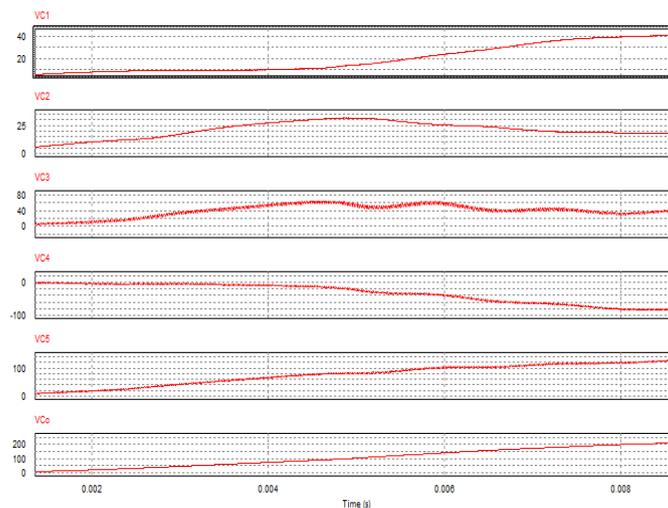
**Figure 5.5 VS across Each Diode**

*Voltage Plot of Capacitor*

The Figure 5.6 providing the information among the capacitors. Form the simulations results we notice that the voltages across capacitors are all of different. In table 4.6 the capacitor values are presented.

**Table 5.4 voltage across Capacitor**

Capacitor	Voltage
C1	41.28 V
C2	31.41V
C3	64.5 V
C4	82.35V
C5	126.80V
Co	210.6V



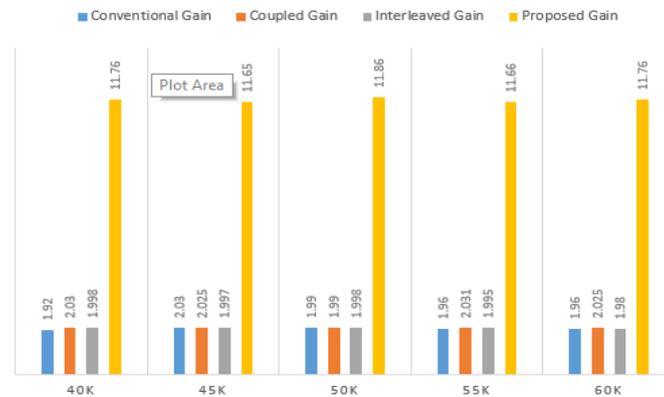
**Figure 5.6 Plots of Voltages values across Capacitor**

### Frequency and Voltage Gain Comparison

Fig.5.7 shows the comparison of voltage gain and switching frequency. All through the experiment we noticed that there isn't such enormous reliance G of interleaved and proposed topology on switching frequency. In case of conventional and coupled topology, conventional gain increase with increasing frequency, while voltage gain of coupled topology diminishes with increasing frequency.

**Table 5.5 Voltage Gain Vs Frequency**

Frequency	Conventional Gain	Coupled Gain	Interleaved Gain	Proposed Gain
40k	1.92	2.03	1.998	11.76
45k	2.03	2.025	1.997	11.65
50k	1.99	1.99	1.998	11.86
55k	1.96	2.031	1.995	11.66
60k	1.96	2.025	1.98	11.76



**Figure 5.7 Voltage Gain Vs Frequency**

### Conclusion

Designing a DC-DC boost converter using any topology must meet some requirements such as a smaller number of elements, high efficiency, low cost, low Voltage stress and high voltage gain. A novel non-isolated interleaved boost converter with voltage multiplier cell has been proposed in this work. The proposed converter has show high efficiency, low Voltage stress and high voltage gain ratio. The measured efficiency of the proposed converter at rated power is 94% at 495 W for boost operation. In addition to the stress reduction on the components, the proposed converter has shown an improvement in voltage gain ratio. The simulated and theoretical results have shown the reduction the voltage stress on each component comparing with conventional and interleaved boost converters. The Voltage Stress on a switch SW1 is nearly to 42 V and on SW2 is 52 V which clearly show that high voltage gain ratio is achieved. Output current is decreased to 2.25A at result the high output voltage is achieved nearly 220 V. It is show that a high DC voltage gain is obtained (220/12 V) that prove the idea.

### Future Work

The advancement miniaturized converter gives the chance of driving further the exchanging frequency to enhance the power density. Increasing the switching frequency makes the passive elements smaller, but the limit of the switching frequency and degree of the advantages needs further examinations. Increasing the switching frequency exacerbate the switching loss.

Conceivable future work may be consisting of general massive signal, and little signal models which can undoubtedly specify dc-dc converters with any quantity of stages and for any positioning. However,

further study on gain extension cells could prompt to new topologies with the capability of improving the efficiency.

Further study on interleaved topologies for conversion may be both the DC/AC inversion phase and the DC/DC conversion stage, and the possible issues for the interaction of the two phases in control.

Further research of the coupled inductor interleaved power converters and performance improvement through structure advancement, as well as comparison with the current state of the class topologies, would be an interesting research topic.

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# Arduino Based Improved Smart Solar PV System with Dual Axis Monitoring and Cleaning System

(Ref No. ICETEMS-21-163)

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## Abstract

Electricity is generated by several sources. Sun is the primary and ultimate renewable resource of energy in the universe. The sun light can be easily converted into electricity through PV Panel. The stationary PV panel works efficiently for a specific time due to the earth's rotation. To get more energy, the panel must be pointed perpendicular to the sun all over the day. This paper presents a PV system which is smart and will increase the output power by keeping solar panel perpendicular to the sun all the time. This system is based on Arduino that controls majority of the components automatically using sensors. The whole system is a combination of hardware and software. The main constituents of system's hardware are a PV module, an LDR module, two geared motors, a temperature sensor, a rain sensor, a dust sensor and a cleaning system. The methodology employed in this system includes the implementation of Arduino based solar tracking system. Four LDR sensors detect the light and give signals to the controller and rotate the motor. Geared motors have been used to rotate the solar panel both horizontally and vertically according to the sun light. The system will be operated automatically as well as manually. All the values will be displayed on LCD. The dust sensor will detect the dust which will trigger the cleaning system. The system information will be shared with mobile user through IOT. The sensors and motors will enable us to make more efficient and smart solar powered automated system which will allow us to draw more renewable energy than typical systems.

## Keywords

LDR, PV Module, IOT, Automated Tracking, Cleaning Module

## Introduction

The most important form of energy is the electrical energy. Electrical energy is the movement of electrical charges from one point to another in a conductor. Electrical charges moving in a conductor is called electricity. The modern world of high technology is so much dependent upon the use of electricity and it has become an integral part of our life because all our devices of comforts work with electricity. Electricity is produced from many sources. But all the sources are now depleting and finishing. The only one source which is always there is the sun. The energy coming from the sun is called solar energy. Solar energy is considered as an abundant and easily available renewable energy source while sun is the major source of solar energy. It is estimated that 120,000 TW of power is available from the radiation of sun deposited on the surface of the earth which exceeds even the highest aggressive energy demand. It is estimated that if we are able to convert 10% of the sun radiation into electric energy, it would be equivalent to 20 TW of power which is double the power consumption from fossil fuels in the world [1]. Therefore, one of the most challenging and promising tasks is to convert maximum available solar energy into electrical energy.

Photovoltaic (PV) is one of the most prominent technology to transform solar energy into electrical energy. The photovoltaic system is based on the P-N junction diode. Sunlight is converted into Direct Current (DC) by PV module using photovoltaic effect [2]. The output efficiency of a PV system can be enhanced with automated tracking and cleaning of the panel. The stationary PV module works efficiently for a specific time. To get more energy from the sun, photovoltaic panels should be moved along with the sun because the efficiency of the module depends upon the intensity of light. The more is the intensity of light, the higher is the efficiency of the panel. There are many methods for tracking the sun in dual-axis solar system. A simple method is by using LDR (Light-dependent resistor) for

finding the position of the sun. LDR is a photo resistor that changes its resistance based on the intensity of light falling on it. By placing four LDRs at each side of the photovoltaic panel, that rotates the photovoltaic panel in a particular direction when that particular side LDR output is low with this method the sun can be tracked with  $\pm 4\%$  degree precision.

#### ***Project Description:***

Our aim is to design the most efficient solar power tracking system which will automatically track the sun's position and accordingly change the direction of the solar panel to get the maximum output from the solar cell and to utilize more and more of the sun light. The system focuses on the controller design and the rotation of motor upon the receiving sun to get utmost intensity of light. A blynk application is added to monitor the performance of solar panel remotely.

#### ***Solar Tracking:***

Solar panel is a collection of many solar cells that converts the energy of light into electrical energy through photovoltaic effect. The solar panel very much influences by the sun light. If there is a hot sun, the efficiency of the panel will be more. Now the sun light does remain the same on the earth because our earth continuously revolves around the sun. So a system is required to align the panel towards the sun automatically. Such a system is known as solar tracking system. The word "Tracking" refers to "the act or process of following something or someone". So the automatic solar tracking is the act or process of following the sun light to get the maximum energy from the sun [4]. If the panel is rotated only in two directions, one axis either vertically or horizontally, then it is called single axis solar tracking system. If the solar panel is rotated in two axes, four directions, then it is called dual axis solar tracking system. We have designed a dual axis solar tracking system that is more efficient than that of a single axis solar tracking system because it has the ability of following the sun vertically as well as horizontally. Wherever the sun in the sky is, the system will be in direct contact with the sun [8].

#### ***Automatic Cleaning***

The solar panel directly depends upon the intensity of sunlight. The more is the intensity of light, the greater is the efficiency of the panel and vice versa. There are many environmental factors that weaken the efficiency of the panel. Dust is one of them. The dust accumulated on the front surface of the panel distorts the incident light from the sun and reduces the power generating capacity of the module. Almost, 50% of the output power reduces if the module is not cleaned for a month [4]. In this system, an automatic cleaning scheme has been developed that reduces the dust hazard. Dust sensor, two wafers motors and wafers have been used for cleaning purpose. The dust sensor detects the dust and triggers the cleaning system automatically via Arduino. This automatic cleaning scheme provides 30 % more energy than that of a flat or typical system.

#### ***IoT Monitoring:***

The acronym IoT stands for "Internet of Things". It is an emerging technology that effectively and efficiently improves our daily life. It has revolutionized many sectors by automating the manual processes. It allows the users to control the systems and keeps aware of system analysis from faraway place [7]. We have used an IoT Module, Node MCU in this system that will enable us to read all the system analysis on our, mobile phone. It acts as an interface between hardware and software through Blynk application. The system is connected to internet via Node MCU in order to monitor parameter online. For this purpose, mobile hotspot is used. After connection with internet, a serial communication between Arduino and MCU gets start.

#### ***Automatic Measurements***

Measurement of electrical quantities used in a system is very necessary. In this system various sensors have been used that enable us to measure various parameters of the system such as intensity of light, system voltage, temperature, humidity and rain. Light sensor is used for the measurement of light intensity, voltage sensor tells us the system voltage, the rain sensor detects the rain drops and temperature sensor describes coldness or hotness of the atmosphere around the system. All these values will be shown on LCD screen and on mobile phone or laptop as well through IoT Module.

## System Diagram

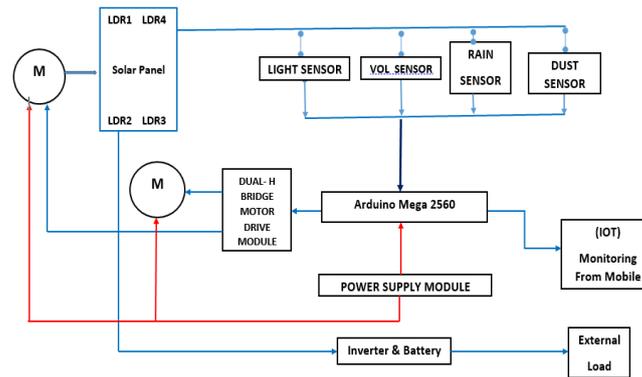


Fig.3.1. Block Diagram

## Simulation

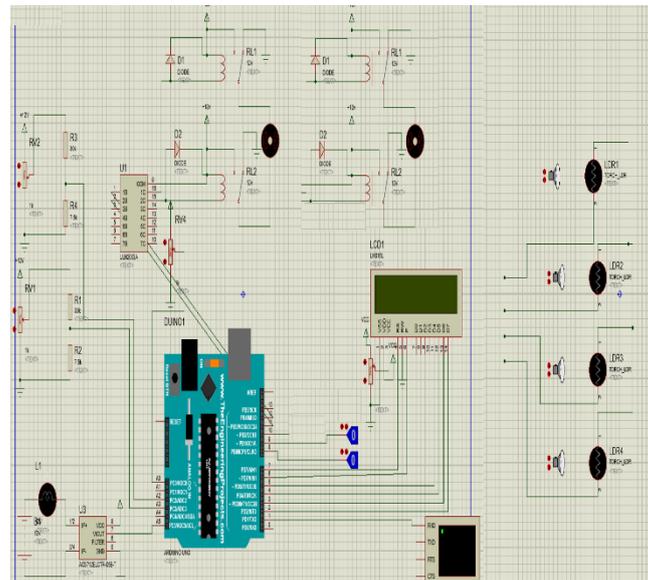


Fig.3.1. Schematic Diagram

## Methodology

Four LDR sensors are used to detect the light. The resistance of LDR depends upon light fall. The altered resistance is changed into analog voltage signal. This signal is fed to Arduino that converts it into a digital signal. When there is difference between LDR voltage levels, Arduino drives the geared motors towards the normal incidence of sunlight where it captures maximum sunlight. The system rotates w.r.t to LDR and stops where the solar panel is getting maximum light intensity. Geared motors have been used that can lift maximum load and rotate the solar panel both horizontally and vertically according to the sun light. The dust sensor will detect the dust which will trigger the cleaning system. Light and voltage sensors will measure the intensity of light and voltage respectively. All the values will be displayed on LCD. The system will be operated automatically as well as manually. The system information will be shared with mobile user through IOT. The sensors and motors will enable us to make more efficient and smart solar powered automated system which will allow us to draw more renewable energy than typical systems. Voltage Regulator will give the fixed output and protect the system from excessive current damage. The inverter will convert the dc power into AC power. The system information will be shared with mobile user through IOT using blink application.

## Hardware Detail

### *Solar panel:*



Fig.1. Polycrystalline Solar Panel

Solar panel is a collection of many solar cells which are connected in definite pattern. The solar cell is a simple PN Junction device that converts the energy of light into electrical energy. A solar cell consists of silicon or gallium arsenide PN junction diode which is packed in a glass sheet. A single solar cell has the capacity of producing about 0.5 volts of electricity. A solar panel or solar module is the combination of several solar cells connected in series to generate the usable voltage. The solar panel voltage can be increased by increasing the number of solar cells. It works on the principle of photovoltaic effect. When we place solar panel in sunlight, it will absorb the sunlight and then it will convert it into electrical energy.

### *LDR*



Fig. Light Sensitive Resistor

Some electronic components can sense the intensity of light. LDR is one of them. LDR means light dependent resistor [9]. It is also called photo conductor and photo resistor. It is made up of a semiconductor named Cadmium Sulphide. It works on the principle of photo conductive effect; change in conductivity due to light or the dissolution of bond in a semiconductor by light irradiation. It varies its resistance depending on a light. If light is increased, it has high resistance and if there is no light, it will have low resistance. It is mostly used for sensing purpose to capture solar energy. Four LDRs have been used in this system at all which enable the panel to rotate in four directions.

### *D.C. Geared Motor*



Fig.2. D.C. Geared Motor (12V)

Motor is used to rotate the solar panel according to the sunlight. Geared motor is one which is capable of lifting a heavy load. This is 12 volts D.C. geared motor consists of nineteen metal gears. Two similar type of geared motors have been used for rotating the panel horizontally as well as vertically.

### ***Motor Drive***

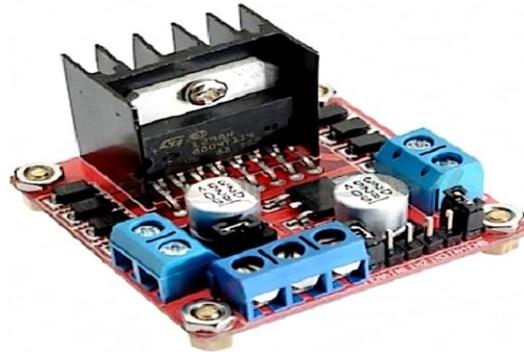


Fig.3. H-Bridge

Motor drive works as motor controller. It is used to drive the motor and to change the speed and direction of the motor as well.

### ***Arduino Mega***

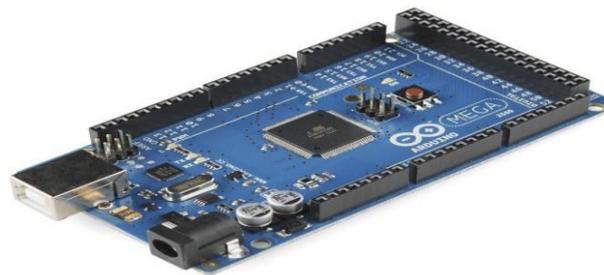


Fig.4. Arduino Mega 2560

Arduino is a microcontroller that controls all the hardware components of the system. It works as microprocessor. Arduino Mega is an advanced board for integrating distinct sensors and devices for automation. It has 54 pins for input and output at all. It consists of a microcontroller, digital pins, analog pins, power supply, power check, the USB Port and the reset button. The controller controls the data. The 13 digital-pins mostly used to connect the output components- analog-pins connect different-sensors. For the output and the input components the power-supply is used. The power-check gives power supply-to-Arduino. USB Port helps in uploading the program into Arduino through a USB cable.

### ***I2C Module:***

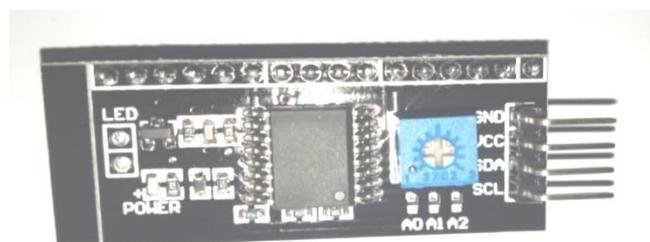


Fig.5. I2C Serial Module

It is used as series to parallel convertor. It is connected to the back side of LCD in order to reduce the more pins of LCD to only four pins.

***Rain Sensor:***

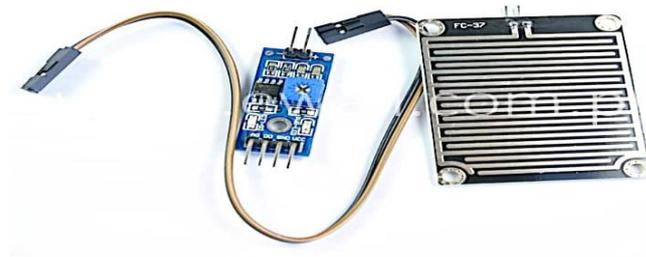


Fig.6. Rain Sensor for Raindrop Detection

Rain sensor is a measuring instrument used for the detection water. When it rains, it becomes functional and sends signal to Arduino.

***Dust Sensor***



Fig.7. Dust Sensor for dust detection

Dust sensor is a measuring device used for dust detection. It can detect the dust particles which will trigger the cleaning system through Arduino controller.

***Voltage Sensor***

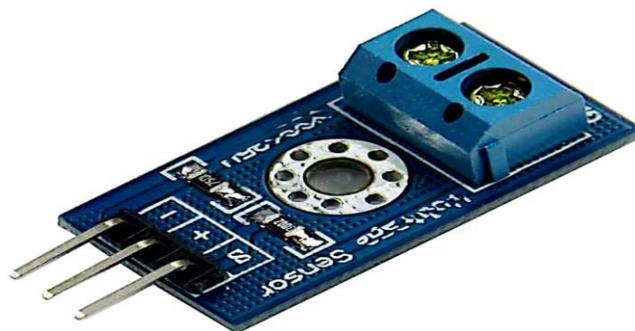


Fig.8. voltage sensor

Voltage sensor is a device that converts the circuit voltage into physical signal similar to voltage. The physical signal helps to determine or measure potential difference between the two points.

### *LCD Display:*



Fig.9. 20x4 LCD

It is used to display different parameters which are fetched by the Arduino using sensors. This is a 20 character by 4 line display that runs at 5.0 volts, includes blue LED backlight. It has four lines and each line can handle twenty characters.

### *Wafers*

Wafers have been used for cleaning the panel. It is totally automatic that is based on the dust sensor. A total of two vehicle wafers have been used in this system.

### *Wafers Motor*

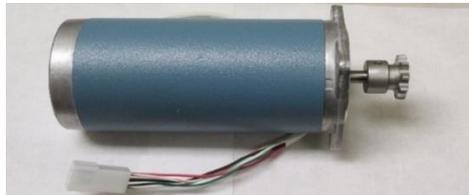


Fig.10. Wafer D.C Motor

It is simple D.C motor that is used in the vehicles. A set of wafer motors have been used in this system that are controlled by Arduino.

### *IOT Module*



Fig.11. Node MCU

It is a very important component named Node MCU. As we have added a feature of IoT to the system, for which a wife or internet is needed to monitor parameters online. To fulfill the purpose, this is devised has been used.

## **Results & Comparison**

When we used the system with dual axis tracking and automated cleaning, the results and energy output for the below mentioned conditions were as follows;

Table.5.1. energy output of the system

Conditions	Efficiency
Stationary and Dusty	15
Kept stationary and automatic cleaning	19
Kept tracking and automated cleaning	40

## Conclusion

By summing up, we can conclude that the system simulation was performed using Proteus. A simulation was carried out to know whether the system performs the result or not. Simulation process shows the exact circuit diagram and connections of the system. The experimental observation was carried out to compare the performance enhancement of the present system and a typical system.

From this project it is concluded that this system was based on Arduino mega 2560 operated effectively and systematically while the solar panel was rotated through the dc geared motors. The system was tested for one day and its operation was observed regularly. This designed system tracked the sun efficiently throughout the day by following direction of sun vertically and horizontally. The Arduino Mega was programmed such that it took decision on the recorded previous values of voltage. This Sun tracking system with dual Axis along with dust and detection scheme and IOT Module is more efficient system compared to single axis or double-axis tracking. Furthermore, the whole system was controlled through single Arduino Controller. The system can utilize 80% to 90 % of the sunlight and produces 30 % to 40 % more power than a typical solar tracking system.

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# Ground-water Replenishment using Rainfall Harvesting Technique; A case study of Phase-VI Hayatabad, Peshawar, Pakistan

(Ref No. ICETEMS-21-164)

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## Abstract

Groundwater is a valuable resource on this planet, People living in urban areas mostly use groundwater for their survival. This excessive sustained groundwater pumping results in alarming depletion in groundwater levels. The increase in population and urbanization are the major causes of the decreasing rate of groundwater replenishment. The surface water on the other hand becomes inaccessible and polluted due to human activities. The ground-water level is rapidly depleted under the increasing rate of urbanization and abstraction of groundwater in Peshawar, Pakistan. In order to decrease pressure on the municipal water system, Rainfall harvesting method (RHW) is applied for 3 Marla roofs (816.752 ft<sup>2</sup>) have stored 780-liter water in 27.6 ft<sup>3</sup> tanks on 5th August-2021 and 1547 liter on 8th August-2021. The RHW method is applied for the selected area having 1069781m<sup>2</sup> (26.41 %) covered area/roof-top area can store 19531 m<sup>3</sup>/day water .while the supply of municipal water from 19 tube-wells is 15255.20 m<sup>3</sup>/day and the demand is 20978.3 m<sup>3</sup>/day. If the dwellers are convinced to install the designed volume storage tanks in their vicinity and use that water for all the activities other than drinking can save 30-40 % ground-water abstraction.

## Keywords

Groundwater Replenishment, Rainfall Harvesting Method.

## Introduction

The increasing rate of Urbanization, population, and other economic development tends to increase the water demand worldwide. Major of the world use surface water to meet their demand, but groundwater is also used as an additional water source [1] and if the abstraction of groundwater exceeded the groundwater recharge through any mean, groundwater depletion occurs [2]. The depletion results from devastating effects on surface flow/natural streams.

Pakistan is one of the rapidly increasing growth rate population country having 226,272,889 population on October 5, 2021, which was 220,892,340 people at the mid of the 2020 year with 2.83% growth rate. Based on world meter elaboration Pakistan is the 5th largest country among other countries by population [3]. Around 35% of the total Pakistan population faces the problem of access to safe drinking water. The term access defined by National Drinking Water Policy that at least 45 to 120 LPCD water must be available to rural and urban areas, while the time required for this much water will not be more than 30 min [4]. According to World Bank research, Pakistan is a water-stressed country till the year 2000, as the water availability level was 1700 cubic meters per capita per year. And this situation become more severe in 2002, in which the water availability decreases to 1500 cubic meters per capita per year [5]. While the forecasted water scarcity level of Pakistan for the year 2035 is 1000 cubic meters per capita per year [6]. The United Nations Environmental Program collect the research analysis of 200 scientists from 50 different countries, that there will be two major concerns for the world, one is water scarcity and the second will be global warming. But the water scarcity challenges dominate over all other issues internationally [7].

The purpose of this research paper is to highlight the issue of water scarcity in Pakistan and apply the method to store unconventional water like rainfall water from the rooftop of different sizes of houses. And use that water for groundwater recharge and other uses other than drinking. To fulfill the requirement Phase VI, Hayatabad, Peshawar, Pakistan has been selected as a study area, as the whole

area. The study area dependency is complete on groundwater, abstract water from 19 different tube wells located in Hayatabad, Phase-VI.

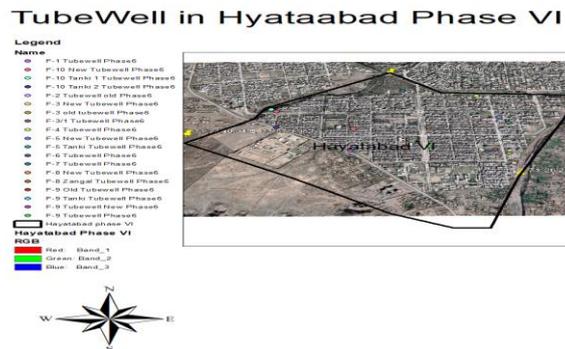


Figure 1: Location of different tube wells present in Hayatabad, Phase-VI, Peshawar.

## Literature Review

Groundwater has been recharged through different unconventional methods, Rainfall harvesting is one of the techniques used to store rainfall water.

Groundwater samples were collected from 64 different districts out of which 61 districts', presence of arsenic was about 0.05 mg/l (unacceptable limit), while surface water contains a high amount of salinity due to the coastal region. Therefore the rainfall harvesting technique was suggested to store the rainfall water mostly in the hilly areas, as heavy rainfall occurs in the rainy season especially from the end of March till September [8].

The rainfall harvesting method is used in North Darfur and South Kordofan in Sudan. As the climatic condition in Sudan is arid in the north and wet and dry tropical weather in the southwest. The selected areas completely rely on groundwater supply or stored water for their water supply. The current average rainfall varies from (47in) in the south and (4in) in the north. This decreasing amount produces a very difficult situation for domestic and agricultural water use without the storage of rainfall water through different harvesting methods [9].

Rainfall harvesting as an effective method may be used as an alternative to water supply in water scarcity regions. In Southern Italy, the analysis has been done on the reliability of using the rainfall harvesting method by supplying water for toilet flushing and gardening. A single-family house has been selected for application of the model [10].

## Methodology

The Rainfall harvesting method studied for Hayatabad Phase-VI, Peshawar, Pakistan with lat 33.9551° N and long 71.94329° E. with a total area of 4050km<sup>2</sup>, out of which the covered area is 1069km<sup>2</sup> (26.41 %), 1131km<sup>2</sup> (27.93 %) was the paved/ road area and 1849km<sup>2</sup> (45.65 %) was uncovered area. The area has been selected because the complete area relies on groundwater results a major depletion occurring in Peshawar District.

The RWH needed mean monthly rainfall data to investigate that how much water can be stored through different categories of areas. The sample of monthly rainfall data is given below.

Table 1: Monthly total rainfall in mm occur in Peshawar.

MONTHLY TOTAL RAIN (MM) [-1=TRACE]		[-100 Means data not available ]										
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2000	37.0	28.5	41.0	5.0	10.0	12.5	11.0	16.0	46.8	9.0	0.0	22.0
2001	0.0	1.6	37.5	37.5	19.0	36.5	50.0	39.0	18.0	0.0	24.0	0.0
2002	2.0	76.0	73.0	21.0	8.0	53.0	0.0	87.0	20.0	2.0	8.0	38.0
2003	33.0	131.5	66.0	129.0	23.0	10.0	156.0	114.0	111.0	70.0	42.0	19.0

2004	109.0	93.0	0.0	60.0	0.0	0.0	7.0	57.0	35.0	24.6	15.6	34.4
2005	131.0	112.2	139.2	29.8	37.0	0.0	31.0	11.6	71.3	4.0	12.3	0.0
2006	55.3	17.5	27.4	15.3	5.0	24.8	56.6	8.0	5.8	15.0	21.0	60.0
2007	0.0	159.1	81.0	14.6	21.8	54.1	50.8	18.2	13.2	0.0	7.0	0.0
2008	63.5	8.9	10.6	107.1	2.7	9.6	63.3	136.3	12.0	0.0	1.6	13.8
2009	30.1	35.3	48.5	96.1	42.6	2.1	22.5	43.5	14.6	0.0	16.0	0.6

Source: <https://www.pmd.gov.pk/en/>

Analyze the rainfall data to get 38.2 mm rainfall intensity for the Peshawar region, which we can collect, store and use for different domestic activities. There are 19 tube wells located in different sectors in our study area with the following information.

Table 2: Information of Tube wells located in study area data sample.

Tube well	Horsepower of Machine	Discharge (G/hr)	Depth of tube well (ft)	Pipe Dia (in)	Operating Time		Machine dept setting (ft)	Water Supply (m <sup>3</sup> )
					From	To		
F-1	60 Hp	17000	480	6	4:00 AM	7:30am	260	836.58
					10:00 AM	2:00pm		
					5:00 PM	7:30pm		
F-2 (old)	50 Hp	14000	550	6	4:00 AM	7:30am	270	688.94
					10:00 AM	2:00pm		
					5:00 PM	7:30pm		
F-3 (old)	60 Hp	17000	411	6	4:00 AM	7:30am	250	836.58
					10:00 AM	2:00pm		
					5:00 PM	7:30pm		

After analyzing the collected data of Tube Wells located in the study area, the total water supply to the Hayatabad Phase-VI is 16091.84 m<sup>3</sup>/day. But according to Table 3, the population is 59938 needed 20978.3 m<sup>3</sup>/day, which means that lack of water supply is 4886.46 m<sup>3</sup>/day.

Table 3: Liter per capita per day calculation for Peshawar district.

Use of Water	LPCD
Drinking	7
Cooking	14
Wash Basin	46
Car washing	18
House cleaning	14
Washing machine	32
Toilet	65
Bathing	98
Kitchen	56
<b>Total</b>	<b>350</b>

### **Rainfall Harvesting**

As the only source of water supply to the study area is groundwater, which does not fulfill the water demand as per our calculation. There is a need to store water as unconventional water sources from different means. This research work is about storing the rainfall water to cover the water demand deficiency. To achieve the results the study area was first categorized as paved and unpaved areas. And then sub-divided the paved areas into rooftops, roads, paved streets, etc.

Figure 2 shows the number of houses present in Hayatabad Phase-VI counted from the map provided by PDA for rooftop rainfall water calculation. There are 4969 built-in plots, out of which 1025, 543, 1865, 832, 675, and 29 houses of 7 Marla, 3 Marla, 5 Marla, 10 Marla, 1 Kanal, and 14 Marla respectively.

The idea is practically applied in the study area for one house and store the rainfall water of two rainy days, i.e. on 5<sup>th</sup> Aug-2021 and 8<sup>th</sup> Aug 2021, in a storage tank having 2.1m x 1.1 m x 1.5m dimensions, which stores 780 liters and 1547 liter water. The total construction cost was RS.34125 estimated. Then we calculate the water quality of stored water by collecting a water sample, tested in the CUSIT lab seems good.



Figure2: Application of rainfall Harvesting Method for one roof in Hayatabad Phase-VI, Peshawar.

## Results

The same method was applied to the paved area of the selected location by designing water storage tanks for different plot sizes. Table 4 shows different designed dimensions of storage tanks based on available plots after calculating their rooftop area.

Table: 4 Dimensions of storage tanks for different plots area.

Rooftop Area (m <sup>2</sup> )	C	i(mm)	i(mm)	V=CiA (m <sup>3</sup> /sec)	A(m <sup>2</sup> )	Depth of Tank (m)	Width (m)	Length (m)
3 Marla								
68	0.85	38.2	0.0382	2.21	1.7	1.3	1.3	2.61
5 Marla								
115	0.85	38.2	0.0382	2.05	1.6	1.27	0.9	1.8
7 Marla								
139	0.85	38.2	0.0382	4.52	2.7	1.65	1.17	2.34
10 Marla								
213	0.85	38.2	0.0382	4.74	2.8	1.68	1.19	2.38
14 Marla								
301	0.85	38.2	0.0382	9.8	4.6	2.14	1.51	3.02
20 Marla								
479	0.85	38.2	0.0382	15.55	6.2	2.5	1.77	3.53

## Conclusion

The covered area of the rooftop in Phase-VI, Hayatabad is 1069781m<sup>2</sup> (26.41%), which can store 19531.45 m<sup>3</sup>/rainy day the rainfall water in the designed tanks for each sector and different sizes of houses if installed. The water supply to the region is 16091.84 m<sup>3</sup>/day, while their demand is 20978.3 m<sup>3</sup>/day. If the RHW is used for domestic purposes other than drinking, cooking and bathing can reduce the per capita demand from 350 to 231 m<sup>3</sup>/day, which can further be reduced if the RHW is treated and used for other purposes also. This decrease changes the abstraction of groundwater from 16091.84 m<sup>3</sup>/day to 1384567 m<sup>3</sup>/day, which means that 13.95 % abstraction of groundwater can be reduced.

Annually, the installed tank can store RHW water of about 17402552.195 m<sup>3</sup> from all the rooftops of Phase-VI, which can save 23 % extraction of groundwater.

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# Design and Fabrication of an Intelligent Cardiopulmonary Resuscitation Device

(Ref No. ICETEMS-21-169)

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## Abstract

Cardiac arrest is common all over the world. Cardiac arrest is a state of health where the heart suddenly stops beating and as a result of the blood flow decrease to the brain and other parts of the body. The first step for the patient's treatment who has experienced cardiac arrest is to provide cardiopulmonary resuscitation (CPR). While the compression rate and fixed force providing constantly for CPR mechanisms are far behind the human capability and also person gets exhausted and tired from doing such a thing for a long time. So, there is an intense need for an automatic mechanical device that provides CPR according to the American Heart Association (AHA) or any other standard guidelines, the device made for CPR is called a CPR device. This device increases blood flow to the brain and other parts of the body. As a result, the chances of a patient's survival have been increased. As the lower sternum is compressed, the intrathoracic pressure is increased and during the relaxation phase, the blood flows in the body and reached different parts of the body. The device provides 80-120 compression per minute with a ratio of 30:2. It means that the device provides 30 compressions and then automatic stop for two (2) ventilation and the cycle repeat itself continuously with a depth of 1.5-2 inches depending upon the patient's age. To meet the American Heart Association standard guidelines, a program has been set for the Arduino controller to provide such a condition and fulfill the requirement.

## Keywords

Cardiopulmonary Resuscitation, Active Compression Decompression, Fuzzy Inference System, Intra Cranial pressure.

## Introduction

According to the American Heart Association (AHA), Cardiopulmonary arrest or cardiac arrest is the leading cause of death, approximately one million per year worldwide. Across the world, cardiac arrest causes more deaths than Tuberculosis, Cancer, Malaria, Pneumonia, AIDS, firearms, and vehicle accidents combined. Cardiac arrest occurs when the beating of your heart stops and thus the flow of blood to all body organs stops. It causes the starving of oxygen in the body and the person falls unconscious. For patients under cardiac arrest, the first resuscitation procedure to apply is cardiac pulmonary resuscitation CPR. CPR is considered a lifesaving technique useful in many emergencies, including heart attack, drowning, etc. in which the lung's breathing or heart's beating is stopped. CPR is a combination of chest compression and ventilation and provides blood flow and oxygen to the heart and brain. CPR must be performed as soon as cardiac arrest occurs because too much delay would reduce the survival rate of a patient. According to the study report by AHA, it was revealed that approximately 350,000 cardiac arrests happen outside the hospital per year. In 2015, in the US only, the sudden cardiac arrest mortality rate was 366,807. According to the study, CPR could increase the chance of survival double or triple if performed just after cardiac arrest. About 90 percent of cardiac arrest patients die, who receive an out-of-hospital cardiac arrest (OHCA). According to a survey in 2017, among the people facing a heart attack outside the hospital, only about 46% of people get bystander CPR, out of which only 45 percent survived. Such a low rate of bystander CPR is due to the main three reasons. 1. Lack of confidence, 2. Lack of knowledge about CPR, Fear of doing something wrong. 3. Causing severe injuries to cardiac arrest patients. (Hwang 2013) According to the American Heart Association, AHA, mostly victims of OHCA receive manual chest compressions. The rescuer

applies the chest compression who compresses the chest by placing hands over the sternum and apply force with hands. According to the AHA guidelines, chest compressions must be performed with a high rate of 100-120 compressions/minute and with a depth of 2-5cm. Unfortunately, compression is mostly performed incorrectly, which could compromise the survival rate. Also, it is difficult for ordinary people to compress continuously with such a high rate and force as human beings get tired and exhausted so there is an intense need for mechanical CPR devices because mechanical devices could apply compressions more consistently than manual ones.

## Related work

Cardiovascular disease is one of the main causes of death worldwide. About millions of people die of cardiac arrest every year. CPR is the only hope for the victims of cardiac arrest. Various approaches are in practice to encounter cardiac arrest situation such as chest compression. The first attempt to cope with sudden cardiac arrest began in 1740 in Amsterdam, where an organization named the Paris Academy of Sciences formed a set of rules to deal with drowning. They recommend mouth-mouth resuscitation for the drowned victims for the first time. After 17 years, in 1767, the Society for the Recovery of Drowned People was the first organization to make efforts to deal with sudden and unexpected deaths. (Ristango *et al* 2009) Modern CPRs are made according to international guidelines of the American Heart Association, which are published every five years. In 2015 the latest guidelines were published. According to the American Heart Association 2015 recommendations, chest compression must be performed at the rate of 100-120 compressions/minute and up to 5-6cm depth for adults and 4-5 for baby applied at a rate of 30: 2. It means that, after 30 compressions, two ventilations must be provided by the rescuer of the victims. (Ristagno.G and Tang.W 2009) The mechanism of blood flow effectively and efficiently could be achieved if rescuers and investigators are well aware of the process of blood flow. Two main different theories have been suggested to explain how blood flow is produced through compressions in cardiopulmonary resuscitation (CPR). These theories are cardiac pump compression and thoracic pump compression theories that are explained as under Cardiac compression theory assumes that during artificial systole (chest compression) heart is compressed between the sternum and spine (vertebral column) due to which blood is pumped into the right ventricle. Cardiac compression generates high pressure in ventricles than elsewhere in the thorax. The reverse flow of blood was blocked due to the closing of the mitral and tricuspid valves and the opening of the Semilunar valves (aortic and pulmonary valves) in response to the direct flow of blood. In artificial diastole (relaxation of chest compression), intracardiac pressure falls, mitral and tricuspid valves open, and so the heart is filled with blood and air returns to the lungs. The thoracic pump mechanism occurs in the relaxation phase of cardiac compression. This mechanism was first proposed by Criley *et al.* And developed by Niemann *et al.* It was probably employed for the first time in cough CPR. All blood-containing structures within the thorax are considered to be flexible tubes or chambers allowable to compress with external pressure. According to this alternative theory, blood flow does not occur through direct compression of the heart, but rather by intra-chest pump mechanism. During compression, increased intrathoracic pressure, forces blood from the thoracic vessels to general circulation in which the heart acts as a tube and not as a pump. This compression causes a steady increase in pressure throughout the entire chest, and retrograde venous flow is also impeded by the collapse of the veins at the chest inlet, as well as by closing the venous valve. According to this theory, the mitral valve should remain open throughout the entire heart cycle and ventricular size to show minimal changes during CPR. (Cave.M.D *et al.* 2010) HFCC is a mechanical method for respiratory physiotherapy that produces rapid air inside and outside of the lungs. It is performed at a very high frequency (usually at the rate of more than 120 compressions per minute). Also, AHA 2015 guidelines recommend 120 compressions/minute. According to a clinical trial performed on some cardiac patients, compression at such a rate improved hemodynamics (blood flow) compared to standard CPR, but it also increases the possibility of breaking the ribs. So routine use of HFCC for cardiac arrest is not recommended due to insufficient evidence. (Babbs.F.C and Kern.B.K, 1994) Compared to usual closed-chest CPR, open-chest cardiopulmonary (OCCPR) improves vital organ perfusion during cardiac arrest. Yet its use is significantly limited to the treatment of traumatic arrest. It is often considered as the last chance to save critically injured patients. In open-chest CPR, the heart is accessible only through a thoracotomy. In OCCPR, compression is performed with the help of the thumb and fingers or palms and fingers to the

sternum. Nowadays open chest compressions are rarely employed outside however helpful if a heart attack occurs during surgical operations when the chest or abdomen is already open. (D. M. Cave *et al.* 2010) The American Heart Association does not consider cough CPR, a traditional form of resuscitation. According to the AHA and ECC (2010) guidelines for CPR, cough CPR is not beneficial for non-responsive victims and must be performed by an experienced person only. Cough CPR is performed during sudden arrhythmia (abnormal heart rhythm). At this stage, the patient is forced to cough vigorously and repeatedly to keep adequate blood flow to the brain to stay conscious until the heart condition (arrhythmia) is treated. "Cough" CPR is performed only in an intensive care unit (ICU) where the patient's condition is conscious and monitored continuously. Also, a nurse or a doctor is present who instructs and trains the patients to cough vigorously after every 1-3 seconds of a sudden arrhythmia. However, as it is not effective in all types of patients, it should not delay further treatment. American Heart Association AHA recommends performing CPR in a prone position and allows prone CPR in a case when a patient couldn't be turned to a prone position (Babbs.F.C et al 1994). CPR by manual chest compressions is considered to be a simple quick technique for creating artificial blood flow during cardiac arrest, but in CPR compression should be at the rate of 80-120 compressions/minutes and with a force of (100-125) N which is not possible for human to provide compression at such high rate as get exhausted and tired and thus unable to generate the required level of blood perfusion. Moreover, Auto pulse device employs only thoracic compression which produces high blood flow compared to CPR consisting of sternal/Piston compression.



Figure 1: Auto Pulse CPR Device (Krep.H *et al* 2007)

The LUCAS device 1 is a mechanical device that provides automated and regular chest compressions and decompressions. It uses the gas-powered mechanism for compression-decompression CPR. It consists of a piston driven by a pneumatic cylinder with a backplate attached. However, LUCAS 2 is electrically powered in which chest compressions are driven by the piston at a rate of 100/minute and to a fixed depth of 4–5 cm using a piston.



Figure 2: Lucas Device (Gyory.A.R *et al* 2017)

## Materials and Methods

In this device, the cardiac pump mechanism is employed in which the chest is pushed between the sternum and spine through the use of a piston and actuator mechanism. The cardiac pump mechanism was employed in this device because from the study it has been proved that blood flow was higher rather than by using the thoracic pump mechanism. This CPR device design resemble LUCAS (Lund University Cardiopulmonary Assist System) CPR device developed by LUND university. Furthermore,

this design is approved by medical experts so designation and fabrication of this type of CPR device are performed. Hardware description are given below in the form of table.

Table 6:Description of the size of the CPR device

Component	Dimension L x W x H (inches)
Overall Dimensions	25 x (13-25) x 31
Circuit box	13 x 12 x 11.5
Piston	2L x 0.25r
Stabilization strap belt	12 x 2 x 23
Back plate support	22 x 13 x 2
Actuator	7 x 2 x 8

To develop an automatic CPR device, both the hardware and software are combined to get better results. Although CPR could be performed manually but couldn't performed so precisely and accurately so there is a need for an automatic device that would provide compressions automatically according to the required rate, depth, and force. For this a circuit would be developed and automate it in order to respond the queries How many compressions must be given, what would be the compression rate, what would the compression depth, after how many compressions ventilation must be given and how much ventilation must be provided. For the automatic control of the CPR device, it is needed to develop a relay driver circuit which is as under. ULN2003 IC is employed in the relay driver circuit to control the relay. In this CPR device, two ventilations must be given after every 30 compressions according to American heart association guidelines. For this purpose, it is needed to develop a relay circuit. The purpose of this circuit is to develop a delay for giving two ventilations after every 30 compressions. After every 30 compressions, the motor would stop for 15 seconds in which bystanders would deliver ventilation to cardiac arrest patients. The following components have been employed in the relay driver circuit. The following figure shows the schematic diagram of the relay driver circuit QX-15F(T90) DC relay, ULN2003 Motor Driver IC, 12V battery and Arduino Mega.

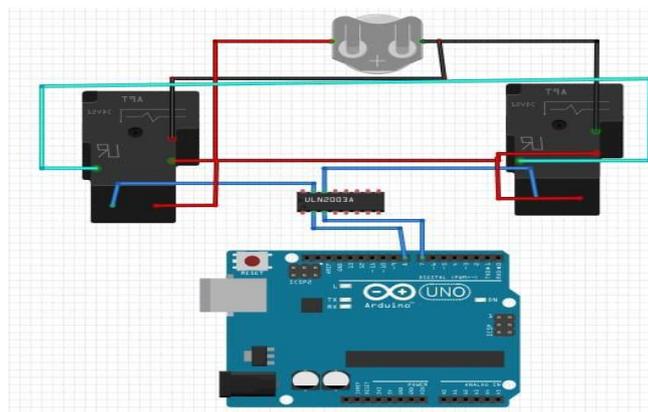


Figure 3: Relay driver circuit in fritzing software

In choosing a dc motor for a CPR device, calculating the requirements of mechanical power is considered the first step. If the required mechanical power is known, then the required motor could be easily found for this device.

$$Prot = \tau \times \omega \quad (1)$$

However, to calculate torque which is also called rotational power, first convert the velocity to the rad/sec unit and then multiply the velocity (in rpm) by the constant  $(2 \times \pi) / 60$ .

$$\omega \text{ rad} = \omega \text{ rpm} \times (2 \pi)/60 \quad (2)$$

it has been determined the power required to drive the motor of required torque and speed in table 2 according to the formula.

$$\text{Power (kW)} = \text{Torque (Nm)} \times \text{Speed (rpm)} \times 0.1047$$

Table 2: Relationship between torque, speed, and power

Torque (Nm)	Speed (RPM)	Power (W)
40	120	500
40	100	420
30	120	380
30	100	310
25	120	310
25	100	260

From table 2, it is shown that the power required for a dc motor of torque 25-40 Nm and speed 100-120 rpm is 260-500 watts.

## Experimentation

During testing of the CPR device, the main objective is to note down the compression rate and compression depth. Compression has been performed with the help of an automatic piston, controlled by a relay driver circuit and driven by a dc motor. A high ampere battery has been employed to provide power to the CPR device. The device has been tested on dummy bodies and also on persons of different chest sizes and heights. The Observations of the device are as under. The first experimentation has been performed on a dummy body of chest height of 09 inches and a width of 16 inches and the compression rate and compression depth of the CPR device have been noted.

Table 3: Experimentation

Exp No:	Chest height In	Chest width (Inch)	Com rate	Time (Sec)	Vent After 30 comp	Com Rate per min	Com Dep (in)	Com Force lbf
1	09	16	30	16	2	95	1.3	<u>100</u>
2	09	16	30	15	2	100	1.3	<u>100</u>

Table 3 shows the observation result of experimentation on dummy body performed by CPR device. The table explains the compression rate, compression depth, and applied force on the body during compression. After that, experimentation has been performed on the human body of a chest height of 13 inches and a width of 18 inches and note the compression rate and compression depth of the CPR device. Below Fig 4 shows the operation performed on the human body lying under a CPR device and also observation has been noted as shown in table 4.



Figure 4: Experimentation on the human body

Table no:4 shows the observation result of experimentation on the human body performed by the CPR device. The table explains the compression rate, compression depth, and applied force on the body during compression.

Table 4: Experimentation

Exp No:	Chest height (Inch)	Chest width (Inch)	Com Rate	Time (Sec)	Vent After thirty comp	Com Rate per min	Com Dep (inch)	Com Force (lbf)
1	13	18	30	15	2	100	1.5	100
2	13	18	30	14	2	108	1.5	100

Besides the above experimentations performed on different dummy and human bodies, different experimentation has been performed on persons of different ages, chest heights, and widths.

The below table No: 5 shows the overall result of experimentation of CPR device performed on different bodies of different chest heights and widths

Table 5: Final result of experimentation on multiple bodies

Exp No:	Chest height (Inch)	Chest width (Inch)	Comp rate	Time (Sec)	Vent After every 30 sec	Compr Rate per min	Com Depth (inch)	Com Force (lbf)
1	09	16	30	16	2	95	1.3	100
2	09	16	30	15	2	100	1.3	100
3	13	18	30	15	2	100	1.5	100
4	13	18	30	14	2	108	1.5	100
5	15	24	30	15	2	100	2.0	125
6	15	24	30	13	2	120	2.0	125
7	7	13	30	16	2	95	1.3	100
8	7	13	30	15	2	100	1.4	110
9	14	27	30	14	2	108	1.9	125
10	14	27	30	13	2	120	1.8	125
11	11	16	30	16	2	95	1.2	100
12	11	16	30	17	2	91	1.3	100
13	18	24	30	13	2	120	1.4	125

## Results

Fuzzy logic implementation has been performed on the CPR device to obtain effective and accurate results. The compression rate, compression depth and Ribs condition of CPR device are controlled by

doing CPR on the person of different ages using fuzzy logic toolbox that consists of different compositional rules employed for solving the problem. In this project, the Mamdani rule of composition is employed for fuzzification and the centroid method is employed for the Defuzzification of the results. Fuzzy logic has the advantage that these systems involve human reasoning and decision making, so they are useful in providing solutions to complex problems in different types of applications. The following procedures are employed in fuzzy logic implementation on the CPR device. Knowledge Base, Input/output List., Membership function definition for input/output., Rule of Inference (Fuzzification) and Centroid Method (Defuzzification). implemented according to the American Heart Association (AHA) and European Resuscitation Council (ERC) Guidelines 2015. First, the range of all of the Inputs and outputs needed for the CPR device has been specified and then implemented on a CPR device according to their membership function. We have two Inputs one is the Patient's age that is Childs, Adults and Senior Citizens and the other is Force applied for the child, adults and senior citizens and the three Outputs are Compression rate, Compression Depth rate and Ribs condition. The range of all the inputs and outputs of the CPR device and their membership functions are as follow

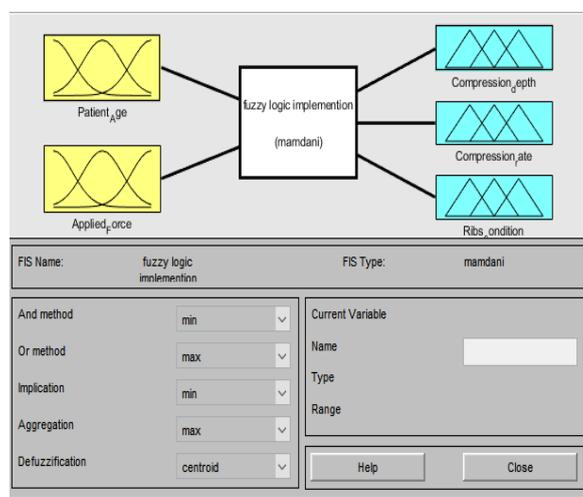


Figure 5: Input and Output list

Table 7: Compression depth, compression rate and ribs condition range

Input Factor	Comp Depth (inch)	Comp Rate Per min	Ribs condition		
			Good	Broken	Force
Child	0.8-1.1	80 – 95	0.3 – 0.9	0 – 0.6	Child force Adult force
Adult	0.95 -1.25	87 – 106	0.3 – 0.9		Adult force
Senior Citizen	1.1-1.4	95 – 120	0.3-0.9	0-0.6	Senior force Adult force

After defining the rules for CPR device, fuzzification process has been performed on it. The following fig 8 shows the fuzzification process of CPR device.

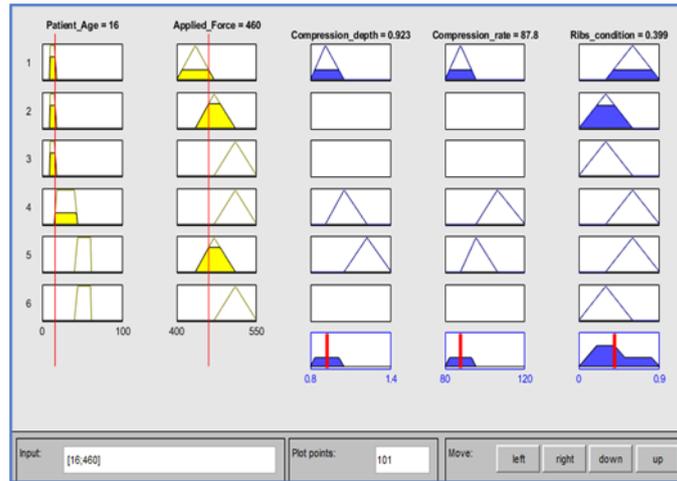


Figure 6: Fuzzification Process

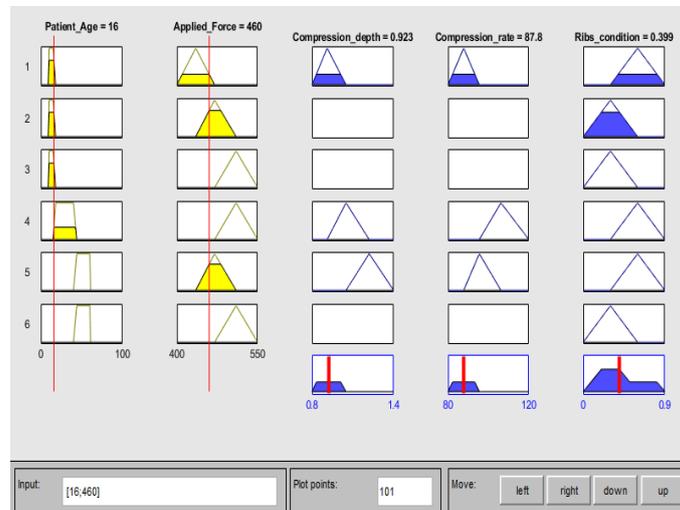


Figure 7: Defuzzification process

## Conclusion and Future Work

Cardiac arrests occur once every two minutes across the globe. CPR is an emergency procedure to be performed during cardiac arrest. The main aim of CPR is to maintain blood movement to the main organs and tissues of the body. First of all, the function of the brain fails to work. Brain survives only five to six minutes after a patient goes into cardiac arrest. That is why early approach, early CPR and early treatment are so important. For this purpose, a CPR device has been designed and fabricated that would do compressions according to the AHA guidelines. The device is automatically controlled through relay driver circuits using ULN2003 IC, powered through Arduino which would control the device compression mechanism. It is very easy for ordinary people to operate and could be employed for patients of different ages, chest height and widths. In future we would work on advancement of CPR means that we would make a robot that could be employed for Chest compression and develop a medical parallel robot to assist in CPR operation.

## Acknowledgement

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# Post CPEC Infrastructure Requirements of Peshawar; A Case Study on Residential Areas

(Ref No. ICETEMS-21-183)

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## Abstract

Pakistan is facing housing unit's problem for more than 70 years. A number of housing schemes were launched to overcome the issue but it was difficult to fulfill the demand of housing units for increasing population, mainly because of two reasons: 1. low income generation of common people, and 2. No initiatives from government of Pakistan for facilitating economic capacity tools & structure available to common people. In 2015 China Pakistan Economic Corridor (CPEC) was initiated and Economic zones were also developed near Peshawar district (defined as node city of CPEC). Increase in population is expected in the future due to Industrialization, Trade, Economic activity, and Employment in the node cities of CPEC. This research addresses the problem of housing units in Peshawar district and provides guidelines for modern designed cities. The major residential areas of Peshawar are deigned which can only fulfill the demands of natural population growth. To address the requirements of residential units in Peshawar the study was focused on the future demands of residential units in Peshawar with natural and CPEC related growth of Population. A Future increase in population was forecasted and a survey of the Peshawar region was carried out to identify feasible locations for new residential projects and major residential areas. Remotely sensed data were used for geographical & statistical analysis of feasible sites. Geo-Spatial planning techniques GIS & Computer Aided design software was used to design the residential areas for forecasted population according to the guidelines of Nation reference manual on Planning & Infrastructure (NRM).

## Keywords

CPEC, Economic zones, Housing units, Population, NRM.

## Introduction

Pakistan has a growing semi-industrialized economy that relies on manufacturing, agriculture, and remittances. It is spending more on imports than it receives on exports. Pakistan also needs to focus on building its domestic industry to expand its export portfolio and enhance its competitiveness in the international markets. Pakistan needs to modernize its industrial sector by establishing new plants and equipment to enhance global integration (Malik, 2019).

The CPEC is an ongoing development megaproject which aims to connect Gwadar Port of Pakistan to China's northwestern region of Xinjiang, via a network of highways, railways, and pipelines (see figure for highways network). The investment on the corridor will transform Pakistan into a regional economic hub China-Pakistan Economic Corridor is a framework of regional connectivity. CPEC will not only benefit China and Pakistan but will have a positive impact on Iran, Afghanistan, India, the Central Asian Republic, and the region. China Pakistan Economic Corridor is a journey towards economic regionalization in the globalized world. China Pakistan Economic Corridor is the hope of a better region of the future with peace, development, and growth of the economy (Govt. of Pakistan and China, 2019).

CPEC will have a more positive impact on Pakistan because it is going through the whole of Pakistan in this way many investors will come forward to invest in different industries for future benefits. As industries grow with time will create a lot of jobs for Pakistani as well as for Chinese citizens. CPEC authority had announced economic in major cities of Pakistan (for those cities which are considered economic and business hubs). The infrastructure-related work will be completed soon and also will be opened for investors before 2025 (Govt. of Pakistan and China, 2019).

Focusing on Peshawar which is also a major city and considered as a business hub by traders, it is also declared as a node city for CPEC and Economic zones are also developing near Peshawar (Rashakai Economic zone and Mohmand Marble City, development works are going on which will complete in near future), which will be very fruitful in future (see figure 1). Peshawar is a renowned city for business for centuries, it is also remained as a business hub during and after the Mughal Era. Also, traders of Afghanistan and the Central Asian Republic followed the route of Peshawar for business purposes (Jalalabad to Peshawar and then to Delhi). It is also observed that business-centered cities are considered more attractive for business persons and also for jobless peoples.

The research study conducted, was about the infrastructure requirements of Peshawar in the residential sector (A feasibility study for CPEC generated population) because when a large number of people will come to Peshawar for several reasons and hence they will contribute to Peshawar’s population, the requirement of infrastructure will also increase as well.

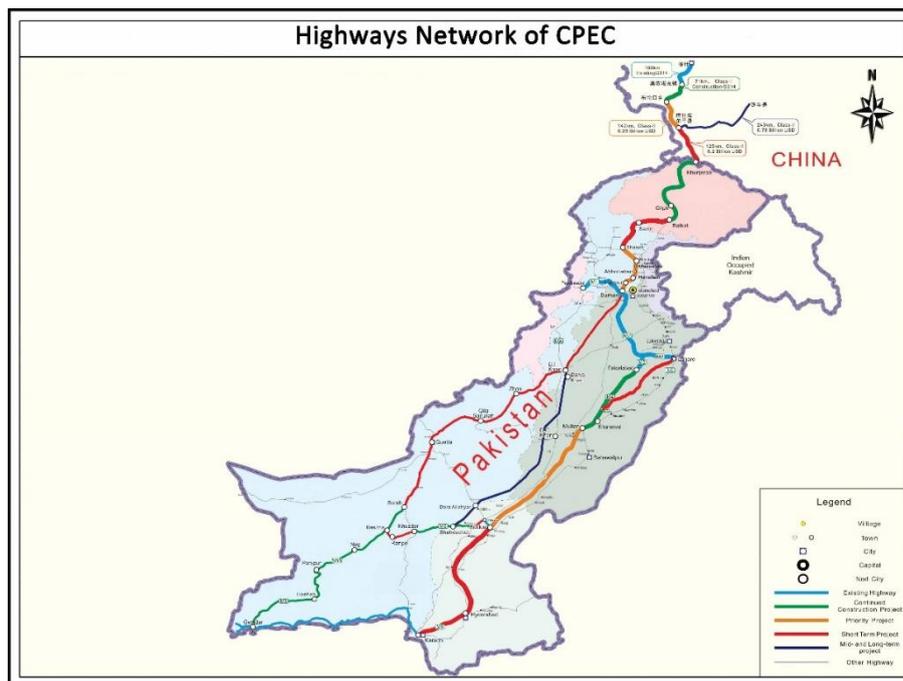


Figure.1 Economic Zones in Highway network of CPEC in Pakistan [Source: <http://cpec.gov.pk>]

## Literature review

Pakistan is one of those developing countries where the urban population is increasing significantly, the urban population shows a growing trend of 36.38 percent, and the average annual population growth rate growth in urban areas is 2.7 percent (Ministry of Planning, 2013). In the context of urbanization, the population is moving towards urban centers due to better socio-economic facilities in the urbanized region. Pakistani cities are the sources of economic growth and playing a central role in national economic development, however, cities are short of delivering basic services to many of their residents. Therefore, the federal government emphasizes on creation of consensus for coherent housing and urban development and management throughout the country, while fully acknowledging housing and urban development as primarily the domain of provincial and local governments (Department of Economic and Social Affairs and population Dynamics, 2011). About 50 percent of the urban population is concentrated in ten major cities, that is, Karachi, Quetta, Hyderabad, Multan, Lahore, Faisalabad, Rawalpindi, Gujranwala, Islamabad, and Peshawar (Figure 2).

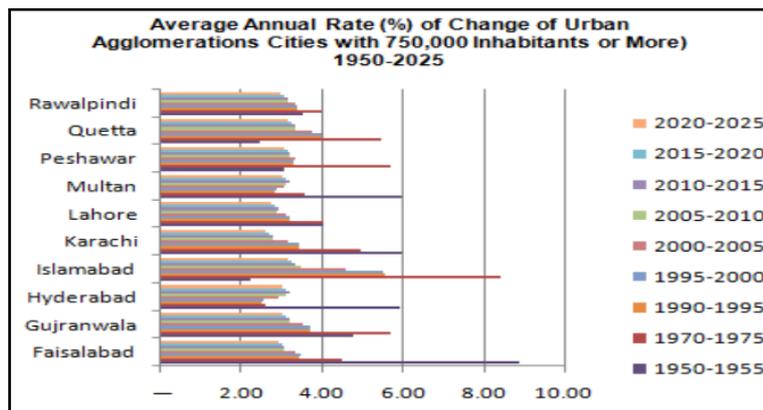


Figure.2 Percentage Increase in Urbanization [Source: UN.org “World Urbanization prospects, 2011”]

The present unplanned and haphazard development pattern in most of the cities is continuing unabated. Very few cities have professionally managed traffic, waste disposal, sewage collection, safe drinking water, and pollution control systems. On the other hand, the income of the City District Governments is limited and these have to heavily rely on the provincial and federal governments (Ministry of Planning, 2013).

The national average household size was calculated as 6.31 members per house (see table 1), **Urban 6.03** whereas rural was 6.47 in the year 2015-16 (Pakistan Bureau of Statistics, 2015-16).

Table.8 Household size in Pakistan [Source: (Pakistan Bureau of Statistics, 2015-16)]

AREA	Average Household Size	
	2013-14	2015-16
Total	6.35	6.31
Urban	6.09	6.03
Rural	6.49	6.47

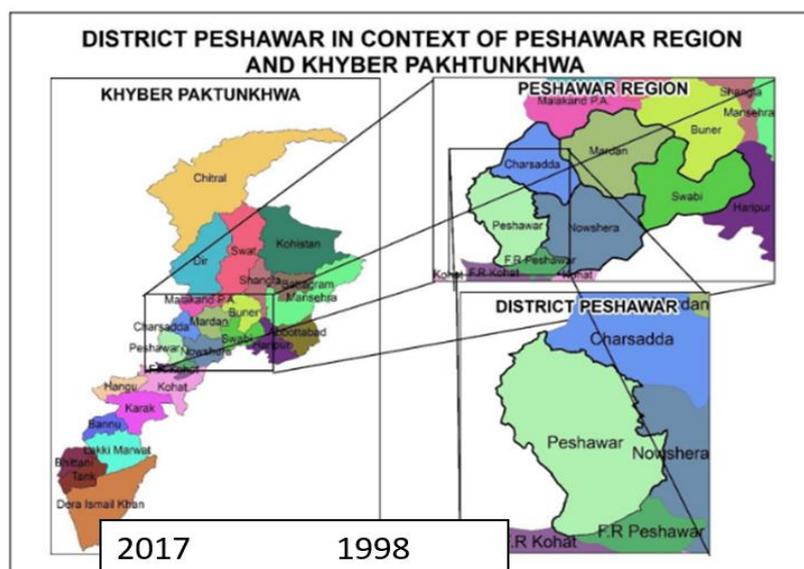


Figure.3 District Peshawar with context of Peshawar region and KPK [Source: (P & D and UPPU, 2017)]

Peshawar is the capital of Khyber Pakhtunkhwa (KPK) province, is located at the north-west end of Pakistan, about 160 km west of the federal capital Islamabad. Peshawar has a geo-strategically important location and an enriched history. The total area of the district is 1,216.17 Km<sup>2</sup> (see figure 3) (District Disaster Management Unit, 2017), (P & D and UPPU, 2017). The population of Peshawar according to Census 2017 was 4.27 million (Pakistan Bureau of Statistics, 2017).

## Methodology

A multi-stage methodology was adopted for the research, different steps involved in research were; Study area identification then literature review for the research procedure. Collection of data from various government and non-government departments, the data consisted i.e. Boundaries of Peshawar district, Major Residential areas of Peshawar and their population with average household size and requirement of houses and other required data. A further survey of Peshawar district was important to locate/point out areas for new residential projects, Then Geographical and Statistical analysis of the feasible sites was carried out, Spatial Statistical techniques using GIS, and use of Computer-Aided Design (AutoCAD, Civil 3D, Sketch up, etc....).

The following areas of this research project were explicitly associated with Civil Engineering:

- Surveying of Area
- Satellite and other remotely sensed data analysis
- Geo-Spatial Planning
- Town Planning/Urban Development

## Results and Discussions

### Population

The average population density for Peshawar is approximately **16791 capita/Km<sup>2</sup>**, whereas a medium density residential area would be better because when the population density increase congestion will also increase which reduces mobility.

Natural population forecasted for 2050, **P<sub>2050</sub> = 10283923.33 = 10.28million**

Expected CPEC generated population in 2050, **P<sub>CPEC-2050</sub> = 166514 = 0.167million** (see graph in figure 4).

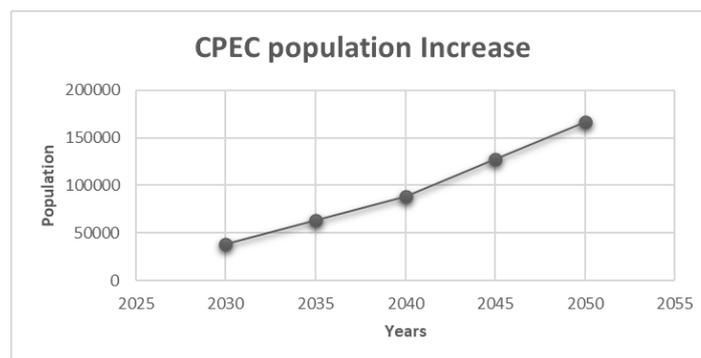


Figure.4 District Peshawar expected CPEC population increase

### Area Identification/selection

To accommodate the CPEC generated population (0.167M), various feasible locations were identified which can fulfill the future requirements (see figure 5).

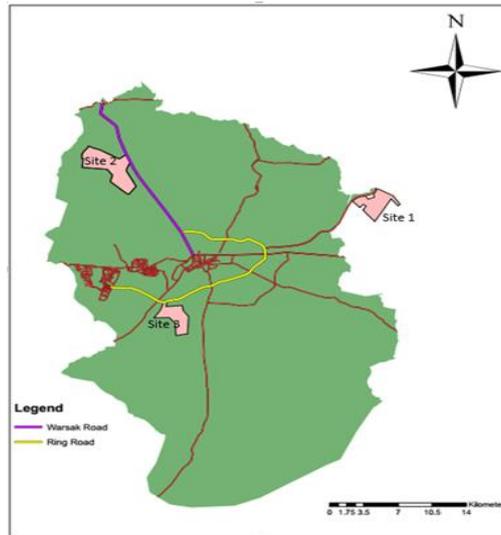


Figure.5 Feasible Sites for CPEC generated population

**Landuse distribution**

The areas/land use distribution was carried out using percentage distribution for each zone according to the range provided by NRM. The required number of facilities were also determined from NRM and shown in form of table. The master plan of one site was also prepared for the residential project (see figure 6).

Table.1 Facilities in the Residential area

Components	Houses	Masjid	Primary Schools	Dispensaries	Playgrounds	Secondary Schools	Colleges	Hospital	University	Community Parks
No.	27700	40	37	37	37	8	4	1	1	3

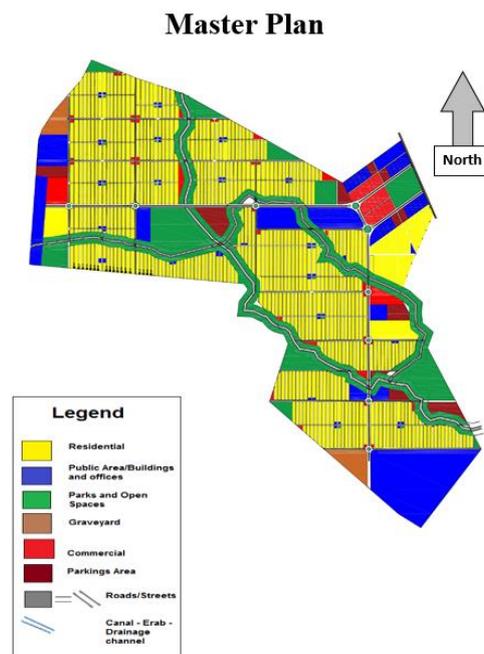


Figure.6 Master Plan



## Conclusion and recommendations

This study was approached by studying the current situation of Peshawar in context to its geography and population. The current average population density of the Peshawar is 16790 capita/Km<sup>2</sup>, where for designing new city a normal range population density is recommended.

The main aim of research was to determine the future needs of the population of Peshawar in context to natural and CPEC increase. The population increase for 2050 was calculated using equation 3.3b from which it is estimated that the population of Peshawar will be more than 2 times of current population whereas the population generated due to CPEC related activities will be approximately 0.17 million. In order to accommodate this population (only CPEC generated population) approximately requires 27700 housing units. The size of housing units may differ but should be in the following range (1575 sft to 4500 sft) as an average house size with average household size of 6.5. The feasible locations within Peshawar were identified, which can fulfil the residential needs of the population generated due to CPEC growth rate only, for this purpose 3 different areas in Peshawar district were identified and studied by comparing with ideal conditions and specification of National reference manual on planning and infrastructure of Pakistan.

The recommendation for further work in the same field is given as follow;

- A detailed study of Peshawar population by considering migration rate along with mortality rate and projection of Peshawar`s population considering the mentioned for more accuracy in results
- A Detailed design of Urban system for the future population which should include
  - Design of combine Sewer system by studying the contours of the area of feasible locations and layout of the designed sewer system for the forecasted population
  - Detailed design of Roads by considering peak traffic flow for the population facilitated at a single location

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**ENGLISH**  
**&**  
**APPLIED LINGUISTICS**

# Covid-19 and War Metaphor; A Linguistic Projection through Pakistani Advertisements

(Ref No. ICETEMS-21-032)

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## Abstract

This paper analyses the war metaphor used in selected Pakistani advertisements about Covid-19 pandemic. The research particularly explores the working of conceptual *war* metaphor through Conceptual Blending theory (Fauconnier 1997, Fauconnier and Turner 1996, Turner and Fauconnier 1999, 2000). The paper discusses the cognitive mapping for the Covid metaphors through linguistic analysis which results in a psychological effect of war narrative on the audience. The war narrative thus leads to produce effect of fear and dread; the audience resultantly finds safety in following the Covid SOPs by consuming the advertised product. This study is a qualitative analysis of *war* metaphor used in selected Pakistani advertisements of soaps, detergents, sanitizers etc. The significance of this research is to correlate the importance of metaphor used in advertisements to magnify the fear of Covid pandemic through language manipulation. As language becomes psychological affair through metaphors; it heightens the effect on the audience which in turn leads to active positive response from them. The response is not only in submission to follow the message of the advertisement but also in readily consumption of the advertised product against the dangers and challenges posed by Covid-19.

## Keywords

Covid-19, War metaphor, Blending Theory, Advertisement Language

## Introduction

Media in particular advertisements use discourse which linguistically and cognitively rationalizes the intended message or propaganda. It is not only the window dressing of the advertised product which catches the attention of the customer; the language used for commercials is also pivotal in appealing to the shopping sense of the audience. However, the effect of media language is not only verbal; it has added cognitive aspect which creates make believe impact on the minds of the populace. With the surge of Covid-19 pandemic, different sanitary products took a hike by capitalizing on the notion of providing safety against the fatal virus. The selected commercials in this paper discuss the cognitive facet of language mainly deployed through the metaphor of war. This metaphor activates the conceptual networking by corresponding similarities between the source and target domain. The source domain is the war metaphor whereas the target domain is the narrative of the advertisement. The similarities between the two domains create semblance between the advertised product and weapon effective in attacking the germs (enemy). Consequently, the war metaphor used in these commercials trigger war schema which manipulates the customers to trust and buy the advertised product.

## Note

The rationale behind the selected advertisements is that they guarantee the effectiveness of their products to counter the Covid-19 pandemic. Furthermore, these commercials establish their premise on the metaphor of war to create the effect of urgency and effectiveness of the advertised product. There are however, minor differences in the details of projection of the war metaphor. The Protex soap advertisement speaks of the intermediate stage of battling against the virus and thus advocates the continued use of the product to win the fight against Covid. The Safeguard soap commercial plays on the notion of heroic figure “commander safeguard” that is to save the consumers by providing long lasting protection against the virus and germs. The Robin bleach commercial rationalizes its

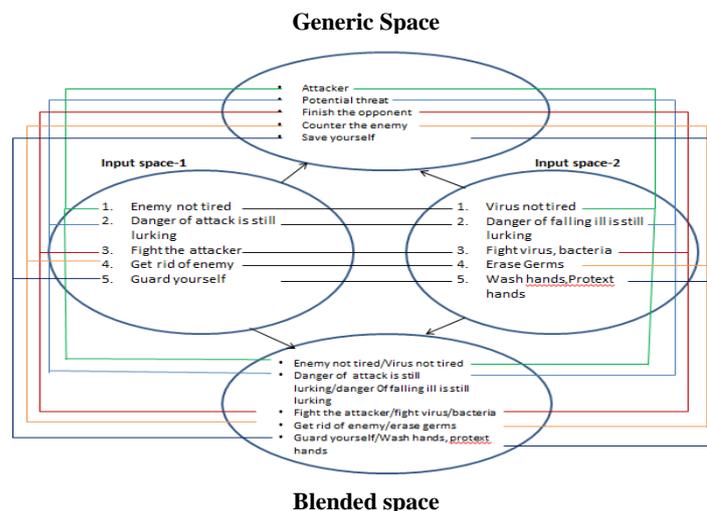
consumption for sanitizing purposes by targeting the invisibility of the germs and highlighting the multipurposeness of the initially known bleaching product. Peak Freans taps on the patriotic spirit of Pakistani nation by verbally drawing parallels between the nation facing the pandemic and an army at war.

## Conceptual Metaphor Theory and Blending Theory

The Conceptual Metaphor Theory (Lakoff and Johnson 1980) contends that metaphors are not merely linguistic expressions; they are deeply rooted in cognitive structure mappings. This theory rejects the idea that “metaphor is a decorative device, peripheral to language and thought” (Deignan, 2005:13). Blending Theory (Fauconnier 1997, Fauconnier and Turner 1996, Turner and Fauconnier

1999, 2000) takes a step deeper and explains the online construction of these mappings which develop between mental spaces. In Blending theory, these mental spaces include two “input spaces” which refer to the source and target domains of Conceptual Metaphor Theory; a “generic space” which presents conceptual structure shared by both the input spaces and a “blend space” where the material of the input spaces combine and interact. (Grady *et al.* 1999: 103). It is in the blended space that meaning of metaphor is generated. This research will make use of Blending theory to explain the metaphor of war as used by the selected advertisements to rationalize the effectiveness of their product against Covid.

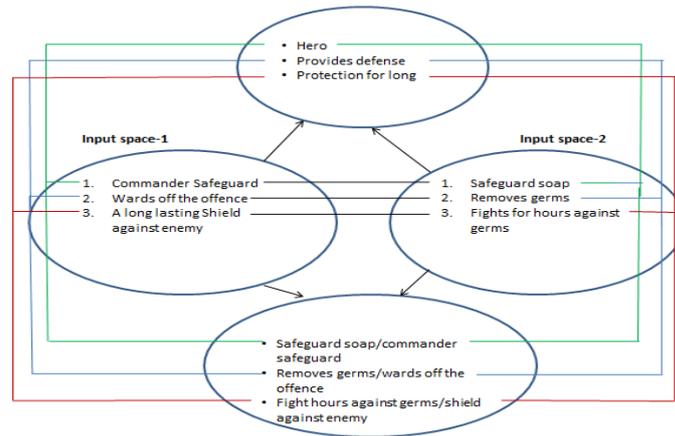
Conceptual Network for the Metaphor of War Field for Protex Soap Advertisement(Figure –A)



Protex advertisement builds on the imagery of war by utilizing war metaphor. The two input spaces perfectly map on to each other as the contagion referred to projects itself on the domain of war (input space-I) in which the enemy is persistent in making its attack. Similarly the danger of falling ill corresponds with the eminent danger of being attacked by the opponent. By using the advertised soap, germs are erased which are cognitively projecting an image of killing the enemy. The metaphor of war thus becomes comprehensible because we see a perfect blend between the two input spaces in the blended space. The blend is sound because the spaces also share same generic characteristics. These also include the features of offence, defense action between the causing enemy and defending soldier which in this case is the customer.

### 3.2 Conceptual Network for the Metaphor of War Field for Safeguard Liquid Hand Soap Advertisement(Figure –B)

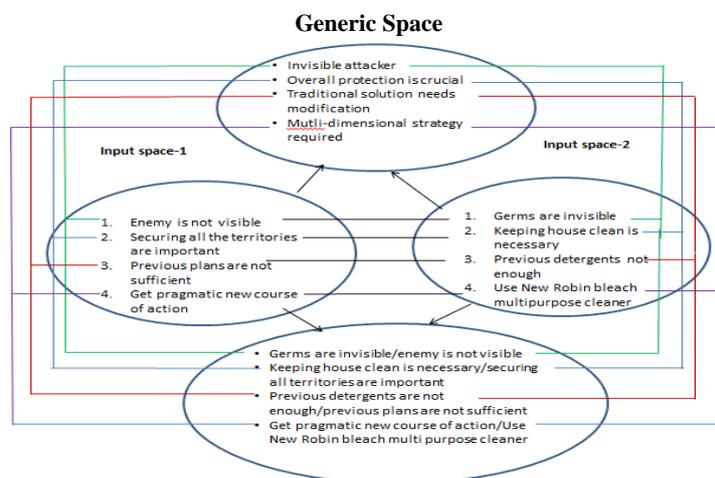
#### Generic Space



**Blended Space**

The advertisement of Safeguard liquid hand soap plays on the idea of a hero figure that saves the community from destruction. Besides the appearance of the action figure of commander safeguard in the commercial, it is the parallelism between him and the advertised product which attracts the attention of the consumers especially the youngsters who idealizes the action hero. Seen through conceptual network, the input space-1 corresponds with the input space-2. The matching features of the two spaces converge in the blended space in which safeguard soap parallels with commander safeguard; one removes germs the other wards off the offence; and one is effective against germs for hours while the other shields the user against enemy for long. At the same time the metaphor of commander safeguard, war hero, is intelligent as the input spaces share general characteristics of a hero providing long protection against peril.

### 3.3 Conceptual Network for the Metaphor of War Field for Robin Bleach Advertisement (Figure –C)

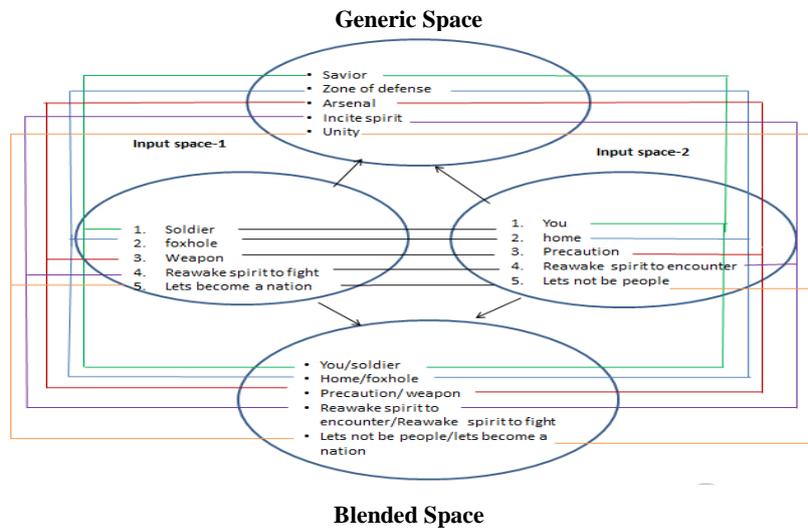


**Blended Space**

Robin bleach which initially enjoyed its fame as a bleaching product for white fabric re-launched itself as a sanitizer against virus and bacteria during Covid pandemic. It establishes its effectiveness through war metaphor. One can see the input space-2 using narrative of the advertisement in which germs invisibility becomes the premise for the vulnerability of human life. Building on this notion, the advertisement shows the efficiency of the product as water dissolvent which can be used to mop floors, furniture and door handles etc. The commercial states that traditional detergents and soaps are no more effective however Robin bleach (previously fabric bleach and now modified as sanitizer) can fight off the dangerous virus. The input space-2 therefore corresponds with input space-1 where the invisible germs becomes invisible enemy; keeping house clean becomes securing all territories; failure of previous detergents becomes inefficiency of previous plan of action; new Robin bleach multipurpose cleaner becomes pragmatic new course of action against enemy in war. The metaphor is sound as the

spaces share generic features of confronting invisible enemy with a new strategic action which in this case is Robin bleach.

### 3.4 Conceptual Network for the Metaphor of War Field for Peak Freans Advertisement(Figure –D)



Peak Freans ran the awareness message to get the people of Pakistan on board to fight against Covid Pandemic. As for many the SOPs like social distancing and staying at home was frustrating and challenging, there were cases where people would break the protocols and go out and do social gatherings. The advertisement after directly warning the viewers about the repercussions, switches to self-explanatory metaphor. The message verbally draws parallels between viewers and soldiers preparing to put up a fight. Staying home corresponds with stationing in foxhole; taking precaution (following Covid SOPs) becomes using weapon in the war domain. This message has national appeal because it furthers the rise of nation against the pandemic by rekindling the spirit to fight not individually but as a nation. Thus the issue is portrayed not a personal dilemma but a national health crisis. On a deeper level, the pandemic becomes a reason to unite the different sects and cultures of Pakistan to rise as one nation. In the generic space the input spaces share similarities as both discuss a savior setting a zone of defense and using arsenal against the portended threat. Not only this but to stand and unite against the danger as a single unit by igniting the spirit of unity.

## Conclusion

Blending theory aptly explains the conceptual networking of conceptual metaphor of war in the above discussed commercials. The metaphor of war assists in the description of abstract concept of warding off the invisible virus through the physical experience of waging or fighting a war against the enemy.

In other words, commercials make sense of abstract notions through dynamics of experiential reality. Moreover the gravity of combating Covid- 19 virus is instantiated through war metaphor which compels the customers to get armed by buying the product which claims to be effective against the virus.

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**HEALTH SCIENCE  
&  
PUBLIC HEALTH**

# Prevalence and Antibiotic Susceptibility of *Salmonella Typhi* Isolated from Tap Water Sources at District Peshawar

(Ref No. ICETEMS-21-020)

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## Abstract

*Salmonella typhi* is a gram negative bacterium that is anaerobic. They are non-spore forming rods. It can grow on selective and differential media i.e. XLD and SS agar. It produces H<sub>2</sub>S gas and results in colorless black centered colonies. They have MDR genes that can result in causing some severe diseases. Typhoid is caused by *Salmonella typhi*. Typhoid is a bacterial infection that can lead to a high fever, diarrhea, and vomiting. It can be fatal. Current study was based on isolation of *S.typhi* from water samples. Out of 30 samples 18 samples containing *S.typhi* was identified. Samples grown on XLD agar SS agar showed black centered colonies. The further phenotypic confirmation, the isolates were subjected to different biochemical tests which are Triple sugar iron test (TSI), Indole test, Urease test, Citrate test, Oxidase test and Gram staining. In all of the isolates Catalase is positive, oxidase is negative, Triple sugar iron test is positive, indole negative, Urease is negative, citrate is negative and gram staining confirmed gram negative rods. After phenotypic and biochemical confirmation, Antibiotic sensitivity test was performed via Kirby Bauer disk method. The disks used were Gentamicin (10 µg), Ciprofloxacin (5 µg), Amikacin (30 µg), Cefoxitin (30 µg), Aztreonam (30 µg), Penicillins (10 µg), Cefotaxime (30 µg). After the antibiotic sensitivity was performed via Kirby Bauer disc diffusion method, the results showed that Gentamicin was 5% resistance, 5% intermediate and 90% sensitive, Cefotaxime was 100% sensitive, Cefoxitin was 100% sensitive, Ciprofloxacin was 5% intermediate and 95% sensitive, Penicillin was 100 % resistant, Aztreonam was 100% sensitive and Amikacin was also 100% sensitive. The current study showed that drinking water sources at Peshawar were contaminated with *S.typhi*. In order to prevent the emergence of typhoid, steps should be taken on war footing to stop the emergence and possible spread of infection. For this purpose, good sanitation measures and personal hygiene should be followed.

## Keywords

Salmonella typhi, salmonella typhi in water, typhoid fever, enteric fever, salmonella

## Introduction

*Salmonella* is a gram-negative bacteria belonging to the Enterobacteriaceae family. *Salmonella* is a gram-negative bacterium which is found in water as well as in food and can cause diseases in animals and humans. In humans *S.typhi* can cause septicemia, typhoid fever, infections of physiological tissues, and gastroenteritis. *Salmonella Typhimurium* is able to survive in a pH range of 3.8 to 9.5, with a pH of 6.5–7.5 being optimum [1]. *Salmonella typhi* is a Gram-negative bacterium which causes water diseases and food diseases like gastroenteritis and many other infections [2]. It causes typhoid fever, a disease that has affected people from many years and is still spreading. [3]. South Asia, which includes Pakistan, is estimated to have 3.6 % typhoid cases per 0.1 million people [4]. Children aged between 5–9 years had the largest morbidity and mortality rates i.e. 56 % of and 59 %, followed by kids under the age of 5, 12.6 % of cases and 17 % respectively [5].

## Methodology

Samples collected from different areas of Peshawar in sterile bottles from the main reservoir (tube well) and from tap water, and sterile bottles are carried to the medical laboratory and subjected to enrichment culture for *S.typhi*.

## **Culturing**

### **XLD**

Xylose Lysine Deoxycholate agar (XLD agar) is a selective growth medium used in the isolation of *Salmonella*. XLD Plates were inoculated with water samples by spread plate technique. The plates were incubated for 24-48 hours at 37°C [6].

### **Sub culturing**

#### ***Salmonella Shigella Agar (SSA)***

After obtaining black centered colonies on XLD agar, sub culturing was done on SS agar. Sub culturing was done using fourth quadrant streaking to obtain isolated colonies; the plates were incubated at 37°C for 24-48 hours [7].

### **Gram Staining**

Using a sterilized dropper, single drop of saline solution was added to a clean slide. With the help of sterilized loop a single colony was mixed in it to prepare a smear and heat fixed. After heat fixing the slide, crystal violet solution was added for 30-60 seconds before rinsing it with distilled water. Addition of gram's iodine to the slide covering smear for 30 seconds, the slide was then washed with 95 % ethyl alcohol to unbind color before being washed with distilled water. Counter-stain (safranin) for 30 seconds was added before washing with distilled water. Allowed the slide to air dry and then observed under the microscope [8].

### **Biochemical tests used for confirmation of *S.typhi***

*Salmonella typhi* colonies identified and confirmed by XLD, SS agar and via gram Staining. Was further confirmed phenotypically via the following biochemical tests.

#### **Triple sugar iron test**

Triple sugar iron media is used for TSI test by following standard procedure. The TSI tubes were butt inoculated with black colonies and then streaked the surface of the agar slant. The tubes were then incubated overnight and results were noted.

#### **Indole test**

Indole test is used to confirm *S.typhi* phenotypically. For this purpose a drop of kovacs indole reagent was added to test tube. A single colony was mixed in it. Result was noted after 1 to 3 minutes.

#### **Citrate test**

Simmon citrate agar media is used for citrate test by following standard procedure. The citrate agar tubes are inoculated by streaking the slant's surface. The inoculating loop helped the slant streak back and forth. The tubes were incubated for 24-48 hours at 37°C.

#### **Urease test**

Urease agar media is used for urease test by following standard procedure. The urea agar tubes are inoculated by streaking the surface of the slant. The slant was streaked back and forth by the help of the inoculating loop. The tubes were incubated for 24-48 hours at 37°C

#### **Oxidase test**

Oxidase test was performed for *S.typhi*. For this purpose a drop of oxidase reagent (tetra-methyl- p-phenylenediamine dihydrochloride) was added to filter paper. A single colony was mixed in it. Result was noted after few minutes.

#### **Antibiotic susceptibility**

Antibiotic susceptibility of *Salmonella typhi* was performed via Kirby Bauer disc diffusion method [9].

### Antibiotics disks used and its concentration

Name	Class	Generation
Amikacin (30 µg)	Penicillins	1 <sup>st</sup> generation antibiotic
Gentamicin (10 µg)	Aminoglycosides	1 <sup>st</sup> generation antibiotic
Ceftizoxime (30 µg)	Cephems (Parental)	3 <sup>rd</sup> generation antibiotic
Aztreonam (30 µg)	Monobactams	3 <sup>rd</sup> generation antibiotic
Penicillins (10 µg)	Ampicillin	4 <sup>th</sup> generation antibiotic
ciprofloxacin (5µg)	Fluoroquiolones	2 <sup>nd</sup> generation antibiotic
Cefoxitin (30 µg)	Cephalosporin	2 <sup>nd</sup> generation antibiotic

## Results

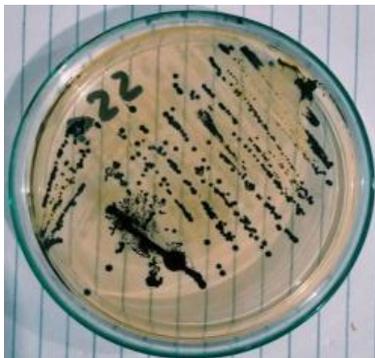
### *Xylose lysine deoxycholate agar*

*Salmonella typhi* showed black centered colonies on XLD agar as shown.

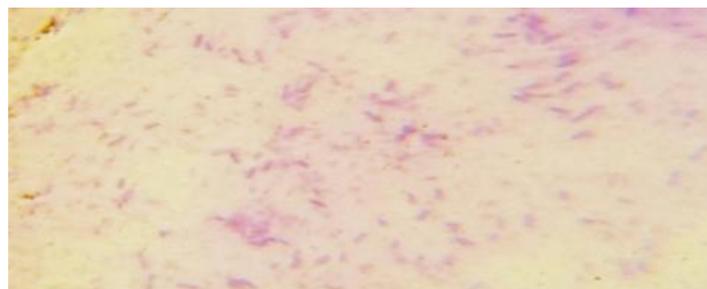


### *Salmonella Shaigela agar*

*Salmonella typhi* showed black centered colonies on SS agar as shown.

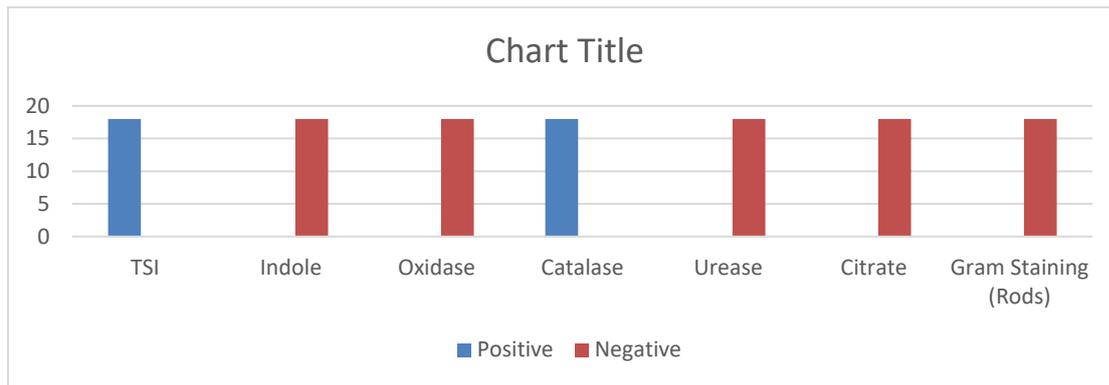


### *Gram staining*



Rods of gram negative observed under microscope.

**Results of Biochemical tests**



**Antibiotic sensitivity**

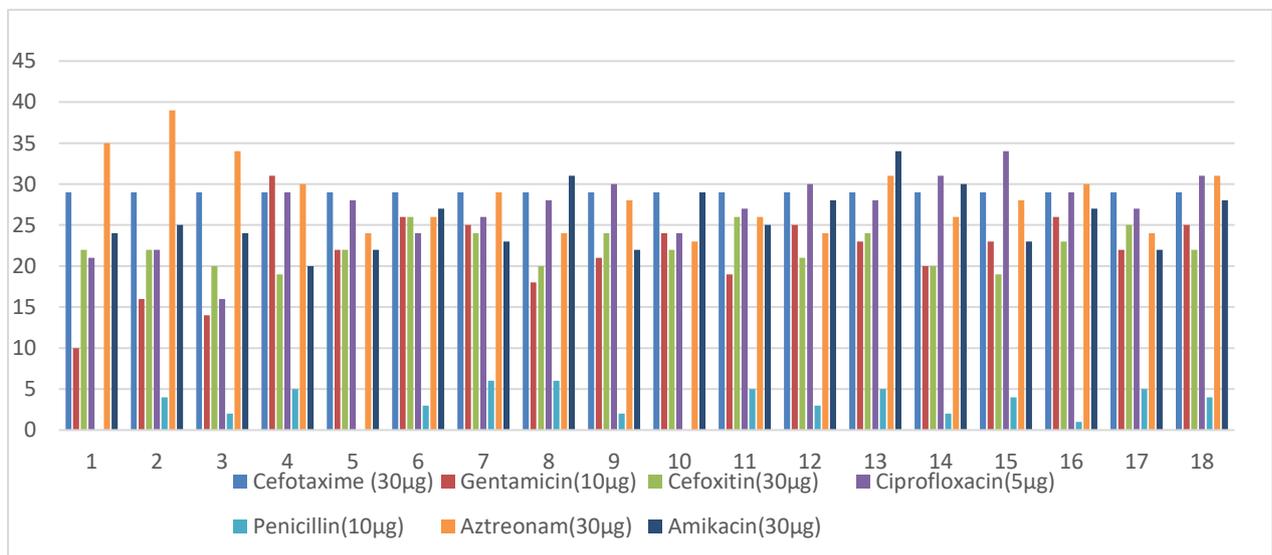
***S. typhi* Growth on Muller Hinton agar Media.**

Antibiotic sensitivity was performed for all the samples as shown in the pictures:



*S.Typhi* shows the sensitivity on the antibiotics in Muller Hinton agar media.

**Results of antibiotic sensitivity test**



<b>Descriptions</b>	
1B,1E,2E,3E,4E,5E,6E,7E,8E,9E,10E,11E,12E,13E,14E,15E,16E,17E,18E.	Resistance
3B,3D	Intermediate
Rest of Sample	Sensitive

## Discussion

In 2012 a study showed 64% of *salmonella typhi* reported in drinking water samples [10]. According to a study conducted at Aga Khan University in Pakistan between 2001 and 2006, the multidrug resistance rate for *Salmonella typhi* strains increased from 34.2% to 48.5% [11]. The current study aimed to isolate *Salmonella typhi* from water samples collected from Peshawar, Pakistan's tap water. The results show that *S.typhi* was isolated and identified phenotypically in 60 % of the samples (out of a total of 30). This rate of occurrence is higher than in previous studies.

### *In contrast*

The previous studies showed that *S.typhi* was resistant to azithromycin and ampicillin. Another study conducted showed the effectiveness of ciprofloxacin against *S.typhi* [12].

## Conclusion

The aim of the current study was to detect and isolate the *S.typhi* from drinking water sources in Peshawar city. The study showed, higher rate of *S.typhi* prevalence in drinking water. This is an alarming situation and possible threat of emergence of typhoid infection in the city. The MDR isolates detected can cause severe illness. Antibiotics were used like Ampiciline (10µm) and amoxicillin (10µm), were resistance and cefataxime (30µm), Gentamicin (120 µm), Cefoxitin (30 µm), ciprofloxacin (5 µm), aztreonam (30 µm), Amikacin (30 µm). Steps should be taken on war footing to stop the emergence and possible spread of infection. For this purpose, sanitation measures and personal hygiene should be followed.

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# MANAGEMENT SCIENCES

# Role of Leadership in Digital Transformation: A Case of Pakistani SMEs

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## Abstract

Digital Transformation has become an important aspect that stimulates various academic areas and affects practice, contributing to independent research streams. In the recent Fourth Industrial Revolution due to rapid technological development and the social and environmental changes caused by the COVID-19 pandemic, new sustainable growth approaches are expected from small and medium-sized enterprises (SMEs). The platform strategy to use a firm's external capability has become vital to SMEs seeking digitalization and sustainability. In such a context, this study identified the factors affecting SMEs' platform leadership and the strategies necessary for digital business consolidation and business continuity. It likewise employed a questionnaire survey targeting 376 Pakistani SMEs. The outcomes indicated that SMEs' platform leadership has a positive impact on platform strategy which in turn, positively influence digital business consolidation and business continuity. However, platform leadership was identified as a factor not directly affecting digital business consolidation and continuity. This shows that platform leadership should be implemented alongside the platform strategy.

## Keywords

Leadership, Platform Strategy, SMEs, Digital Transformation

## Introduction

As digital technology rapidly develops, enormous changes occur throughout the economy and society, as well as to individuals. All companies, irrespective of the domain in the industrial field, are affected by digital platforms and networks. As mentioned in the report "Future of Jobs" at the Davos Forum, the Fourth Industrial Revolution through which companies can innovate their conventional management style is both an opportunity and a threat. The COVID-19 pandemic is globally accelerating the shift of the business ecosystem, centering on technology-based digital transformation. Therefore, digital transformation is becoming a concern of all organizations, regardless of region, country, business type, and size. Likewise, finding an opportunity to secure productivity and added value through digital transformation in companies' fields are needed. However, SMEs' digitalization is notably delayed until now, compared to large corporations' adjustment. The reason is that digital transformation (DT or DX) does not merely mean the digitalization of simple products or services; competitiveness should be enhanced through new solution creation, operation innovation, and business foundation reestablishment using ICT. Activities pursuing new growth should also be carried out in almost all fields, including operation management processes, organizational culture, and business models (Chang et al., 2016; Cho et al., 2015).

What SMEs should most preferentially fortify to respond to digital transformation is securing platform competitiveness (Chesbrough & Adrienne, 2006). SMEs should secure platform-based dynamic capabilities, obtain new business opportunities, and draw the firm's internal and external resources' flexible stratification. For corporate innovation, there is a need to seek a digital network mode platform strategy as current society enters a hyperconnected setting, involving O2O, omnichannel, and sharing economy (Hirano & Hagi, 2011). If a win-win network between corporate ecosystems is formed based on platform, a win-win strategy by which a company finds answers can be enhanced. Further, customers may transform into partners, firms need not independently strive to manufacture, and business market values can be enhanced. SMEs need to be equipped, therefore, with platform leadership and strategy to promote digital-based innovation.

Many previous studies related to the platform business conducted research on platform provider-centered strategy (Torkkeli & Tuominen, 2002; Van Alstyne et al., 2002; Yoon & Seo, 2016). However, this study defined *platform* from the organizational perspective and discussed the platform leadership and strategy that the companies, the platform producers, need. It examined the relationship between SMEs' business digitalization and platform strategy to improve future competitiveness through business digitalization. It empirically presented the effects of SMEs' platform leadership and strategy on firms' business continuity, not to mention on digital business consolidation. Currently, the environmental shift of the business ecosystem is beyond simple technology change. Business model recreation and diversification should flexibly cope with market variability, and so firms cannot concentrate on just internal resources and capabilities. SMEs need to accurately understand the platform's essence, secure platform leadership through cooperation with content providers, and create network effects. The improvement of platform leadership and strategy will eventually accelerate business digitalization, and it will become a factor to lead the business in the new management environment continuously. This study emphasized the importance of SMEs' platform leadership and strategy and discussed the implementation direction from this aspect in the context of Pakistan.

## Hypotheses Development

### *Platform Leadership and Strategy*

A platform is defined as "a tangible/intangible structure designed with a common purpose to be used for diverse functions starting from the place where people get on and get off the train station" in lexical meaning. In the business world, mainly, a platform acts as a catalyst to make value exchange actively occur and create a new market value (Evans and Schmalesee, 2008). The platform's roles can be examined by dividing its area into consumers' perspectives and entrepreneurs' perspectives. The consumers' perspective is classified into communication, entertainment, e-commerce, comparison, and information offering, centered on consumers' activities.

The platform is divided into a software platform, e-commerce platform, payment and financial-related platform, and participatory network platform. The platform is divided into employment, funding, marketing, and e-commerce areas from the business persons' perspective. A representative area is LinkedIn. Users are instructed to write their career (work experience) and interest in their profile, and headhunters or employment personnel use the profiles. Funding is a platform used to receive investments based on various ideas or business plans, and crowdfunding is a typical funding platform. Marketing uses a platform for marketing purposes, including sales promotion, while portals or SNSs are the typical marketing platforms. E-commerce is a platform related to the transaction of goods or services. Not only Google Play or iTunes operating App markets, but various payment platforms are included in the e-commerce platform (Park et al., 2016; Hagi and Wright, 2015; Rogers, 2016).

A platform enables creating new values and connecting people, organizations, and resources in the interacting ecosystem to exchange these values. Therefore, the fundamental constitution analysis of platforms can be explained with opening, sharing, cooperation, and win-win partnership. If numerous people in diverse industrial groups pursue only their profits, the platform's role cannot be played. A platform system operator should maintain specific fees and its advertising income, whereas providers need to open preferred products and software information and prices, and cooperate in the delivery of orders and claim processes.

Consumers should buy necessary products and software through set processes as a platform can grow when each role is based on opening, sharing, cooperation, and partnership. Consequently, the need for the establishment of companies' platform leadership and capabilities is emphasized. Platform leadership signifies corporate capabilities, promoting innovation centered on specific platform technologies at an extensive industry level (Cusumano & Gawer, 2002). Platform leadership can create business dynamism features such as internalities of a network, positive feedback effects, and bandwagon effects. Platform leadership has a merit that may bring about the virtuous circle of business and item production depending on motive and value awarded from complementary products or complementary producers (Lee et al., 2010). The determinant of platform leadership is the complementor, internal organization, and external relationship with platform technology. Cusumano and Gawer (2002) presented differentiated product technology to lead a system, firms' clear scope, win-win

partnership, and relationship with external complementors. Leong et al. (2019) emphasized differentiated product technology, firms' clear scope, relationship with external complementors, and internal organization to implement responsibility policies. Based on the platform's principle, firms should become solution providers by establishing platform leadership to organically combine ecosystem members, compose corporate ecosystem, use external ideas and R&D resources, and implement open innovation. Also, platform strategy alongside platform leadership should be established.

A platform strategy refers to a strategy creating network effects and building a new corporate ecosystem by gathering the participants of mutually different groups (Hirano & Hagi, 2011). A platform strategy in corporate business management strategy is a critical tactic for a firm's survival, and it was used for cost savings and product composition diversity before. Recently, however, a term of a platform strategy has been utilized in various areas within the value chain, including R&D, production, marketing/sales, and after-sales service, centering on the ICT industry group as the ICT sharply develops due to the dissemination of the Internet and mobile technology (Choi, 2016).

To make the platform strategy feasible, the following conditions should be addressed: First, consumers from two or more types of classes should exist. Second, profits should be created by connecting different consumer classes. Third, consumers should obtain more benefits from the platform (Evans, 2003). A platform should be helpful for the management risks of the participating groups, and the characteristics in each group's specialized field need to be developed so that more participating groups can find values functionally (Hagel et al., 2008). Gawer and Cusumano (2007) put forward the commonly revealed factors among companies adopting the platform strategy. Some of them found the strategy a solution to problems and the connection easy to build up. Ben & Lenfle (2010) presented balancing commonality, differentiation, and modularity as a favorable platform. Lee et al. (2010) leaned towards innovation ability, complementarities, efficiency, network effects, and connectivity.

Because a firm's vision and strategy are designed and implemented together, SMEs' platform leadership needs to be considered along with platform strategy. Consequently, SMEs' platform leadership will positively affect the platform strategy and play a vital role in successfully leading the strategy. This study designed the following hypothesis that SMEs' platform leadership positively affects the platform strategy.

<Hypothesis 1> SMEs' platform leadership have a positive effect on the platform strategy.

### ***SMEs' Digital Business Consolidation***

Amid the rapidly changing business environment, business digitalization is stressed through digital transformation. SMEs are required to establish strategic competitiveness for digital business capabilities and digital transformation. Rochet & Tirole (2003) mentioned the importance of an intelligent factory, a business in which perfect communication is possible among stakeholders, smart products, and smart customers to whom ideas and orders are reflected. Lim (2013) emphasized the seven following characteristics as the necessary factors to be transformed as proper digital firms in the Fourth Industrial Revolution era: digitalization

affecting corporate performance, digital integration enabling customers to make customization and individualization, digital culture, data analysis, data analysis capabilities, globalization, and the importance of appropriate investment.

The success of digital transformation can focus on the optimization of the value chain that is automatically controlled and makes dynamic production possible (Mrugalska et al., 2017). As Torkkeli & Tuominen (2002) mentioned, a knowledge management system should be built through these primary factors: IoT, based on big data, real time, and sharing and cooperation of information. Overall, company constitution change and investment should be based on cooperation in which information is shared between a customer and a firm's internal and external connection such as digital technology, data system, and connectivity. For SMEs, a new business model and effective business strategies to achieve business goals beyond conventional business and management techniques are necessary. At this point, the platform leadership and strategy place themselves as the strategy that companies commonly adopt for firms' continuous growth. The reason is that they are acknowledged as access consolidating a

company's important innovation in various industrial groups by creating platform network effects and building new corporate ecosystems (Hirona & Hagi, 2011).

The key to digital transition rests on creating innovation through the strategic utilization of digital technology. Established companies also make a new productivity leap using digital technology. The well-known leading companies such as Google, Apple, Facebook, and Amazon not only accelerate the digital transition but solidify their status as a catalyst of the digital transition of different companies and industries. The leading companies' core competitiveness rests on platform capabilities, which are the combination of digital technologies. The platform does not mean supporting the digitalization level that simply changes work processes from offline to online. Instead, the platform becomes the central axis of business that innovatively changes its strategic direction and business model. This study presents the following hypotheses that platform leadership and strategy will affect digital business consolidation.

<Hypothesis 2> SMEs' platform leadership has a positive effect on digital business consolidation.

<Hypothesis 3> SMEs' platform strategy has a positive effect on digital business consolidation.

### ***Platform Business and Business Continuity***

Nowadays, companies feel the growth limitation in their business structures concerning the conventional value chain. They strongly recognize the need to carry out innovations and cope with changes to flexibly and quickly respond to customer needs (Chesbrough & Adrienne, 2006; Chang & Oh, 2013; Lee et al. 2016). A conventional business takes on a linear value chain structure, creating values going through linear steps from product and service manufacture and sale to users. Meanwhile, complex value is created through complex relationships among producers, users, and platforms in the platform business (Van Alstyne et al., 2016). As the platform business is applied to various industries, new competition order is created beyond the existing linear business model, and platforms become an essential factor for all companies' strategies (Hirano & Hagi, 2011).

One of the most essential activities for companies is building strategies for continuous growth through securing internal and external resources and capabilities (Porter, 1985). Companies should maintain a competitive edge in the market with their capabilities and performances in the changing market environment (Wu, 2007). Significantly, if SEMs utilize internal resources effectively and prepare for cooperative activities with external companies, this can positively affect the SMEs' performance (Yun & Seo, 2016). To adapt to the rapidly changing business ecosystem and cope with the future environment, platform management activities are needed above all (Shapiro & Varian, 2013).

Drawing cooperation synergy with external platform providers and obtaining digital technology rest on companies' attitude toward risks. SMEs need to consider the stagnation of platform growth and platform policy change as the service provider organization's risk becomes extinct according to platforms' status (Lee et al., 2010). To enhance platform capabilities, companies need to encourage risk-taking and system shift, increasing collaboration with many platform-related people/entities. Also, bold investment in digital data and information analysis accessing the changing environment should be made. As Hesse (2007) asserted, companies can expand products and services through platform strategy, enhance organizational survival rate by expanding customers and markets, and continuously grow the organization. As Lee (2016) explained, corporate business digitalization can be promoted through platform business. To achieve sustainable growth, SMEs should maximize knowledge and technology-related resources and consolidate the platform leadership and strategy to invite external organizations. Based on this, SMEs need to consolidate business digitalization for their future values and continuous growth and seek digital innovation strategy. This study designed the following hypotheses based on previous studies:

<Hypothesis 4> SMEs' platform leadership has a positive effect on business continuity.

<Hypothesis 5> SMEs' platform strategy has a positive effect on business continuity.

<Hypothesis 6> SMEs' digital business consolidation has a positive effect on business continuity.

## **Research Method**

**Research Model**

This study empirically analyzed the effects of SMEs' platform leadership and platform strategy on digital business consolidation and business continuity. Based on previous studies' research hypotheses, this study composed the conceptual model, as shown in Figure 1.

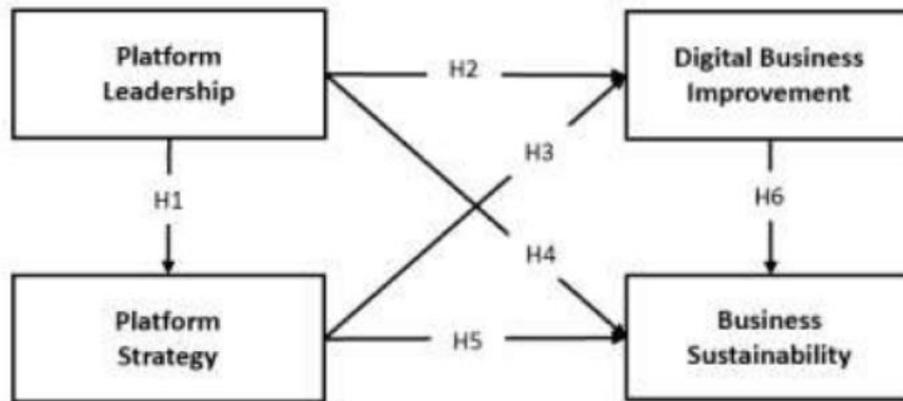


Figure 1 Research model

**Measurement Variable and Analytic Methods**

As shown in Table 1, this study designed each variable's organizational definition and measured questions based on previous studies. A total of 30 factors were significantly analyzed due to factor analysis, so they were used as final measurement factors. The measurement items mentioned above were designed using the 5-point Likert measurement (1=not at all, 5= very so), and the questionnaire was patterned to it. For the descriptive statistical values and normalization analysis of demographic features and variables, SPSS 26.0 was used. To carry out a regression analysis and path analysis for the causal relationship analysis, AMOS 26.0 was used in terms of the structural equation model.

Table 1 Variable Definition

Factors		Survey Items	References
Platform Leadership	Differentiated Technology	-Have an excellent digital platform leading the market. -Be equipped with outstanding technological capabilities for a digital platform development and utilization. -Be active in new digital platform adoption.	Cusumano & Gawer (2002) Lee et al. (2010) Leong et al. (2019)
	Clear Business Area	-Use an excellent digital platform to achieve business objectives. -Use a digital platform to make a new business strategy succeed. -Do not be interested in the business platform beyond the corporate business area.	
	Cooperative Capability	-Collaborate with various external platform companies. -Actively develop or use digital platforms, if necessary. -Stress cooperation between internal organizations to develop (utilize) a digital platform.	
	Organization	-Be equipped with an organization for digital platform management. -Have an organization (team) planning the utilization (consolidation) of a digital platform.	

		-Have a professional administrator in the digital platform field.	
Platform strategy	Unique Capability Consolidation	-Maintain corporate competitiveness within the industry through a digital platform. -Improve corporate business capabilities through a digital platform. -Ensure business differentiation through a digital platform.	Cusumano & Gawer (2007) Ben & Lenfle (2010)
	Value Creation Sharing	-Design an innovative business model through a digital platform. -Collaborate with new stakeholders through a digital platform. -Create a new market through a digital platform.	
	Cost-Saving Effect	- Save new product development costs through a digital platform. -Save production costs through a digital platform. -Save marketing costs through a digital platform.	
	Network Effect	-Efficiently carry out collaboration with partner firms through a digital platform. -Secure more customers (companies) through a digital platform. -Carry out internal business effectively through a digital platform.	
Digital Business Consolidation	-Achieve digital business consolidation and success. -Develop a new business model based on the digital platform. -Secure digital competitiveness within the market.		Wang & Cardon (2019), Eisenmann et al. (2011)
Business Continuity	Continuously develop a new business. -Continuously lead market and customer expansion. -Persistently consolidate corporate competitiveness.		Hirano & Hagi (2011), Hesse (2007)

### ***Survey and Demographic Information***

This study targeted managers or professionals in higher positions in charge of management strategy and digital business work in SMEs, having 50 or more organization members in Pakistan and carrying out an online questionnaire survey for three months between July and September 2020. Four hundred five response copies were collected, and 376 copies were finally analyzed, except 29 response copies having insincere responses or defects. Based on the response collection, 88.7% were males, and 11.3% were women; 0.5% were younger than 30, 5.9% were in their 30s, 24.5% were in their 40s, and 69.1% were at least in their 50s. Those 50 and above have a long work experience. Most of the respondents were highly educated people: 4% were high school graduates, 43.1% university graduates, 52.9% graduate school graduates or higher. As for work experience, 43% had less than 5 years, 1.6% 5-10 years, 8.2% 10-15 years, and 85.9% over 15 years. Concerning position, the employee/section chief composed 5.0%, manager 7.5%, director 10.5%, and executive 77.9%.

Regarding the business type, 37% were in the manufacturing sector, 2.9% in the finance/insurance, 17.3% in the distribution, 34.6% service/R&D, and 8.2% IT/ICT, with most being in the manufacturing and service industries. As to company size, 57.7% were less than 50 employees, the highest, followed by 14.1% 50-100, 20.7% 100-300, and 7.2% over 300 (see Table 2).

Table 2 Demographic Information of the Survey Participants

	<b>Classification</b>	<b>Frequency</b>	<b>Ratio</b>
Gender	Male	333	88.7
	Female	43	11.3
	Total	376	100
Age	Younger than 30	2	0.5
	30 – younger than 40	22	5.9
	40 – younger than 50	92	24.5
	50 or over	260	69.1
	Total	376	100
Education	High school graduate	15	4.0
	University graduate	162	43.1
	Graduate school or higher	199	52.9
	Total	376	100
Work Experience	Less than 5 years	16	4.3
	5 yrs - less than 10 yrs	6	1.6
	10 yrs - less than 15 yrs	31	8.2
	15 yrs or more	323	85.9
	Total	376	100
Position	Employee/Section chief	15	4.0
	Manager	28	7.5
	Director	40	10.6
	Executive	293	77.9
	Total	376	100
Business Type	Manufacturing/Production	139	37.0
	Finance and insurance	11	2.9
	Distribution	65	17.3
	Service R&D	130	34.6
	IT/ICT	31	8.2
	Total	376	100
Company Size	Less than 50	237	57.7
	50 – less than 100	54	14.1
	100 – less than 300	78	20.7
	300 or over	27	7.2
	Total	376	100

## RESULTS

### *Analysis Results of Reliability and Validity*

The factor loading was 0.699-0.890, and the t values were all 10.0 or higher, so statistically significant results were revealed. The average variation value was 0.790-0.974, and the Cronbach  $\alpha$  value was 0.919-0.971, so convergent validity was ensured. As a result of analyzing the fit of the measurement model,  $\chi^2(df)$  was 487.890 and  $\chi^2/the$  degree of freedom was 6.983. Goodness of Fit Index (GFI) value was 0.931, Adjusted Goodness-of-Fit-Index (AGFI) was 0.912, Normal Fit Index (NFI) was 0.925, and Root Mean Square Error of Approximation (RMSEA) was 0.023. From there, the measurement model fit components were statistically significant.

Table 3 Results of Reliability and Convergent Validity Test

Variable	Measurement Item	Standard Loading Value	Standard Error	T-value	CR	AVE	Cronbach $\alpha$
Platform Leadership	PL1	0.898			0.911	0.72	0.934
	PL4	0.790	0.032	20.339***			
	PL3	0.834	0.039	22.612***			
	PL4	0.868	0.042	24.609***			
Platform Strategy	PC1	0.931			0.952	0.832	0.971
	PC2	0.952	0.028	36.883***			
	PC3	0.855	0.035	26.204***			
	PC4	0.909	0.031	31.307***			
Digital Business Consolidation	DB1	0.835			0.919	0.792	0.919
	DB2	0.910	0.049	23.108***			
	DB3	0.922	0.050	23.636***			
Business Continuity	BS1	0.877			0.956	0.878	0.954
	BS2	0.974	0.035	31.596***			
	BS3	0.958	0.035	30.354***			
Measurement model fit: $\chi^2$ (df) 487.890, DF 73, $\chi^2$ /degree of freedom 6.983, RMR 0.032, GFI 0.925, AGFI 0.849, NFI 0.927, TLI 0.922, CFI 0.937, RMSEA 0.023							
* p<0.05, ** p<0.01, *** p<0.001							

According to the standard of Fornell & Larcker (1985), discriminant validity between potential variables is said to be ensured if AVE's square root values calculated from each potential variable should be more significant than the correlation coefficient of another concept. This study examined the AVE values and correlation coefficients between potential variables to identify the discriminant validity. As shown in Table 4, the AVE square root value of each potential variable is more significant than the correlation coefficients of the variable concerned and other variables. The measuring tool ensured discriminant validity.

Table 4 Correlation Matrix and AVE

Classification	CR	AVE	PL	PS	DBC	BC
Platform Leadership (PL)	0.911	0.72	0.849			
Platform Strategy (PS)	0.952	0.832	0.947	0.912		
Digital Business Consolidation (DBC)	0.919	0.792	0.870	0.884	0.890	
Business Continuity (BC)	0.956	0.878	0.798	0.840	0.854	0.937

### Analysis Results of Structural Model

As shown in Table 5 and Figure 2, this study drew the structural model's verified results. According to the fit standard,  $\chi^2$ (df) was 465.842(p=000),  $\chi^2$ /degree of freedom was 6.561, GFI was 0.921, and AGFI was 0.841. RMSEA was 0.022, NFI was 0.931, and CFI was 0.942, so the explanation power was valid.

As a result of examining the final structural model path coefficient for hypothesis verification, the platform leadership positively affected the platform strategy (t=25.689, p<0.001). Platform strategy had positive effects on digital business consolidation (t=4.606, p<0.001) and business continuity (t=2.533, p<0.05). The platform strategy was especially analyzed to significantly affect digital consolidation activities than on business continuity. Digital business consolidation had a positive effect on business continuity (t=6.638, p<0.001), and so the hypotheses were adopted. However, platform leadership did not have direct effects on digital business consolidation and business continuity. The findings confirmed that platform leadership worked as a factor having effects on corporate digitalization and business continuity.

Table 5 Results of Hypothesis Test

	Hypothesis	Standardized Factor Loading	t-Value (p)	Status of Acceptance	R <sup>2</sup>
H1	Platform Leadership -> Platform Strategy	0.953	25.689***	supported	0.908
H2	Platform Leadership -> Digital Business Consolidation	0.118	0.710	rejected	0.782
H3	Platform Strategy -> Digital Business Consolidation	0.77	4.606***	supported	
H4	Platform Leadership -> Business Continuity	-0.053	-0.334	rejected	0.76 2
H5	Platform Strategy -> Business Continuity	0.437	2.533*	supported	
H6	Digital Business Consolidation -> Business Continuity	0.513	6.638***	supported	
1) Structural model fit: $\chi^2$ (df) 465.842, p 0,00, DF 71, $\chi^2$ /degree of freedom 6.561, RMR 0.031, GFI 0.921, AGFI 0.841, NFI 0.931, TLI 0.924, CFI 0.941, RMSEA 0.022 2) * p<0.05, ** p<0.01, *** p<0.001					

## Conclusion

This study documents that SMEs' platform leadership affects platform strategy and the platform strategy has a positive effect on business digitalization and continuity. As insisted in previous studies (Rochet & Tirole, 2003; Evans & Schmalensee, 2008; Lee et al., 2010), the result proves that the platform strategy is a vital management activity for firms' digital transformation. This study shows that SMEs' corporate business digitalization is an essential factor using platform business and platform strategy.

The implications of this study can be examined as follows: Previous studies were mainly on a strategy to enhance platform providers' network effects (Amit & Zott, 2001; Van Alstyne & Parker, 2016). Strategic discussions on how platform providers continuously grow their platform business and expand new business models were mainly dealt with (Torkkeli & Tuominen, 2002; Chesbrough & Adrienne, 2006; Cho & Part, 2015). However, producers' developmental discussions are also necessary as much as platform providers in the platform ecosystem are concerned. This study is meaningful because leadership and issues from the company aspects were presented to promote corporate development using platform ecosystems from the organizational behavioral level.

Second, since Cusumano & Gawer (2002) defined platform leadership, the platform leadership theory has a limitation that it was not continuously connected to empirical research. However, leadership is essential for companies to take risks and innovatively promote platform business according to the feature that the company's external resources should be innovatively adopted and utilized in the platform business. For SMEs sticking to conventional business type and having limitations in bold investments in innovation, the platform business may need more powerful leadership. From this aspect, this study stressed the importance of platform leadership and proved positive effects on firms' digitalization based on platform strategy, which can be meaningful.

Third, this study has a meaning in that it empirically presented that SMEs' digital business consolidation can become a pivotal factor in corporate sustainability. As asserted from previous studies (Chang & Oh, 2013; Hagiwara & Wright, 2015; Wang & Cardon, 2019), SMEs should respond to quick IT knowledge-based economic trends amid today's environment. They may need a mid- and long-term development strategy based on digital transformation. However, as one company cannot lead digital technologies

and strategies with just internal resources and capital, the platform strategy for external resources and the network was necessary for corporate future growth and continuity beyond business innovation. This study has the following limitations: First, this study targeted Pakistani SMEs, and so the study results have a limitation that only Pakistani regional and economic features were reflected. Companies' platform business and digitalization levels vary according to national and economic characteristics. A further study needs to carry out studies targeting American, European, and Asian SMEs and draw differences and common country dynamics. Second, this study examined the relationships between factors on the digital consolidation and business continuity of platform leadership and strategy. However, the effect relationships of the platform leadership and strategy's sub-variables were not drawn, which can be a limitation. Discussions on what components should be considered to establish platform leadership and strategy can be meaningful in actual business. Therefore, further study is required to concretely examine the four components of platform leadership, namely differentiated technology, a clear scope of the firm, relationship with external complementors, and internal organizations to implement with responsibility, as well as the factors for platform strategy; that is, capability consolidation sharing, value creation sharing, cost-saving effect, and network effect.

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# Challenge Stressors and Faculty Job Performance: The Role of Career Success Satisfaction during Covid-19

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## Abstract

Stress is an integral part of teaching profession. Hindrance stressors can affect teaching faculty negatively whereas challenge stressors have positive effect on teaching faculty. Covid19 has increased the overall stress mainly due to online teaching mode and work from home (WHF). The faculty working in higher education institutions (HEIs) in general and the faculty appointed under tenure track system (TTS) were already under stress due to challenging job and goals. The aim of this study was to investigate the impact of challenge stressors (time pressure and workload) on the job performance of TTS faculty during Covid19 pandemic. This study also investigated the career satisfaction as moderator between challenge stress and job performance (under the prevailing Covid-19) circumstance. Survey technique was used for data collection from Ph.D. faculty appointed on TTS in HEIs of Pakistan. 129 TTS faculty participated in this study. Confirmatory factor analysis (CFA), VIF, correlation, reliability, and moderation tests were used. Results showed significant and positive impact of workload, time pressure on job performance of TTS faculty during Covid-19 pandemic. Moreover, career satisfaction was found to have moderating effect between challenge stress and job performance. Thus, it is concluded from the study that TTS faculty's performance is improved due to increase in challenge stressor during Covid-19.

## Keywords

Stress, Challenge Stress, Workload, Time Pressure, Career Satisfaction, Job Performance, TTS faculty

## Introduction

The outbreak of the Covid 19 pandemic has jeopardized the global economy. The lockdown and Work From Home (WFH) have become a new reality and are likely to continue indefinitely (Rochard, 2021). The coronavirus pandemic has altered working conditions, created uncertainties, and increased workplace stress due to job insecurity and work-life imbalances (Lima et al., 2020; Mumtaz, 2020). It harms employee's efficiency and productivity (Sadri & Marcoulides, 1994; Soran et al., 2014). Thus, the current working arrangements and insecurities create more intense emotions such as anger, anxiety, depression, and burnout (Wu et al., 2020). Though the entire world has been under the grip of Covid 19, it has struck South Asia more strongly and adversely. For instance, the second wave in India has collapsed the entire health system, and the fatalities are alarming. Similarly, the third wave in Pakistan is more deadly and is taking more lives. The governments are left with no options other than to impose strict lockdowns, instructing organizations to operate with fifty percent staff attendance, reducing office working hours, and so on.

Pakistan's education sector has been under immense pressure (Farooq et al., 2020). Higher education is faced with challenges to continue its educational activities online despite its lack of infrastructure to support online teaching. However, HEIs have adopted an online mode of teaching for the continuation of the education cycle. Online education is challenging both for the staff and the students (Mahmood, 2021). Though the online education system is crucial to safeguard individuals from Covid 19; the sudden shift to the online mode of teaching has caused increased stress, anxiety, and other mental disorders (Akram et al., 2020; A. Khan et al., 2020; Maqsood et al., 2021; Zeeshan et al., 2020). Countries with adequate infrastructure for online mode of teaching have also reported a high level of

stress among their faculty, such as, Saudi Arabia (Al-Rabiaah et al., 2020), China (Yin et al., 2020), the United States of America (Tobin & Taff, 2020), Slovenia (Košir et al., 2020), Spain (Odrizola-González et al., 2020) and so forth.

In the extant literature, job stress and work outcomes have indicated both positive and negative outcomes (Amah, 2014); however, much of these studies relate to stressors that focus on negative rather than positive outcomes (Podsakoff et al., 2007; Wallace et al., 2009). During the recent episode of Covid-19, several researchers have focused on the negative aspects of stress: hindrance stressors. The positive stress of challenge stressors has been ignored. The challenge stressors motivate employees to put extra effort into a better job performance (Wu et al., 2020). With the increased responsibilities and pressures due to online teaching, it is essential to study challenge stressors and their association with employee performance. Thus, the primary objective of this study is to investigate the challenge stressors and teacher's performance during the coronavirus pandemic.

## **Literature Review and Hypotheses Development**

This study is based on the job demands and resources model (JDR model) and the social support theory (stress and coping theory). According to the JDR model, stressors exist in all jobs, and these factors are grouped into job demands and job resources (Bakker & Demerouti, 2007). Job demands (stressors) are psychological, physical, and organizational factors that demand physical and mental efforts. Work pressure, working conditions, restructuring issues, emotional demands, and role ambiguity are the job stressors. At the same time, job resources are physical, psychological, and organizational factors that help in goal attainment. It reduces negative job stress and accelerates personal growth (e.g., career growth opportunities, learning and development, personal growth, decision-making, organizational support, etc.). Thus, the job is the combination of both negative and positive stressors, which can be elaborated by Cavanaugh, Boswell, Roehling and Bouderau (2000) two-dimensional stressors framework: challenge and hindrance stressors. Challenge stressors are the pathway to mastery, goal achievement, and personal growth and contain dimensions like workload load, time pressure, and level of responsibility (Wu et al., 2020). Though the challenge stressors produce positive outcomes, mental health issues are associated with them (LePine et al., 2005). On the other hand, hindrance stressors are perceived barriers to achieving such goals and contain role ambiguity, organizational politics, role conflict, etc. (Cavanaugh et al., 2000).

The teaching profession is one of the most stressful occupations as teachers are under constant pressure to teach and demonstrate research output (Ryan et al., 2017). Particularly considering the teaching faculty in HEIs appointed through Tenure Track Statutes (TTS) are under constant pressure and stress to meet the minimum performance. The TTS system is different from the Basic Pay Scale (BPS) system. TTS employees are expected to demonstrate research performance and have tight targets, whereas BPS faculty is more teaching-oriented though their promotion is based on research output. However, unlike the TTS faculty, the BPS faculty has no time frame to produce research publications. Thus, the TTS faculty experiences more challenge stressors than the BPS faculty in terms of demonstrating performance within strict timeframes. Also, TTS faculty is required to publish in high-ranked journals as compared to the BPS faculty.

This study investigates the relationship between time pressure (a challenge stressor) and employee job performance under the prevailing Covid-19 circumstances. Moreover, another challenge stressor, i.e., workload, is also investigated for its effect on employee job performance during Covid-19. Lastly, career satisfaction is anticipated to play a moderating role in the relationship between career stressors and job performance. The hypotheses are developed with the support of the literature review in the sections below.

### ***Time Pressure and Job Performance***

Time pressure is an employee's perception that they have insufficient time to accomplish their goals or perform work more rapidly than routine to meet deadlines (Baer & Oldham, 2006). Time pressure can develop job stress among employees in meeting deadlines in almost every type of occupation (Shergold, 1995). Gilboa et al. (2008) suggested that time pressure is a job stressor and can cast favorable and

unfavorable effects on employee job performance. The stress associated with time pressure has dual effects; it can either motivate employees to perform well or negatively affect their well-being and mental health (Maule et al., 2000). Hence, it can both improve or decrease job performance.

However, time pressure as a challenge stressor is associated with developing pre-emptive behavior in employees (Fay & Sonnentag, 2002; Sonnentag et al., 2010). Researchers also suggest that it increase the enjoyment level and enhances performance (Baas et al., 2008; LePine et al., 2005; Zivnuska et al., 2002). Faculty members in HEIs appointed through TTS are always under time pressure and they all strive to achieve their desired performance within the prescribed time. Hence, time pressure is a challenge stressor, which has intensified during Covid-19. Therefore, it is assumed that time pressure has a significant relationship with employee job performance.

H1: Time Pressure has a significant relationship with employee job performance.

### ***Workload and Job Performance***

The workload is the extent to which employees have unnecessary and excessive work to perform and generate positive job outcomes (Cooper et al., 2001). The workload can be categorized into two forms: work overload and work under load. Work overload is defined as having too much to perform in a short amount of time (Amiruddin, 2019). An increase in workload generates two different types of job stress, one positive and another negative (Aziz et al., 2014; Rosen et al., 2020). Stress among employees increases due to high workload and insufficient reward systems, especially in academia (Han et al., 2019). Although researchers are indifferent about these two effects, some suggest that the positive effect of workload is favorable; therefore, employees in different organizations persuade it.

Mostly, employees view workload as a challenge. Accomplishing this challenge leads to achieving personal gains (e.g., promotion, compensation, etc.). Hence, workload positively affects job performance (Podsakoff et al., 2007). Cavanaugh et al. (2000) first pointed out this challenging aspect of workload by dividing stressors into two main categories: hindrance and challenge. In contrast, the workload is a subcategory of challenge stressors. However, studies found mixed results by correlating workload and job performance. Some suggest workload positively affects job performance (Karatepe et al., 2018; Podsakoff et al., 2007). Other studies argue that workload and job performance are negatively related, whereas some even suggest no relationship (Gilboa et al., 2008).

Teaching specified subjects and research are two major tasks of a faculty. Due to the Covid-19 outbreak and lockdown, both are suffered as per usual practices. Teaching courses online requires more effort and research supervision, and research writing has become more complex. Access to data (especially primary data) has been affected by work from home (WFH), and organizations are not allowing access because of strict Covid protocols. Thus, the workload has increased sufficiently. Since the previous results are inconsistent about the relationship between workload and job performance, and it is assumed that this challenge stressor has become more challenging during Covid-19, therefore, it is hypothesized that:

H2: Workload has a significant relationship with employee job performance.

### ***The moderating role of Career Satisfaction***

A career is defined as an "occupation for life" (Simons et al., 2000) or "progressing upward in one or more than one organization" (Eby et al., 2003). Career satisfaction refers to achievements by attaining career-related goals at any point in employee work experience (Arthur et al., 2005). Career satisfaction is a subjective phenomenon that encircles the perception of any employee regarding overall goals, advancement, package, and personal development (Guan et al., 2019). It has a longstanding effect on employee attitude and behaviors across various tasks they perform during their careers (e.g., Spurk et al., 2011).

Career satisfaction is an outcome of individual years of service (Greenhaus et al., 2010). Therefore, the individual has to cope with hurdles, high work demands, and targets to achieve higher career satisfaction. High workload and time pressure drive personal growth and development and thus result in high performance. Studies suggest that employees with high growth needs are more satisfied when challenged and perform well (Gaetrner & Nollen, 2012). Also, engagement in work and active

participation to achieve organizational goals can be observed among employees satisfied with their careers (Harter et al., 2002; Radic et al., 2020). Therefore, based on trait activation theory (Tett & Burnett, 2003), career satisfaction might successfully moderate the effect of stressors (workload and time pressure) on employee job performance (Klehe et al., 2021). According to TAT, the individuals evaluate their work demands based on intrinsic reward (satisfaction) and extrinsic reward (salary, status) related to career success. In the current working environment, relationships with coworkers have become more flexible and shorter, due to which planning and directing careers have become more self-reliant (Sullivan & Baruch, 2009). For achieving career success in a dynamic working environment, individuals consider taking advice regarding their careers and are expected to proactively manage their careers (Direnzo & Greenhaus, 2011; Guan et al., 2019). In this respect, job stressors might help individuals achieve personal benefits (promotion, etc.) by overcoming the challenges linked to the stressor (Podsakoff et al., 2007).

Challenge stressors are perceived as an opportunity for growth, personal gain, achievement, and learning, due to which it is suggested that challenge stressors generate positive emotions in employees (LePine et al., 2005). In contrast, job demands such as time pressure are unfavorable to employee well-being and job performance. However, on the grounds of transactional theory (Lazarus & Folkman, 1984; LePine et al., 2005), employees under time pressure increased their effort as these types of job demands are considered challenging employees. Overcoming these challenges has the potential for achieving personal gains and generates positive emotions among employees. Employees use an active coping style to overcome these demands. Coping with these situations (i.e., workload and time pressure) positively affects employee motivation, due to which their job performance is high.

While working for a higher salary and career satisfaction, the employees will be more productive, and the workload and time pressure will not create hurdles for achieving the desired goals. Employees usually have different ambitions out of their careers, such as a secure job, more salary, better work location, job status, an opportunity for growth, promotion, and experience. Some even consider a job that offers work-life imitative so that they can manage their family life. It can be argued that when an individual appraises time pressure and workload as challenge stressors and thinks that these are the opportunities for promotion and other rewards, it will evoke positive emotions, exhibit better performance and career satisfaction. Career satisfaction includes the rate of advancement/promotion, rank, and salary (Aleksić et al., 2017; Linzer et al., 2000). Thus, time pressure and workload, when paired with career satisfaction, will enhance job performance.

H3: Career Satisfaction will moderate the positive relation between (a)Time Pressure(b) workload and employee job performance so that the relationship will be stronger when the Career Satisfaction is high.

## **Research Methodology**

### ***Sample and Data Collection Procedure***

The target population of the respondents was the faculty members having a doctorate. According to HEC (2019), the number of Public Sector Universities/Degree Awarding Institutes established at Khyber Pakhtunkhwa is 26. Regarding the Ph.D. faculty statistics, 31.77% of the public sector's total faculty is having a Ph.D. degree holder (HEC, 2015). The Tenure Track System (TTS) faculty were targeted due to their contribution to research and other teaching activities, which are higher than BPS faculty. They are usually under pressure for their research and teaching output. Hence, a purposive sampling technique was used to select the relevant sample. Questionnaires were distributed among the chosen sample, which was borrowed from previous literature. Purposive sampling techniques clear the targeted employees, their working space, and working time. A total of 210 questionnaires were distributed personally. A cover letter containing the aims of the study and assurance of confidentiality was attached to the questionnaires. Participation in this study was voluntary.

The general threshold of the response is above 50% of the distributed questionnaires (Babbie & Benaquisto, 2009). The current study yielded a 61% response rate which is quite normal in the Asian context. Upon the collection of distributed questionnaires, nine were incomplete and were excluded. Only 129 questionnaires were found fit for further analysis. Among the returned completed questionnaires, 92% were male. 71 % of faculty were in the age group of 30-40 years, while 29% of the

respondents were above 40 years of age. The mean age was 36.2 years and with a standard deviation of 2.47. In the case of qualification, 98% of the employees had a Ph.D. degree, and only 2% were having a post-doctorate. Cadre wise distribution indicated that 73% of the respondents were assistant professors, 23% were associate, and 4% were professors.

### **Research Instrument**

Data collection tools were adopted from previous studies. All the well-established questionnaires were on five points Likert scale, ranged from 1 (strongly agree) to 5 (strongly Disagree).

We assessed workload with a four items tool (Janssen, 2001). Data regarding time pressure was collected through three items questionnaire designed by Semmer et al. (1998). The five items instruments regarding career satisfaction were adopted from Greenhaus et al. (1990). Lastly, responses regarding job performance were reported and noted with a self-reported seven-item tool developed by Williams and Anderson (1991).

### **Control variables**

For control variables, one way ANOVA test was conducted. In demographic variables, education and gender significantly affect the variables of this study. Therefore, as per previous studies, these variables were taken as control variables (Khan et al., 2015; Tufail et al., 2017).

### **Common Method Bias**

Common method bias has been observed in a single survey method (Podsakoff et al., 2007). Such a problem is considered a latent issue in behavioral sciences. Therefore, Haman’s one-factor test was applied to avoid the problem of common method biases, as suggested by Podsakoff et al. (2003). In this regard, factor analysis was also conducted to check that one general factor is not responsible for most of the variance. The outcomes of the principal component factor showed that a single factor is accountable for 34.84% variance, which is less than 50% indicate that a single factor is not accountable for most of the variance. Hence, the collected data does not contain issues of single method biases. Further, the Measurement model was confirmed via Confirmatory Factor Analysis (Brown, 2015). It was used to validate the CFA was also used to validate the discreteness of the study variables. The one factor model was found that:  $\chi^2/df = 2.23$ ; IFI = 0.91; TLI = 0.92 CFI = 0.92; RMSEA= 0.05.

Table 1 indicates the means, standard deviation, correlation, and reliabilities of the constructs. The coefficient between time pressure and job performance was 0.37 at  $p < 0.01$ . Correlation between workload and job performance resulted in 0.41 at a  $p < 0.01$  significant level. Lastly, the coefficient correlation between career satisfaction and job performance was 0.39, indicates the positive direct relationship between the two constructs.

Table 9: Means, Standard Deviation, Correlation and Reliabilities

	Mean	SD	1	2	3	4
1 <b>Time pressure</b>	2.13	0.92	(0.83)			
2 <b>Work Load</b>	3.42	0.83	0.51**	(0.88)		
3 <b>Career Satisfaction</b>	2.92	1.32	0.19**	0.47**	(0.95)	
4 <b>Job Performance</b>	2.16	1.7	0.37**	0.41**	0.39**	(0.74)

N = 129; Cronbach’s alpha presented in parenthesis.

\*\* Correlation is significant at the 0.01 level.

## **Results**

Table 2 indicated the direct and moderated impact of the study constructs. Hypothesis 1 proposed the direct relationship between workload and employee job performance. The results confirmed the direct

effect significantly ( $\beta = 0.37, p < 0.1$ ). Similarly, the direct effect of time pressure and employee job performance was also confirmed ( $\beta = 0.41, p < 0.1$ ). Lastly, it was found that the relationship between career satisfaction and employee job performance was direct and was found significant ( $\beta = 0.40, p < 0.1$ ).

Cohen et al., (2013) technique was incorporated to check the moderation effect. Independent and moderating variables were mean-centered. So, to check for multicollinearity in variables, variance inflation factor (VIF) (Black & Babin, 2019) and tolerance statistics were calculated. The analysis found that tolerance is equal to 0.96, which is above the threshold of 0.10 (Hair et al., 2009), while VIF is 1.04; therefore, it did not exceed the acceptable range of 5, avoiding the issue if multicollinearity exists.

Hypotheses 3a predicted the moderating role of career satisfaction in the link between time pressure and job performance. The results are given in Table 2. Upon entering the interactive term of TP and CS (Time Pressure x Career Satisfaction), it was found that career satisfaction moderates the relation between time pressure and job performance where  $\beta = 0.25, p < .05$ . Hypothesis 3b expected that higher career satisfaction, stronger will be the moderating effect. In the third step, the interactive term of WL and CS was entered. The results in step 3 given in table 2 confirmed the moderated effect where  $\beta = 0.17, p < .05$ , and the change in R2 was 0.13. Change in R square is not higher as compared to the main effect, still significant and informative.

Table 10: Results

<b>Job performance</b>			
	$\beta$	R <sup>2</sup>	$\Delta R^2$
<u>Step 1</u>			
Education		0.001**	
<u>Step 2</u>			
Time Pressure	0.41**		
Workload	0.37**	0.54**	
Career Satisfaction	0.40**	0.37**	
<u>Step 3</u>			
TP x CS	0.25**	0.31**	
WL x CS	0.17**	0.53**	0.13**

N = 129, ns= not significant

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

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

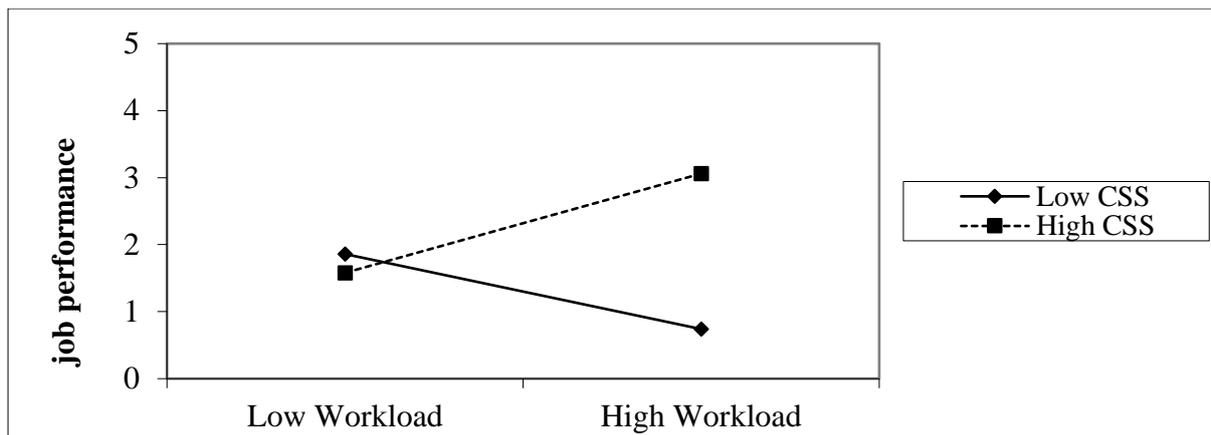


Figure 13: Workload Vs. Job Performance

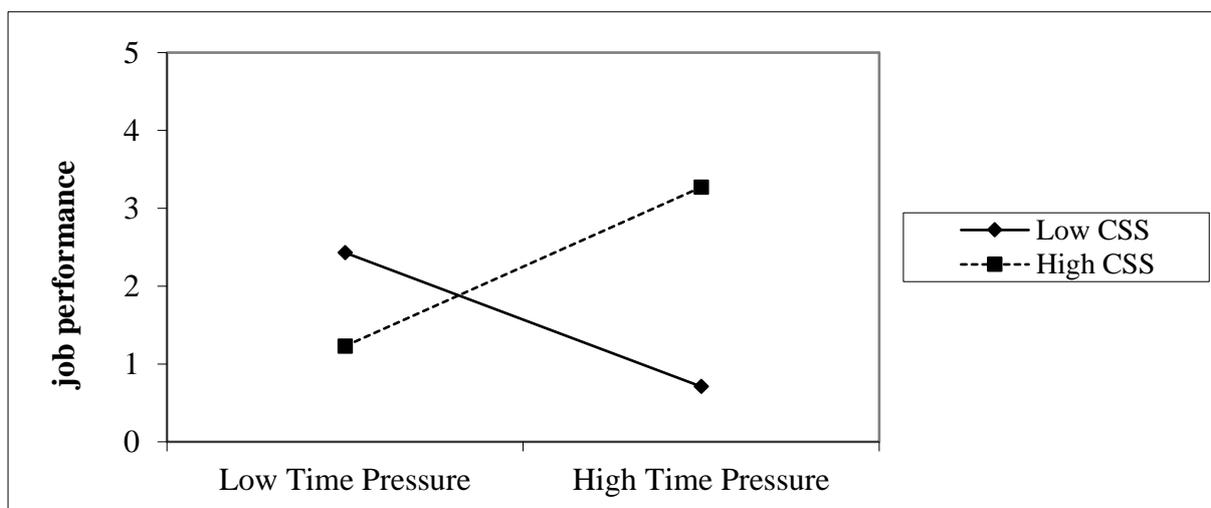


Figure 14: Time Pressure Vs. Job Performance

## Discussion and Conclusion

The findings revealed that both workload and time pressure has a positive association with employee job performance. According to the transactional theory of stress, perception and consequences vary from person to person. A similar trend has been reported in this study which remained as per theory during the Covid 19. According to Cudré-Mauroux (2010), the individuals may perceive the situation as stressful or challenging that evoke a positive feeling and thus provide the opportunity for learning and personal growth, gain, and other benefits. Workload increases employee's job performance so that when the individuals perceive workload as a learning process, the job demands do not negatively affect their performance. During the Covid 19 pandemic, the workload of the TTS faculty in particular has increased, and the result of this study shows an increase in job performance. They think that the extra load will result in growth and opportunity to learn in their fields and thus will provide new job assignments, promotions, and other fringe benefits. In the same vein, (Anasi, 2020; Yang et al., 2004) found that workload is positively correlated with faculty jobs.

In contrast, another study (Gilboa et al., 2008) found a negative relation. There are different perceptions regarding workload and time pressure and have been reported with inconsistent results (LePine et al., 2005). Workload during WFH at the time of pandemic has increased drastically due to work-home interference (Wang et al., 2021); with reduced monitoring and less social support, the job of TTS faculty has become a major challenge.

There is a notable difference between the time pressure desired by any employee and the actual time he/she spend during working hour, and the performance of an employee is affected by the same variance. Thus, time pressure has the propensity to heighten or dampen the employees' performance

(Maule et al., 2000; Yang et al., 2004). Similarly, Gilboa et al. (2008) investigated that time pressure, directly and indirectly, relates to employee job performance. Time pressure does not dampen the employee job performance all the time (Liu et al., 2019; Sun et al., 2018) but provide the pathway to mastery and growth. Time pressure stimulates the energy and attention to complete the task. Ohly and Fritz (2010) also suggested that time pressure acts as a catalyst to encourage employees to achieve organizational goals. If there were no time pressure in the organizations, the optimum level of performance would be difficult to observe (Kocher et al., 2019). The current study also found a direct relationship between time pressure and employee job performance during pandemic among the TTS faculty, consistent with the previous literature (Balducci et al., 2020; Treffers et al., 2020; Wang et al., 2021). Time pressure evokes the feeling of completing the desired and targeted goals in time to get the incentives or any other benefits associated with it. Every organization has targeted goals and objectives. Organizations try to achieve those goals and objectives to survive, which would be impossible without time constraints.

Results of the moderation analysis revealed that career success satisfaction significantly buffered the effect of workload and time pressure on employee job performance of TTS faculty during a pandemic. This suggests that highly career success satisfied employees tend to maintain their high-level performance when paired with workload and time pressure (Presti et al., 2021). Nevertheless, employees with low career success satisfaction did not produce similar results (Sin & Saraih, 2021). Individuals utilize their maximum energy for success in their careers. They consider workload and time pressure as a challenge in their job and thus try to maximize their performance. High performance is expected when the talent and opportunity for growth are consistent with the organization's environment (Glasser & Zhang, 2000). It can be argued that when the organizational climate provides career success opportunities and the employees also want to gain personal growth and achievements will exhibit higher performance and the interactive effect of workload and time pressure will strengthen the same relationship. Although time pressure has been considered as negative in nature (Maule et al., 2000); however, an optimal level of time pressure enhances employees' performance (Baer & Oldham, 2006). Workload and time pressure are contextual factors in any organization. An individual will be satisfied with his/her career when he/she gets the opportunity for growth, higher responsibility, promotion, high salary, etc. The Trait Activation Theory also supports this phenomenon. According to Tett and Burnett (2003), TAT designates one's tendency to exhibit or engage in specific behavior, situation, or contextual factor to provide indicators to behave in a certain way. Time pressure and workload are situational factors so that the achievement of assigned targets within the specified period will be observed to get the promotion and satisfaction in career. These results are essential for understanding the TTS faculty's physical and psychological aspects and their performance during the pandemic.

## **Managerial Implications**

This study brings some managerial implications for academic heads during Covid19 and pandemic outbreak. The deans and heads of departments should consider the workload and time pressure since continuous or extra workload and job demands during WFH are beyond the optimal level will result in strain. The faculty may leave the organization due to high job pressure and increased workload due to WFH and online teaching. Thus, the academic heads should be cautious regarding the targets and demands imply to the employees. The balance will help faculty to avoid exhaustion and fatigue. Promotions and growth must not be solely based on the workload and job demands instead on optimal targets and demands. Task completion, role demand, and timeframe for the task differ in every HEI.

Similarly, the nature of job demands is different between private, and public sector HEIs thus demands the treatment accordingly. To cope with challenges associated with Covid19, the management should tailor the training sessions for such faculty. The educational institution must provide a sharing culture where the faculty do not feel any pressure concerning time or workload.

Extending the literature by empirical studies, the results publicized theoretical contributions. The amalgamation of the Transactional model of stress and AET provide extensions to both frameworks. AET delivers a broad framework regarding emotions, events, and behavior, yet it does not explain the details of events and their distinguished relation with emotions (e.g., during a pandemic). The transactional model inflates AET by presenting stressors as a form of situation and propose motivation

regarding stressors and job outcomes. At the same time, the combination of these perspectives extends the transactional stress model to include behavioral consequences of the emotions generated by stressors. Based on AET, it can be argued that emotions cause discretionary behavior, but it is not the case all the time and can be stem from work attitude as well. In this regard, Podsakoff et al. (2005) investigated numerous cognitive outcomes of stressors. Further, satisfaction regarding a job or career is a cognitive function that results in a positive or negative judgmental reaction in the workplace.

## **Limitations and Future Research Directions**

Despite the significant contribution, the current study brings limitations for the researcher to be considered in the future. Most of the respondents were male. Men and women do not have the same view regarding career success, even in the same profession (Dyke & Murphy, 2006). Therefore, a group-wise study may be carried out. Another aspect could be personality. Personality may not envisage job or career outcomes; it would consequently be advisable to study the development of personality and career success over time.

Due to limited support for career satisfaction, individual differences like self-efficacy may be used as moderating variables. Self-efficacy comes from the mastery approach, which requires experience. By setting higher goals for themselves, the individuals incline to upsurge efforts and reduce anxiety and depression (Bandura, 2012). By avoiding anxiety, challenge stressors may induce positive emotions, thus may result in higher productivity.

The respondents who were taken in this study were on the Tenure Track system. Therefore, it is recommended that a comparative study be carried out between TTS and BPS employees in the future as the parameters for the BPS employees are different and not intense like TTS employees. Similarly, the cultural aspect of the Public and Private sector cannot be ignored. The future research study may replicate the current study in multinational companies where most promotions and other fringe benefits are solely based on performance.

Also, the level of education is an essential aspect of human capital. The level of satisfaction differs across the degree holders; therefore, studies are suggested to be carried out among different degree holders. Likewise, Career stages do not result in the same position for employees. Studies may also investigate the amount of work and time pressure in physical and online teaching and between the senior professors and entry-level teaching staff (Ghani et al., 2020).

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# A Study on Workplace Stress and Employees Performance in Public Sector Universities of Khyber Pakhtunkhwa

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## Abstract

Workplace stress is found as a crucial element affecting an organization's performance and efficiency. Academia is no exception in this regard. The said phenomenon also influences the behavior of expressiveness and the resulting identity of employees presenting themselves in a work-group context. Influenced and guided by the work of Erving Goffman in 'the Presentation of Self in Everyday Life, 1956' as a dramaturgical framework, this qualitative study aimed at exploring the performance of employees through self-exposition in university committees by having semi structured interviews with twenty-five employees of different universities of Khyber Pakhtunkhwa. Maintaining the research ethical dimensions and anonymity of the participants intact, responses from the systematically obtained data through interviews from the participants were transcribed for further analysis through qualitative content analysis method for identification of patterns, which revealed two major thematic categories. The study is anticipated of having contributed contextually to the existing knowledge on performance. The theatrical metaphor coined by Erving Goffman (1956) is pushed to its limits for gaining a view of the extended dramaturgical analogy of performance in the activities carried out during committee meetings by comprehending how employees thought of their performance in publicized roles through social interactions in the universities of Khyber Pakhtunkhwa. Findings of the study provide the employees and management of universities some helpful insights in the management of self-presentation and making their performance more dynamic while in formal work-group contexts, since the decisions made in such environments may be influenced by the nature of interactions and behavioral characteristics of the employees.

## Keywords

Erving Goffman, Dramaturgical Framework, Committee Member, Workgroup, University.

## Introduction

Organizations regularly hold formal committee meetings to make important decisions. Performance of committee members is the sole determinant of the efficacy of a committee. They must be willing to engage in the meeting, as well as have the ability and enthusiasm to support and express their opinions on a particular agenda item. Participants that make a presentation during a committee meeting establish their identity and impression on other group members through self-presentation, which can either enhance or detract their performance. A defining component of this work is the Erving Goffman's dramaturgical metaphor for social interactions argued in 'the Presentation of Self in Everyday life, 1959' (Goffman, 1959). Most university committees meetings take place within the context of a social interaction in Khyber Pakhtunkhwa (K-P). The venue and other illustrative props of the meetings makes a metaphoric scenario of a theater or a drama, where the interaction is a sequential act of becoming an actor and the audience. Goffman (1959) argues of a public face for every social role having associated behavior(s). An actor involves in acquiring and maintaining the public front while performing to project an impression felt ideal for the group. Also, individuals are keen in knowing how others assess them as credible and competent (Bolino *et al.*, 2008). The impressions through self presentation in a committee meeting is an expressive way to serve as an assessment of performance. Now, challenged and confined by the working environment of a university, it can be argued that employees as committee members could not manage their impressions required and resultantly deteriorating an idealized performance. In this study, a committee member is the role for which Erving Goffman's dramaturgical metaphor is taken into account to explore the performance of employees during formal contexts of a university.

### ***Objective of the Study***

To explore about how challenging is the performance of committee members through their self-presentation during committee meetings in stressful workplaces of universities in Khyber Pakhtunkhwa.

### **Review of Literature**

Stressful working conditions are the results of a mismatch between the organization's expectations and and the employees' limited chances to exercise control over them place (Katić *et al.*, 2019) endangering the feelings of self of employees (Boyd, 2020; Foy *et al.*, 2019; Faisal *et al.*, 2019). Several studies have shown that workplace stress is prevalent in Pakistani Universities as well and affects the performance of employees in the form of a single or multiple behaviours including lack of motivation, remaining isolated and losing decision making power (Anjum and Ghose, 2019; Warraich *et al.*, 2014; Makhbul and Khairuddin, 2013; Faisal *et al.*, 2019). Workplace presentation and performance in social settings where frequent activities occur are metaphorically examined by Erving Goffman in his dramaturgical analysis (Goffman, 1959). A performance team is defined by Goffman as a collective group of people working together to develop a single routine activity. During workgroup activities and presentations, actions and impressions emerge as gestures addressed to the public, and the entire round is dramatised (Shulman, 2017). Within the context of workplaces, Goffman observed a number of specific sorts of activity that take place, but with constraints that restrict access to only those activities essential in such social settings (Goffman, 1959).

The social interactions are metaphorically associated to a theatrical performance by Goffman, where the term 'performance' is referred to the entire conduct of an individual in front of a specific audience or observers having the potential to affect them in any way (Goffman, 1959). When individuals take on responsibilities to perform roles that are institutionalised and are attempted to be exemplified in a community, they must conform to the norms and behaviours that are appropriate for those roles (Goffman, 1959; Jones and Pittman, 1982). Although, Goffman's dramaturgical analysis limited to some other professions, the performance of university committee members might be viewed as an idealised performance projecting the morality of the entire group. Also, fully embodying the standard for an ideal impression of performance becomes difficult and at own sacrifice of the performer (Goffman, 1959), a committee members in a university may feel compelled to put in their best efforts in the pursuit of ideals and standards that, if ignored, will be difficult to conceal.

### **Research Methodology**

This study is conducted applying a qualitative research approach seeking to explore the perspectives on the phenomenon occurring in the natural settings with an in depth participation (Creswell and Poth, 2016). The philosophical stance ontologically for this exploratory study is relativism, believing multiple realities, whereas, epistemologically, constructionism, believing that the truth arises of the relationship with the realities in our world. Adhering to the Erving Goffman's dramaturgical framework (Goffman, 1959), the perception of reality of performance is explored on a wide range of interpretations of employees of universities as a socially constructed phenomenon unable of an independent identification according to several researchers (Hassard *et al.*, 1999; Liamputtong and Ezzy, 2005). Face to face and telephonic semi structured interviews from twenty sample respondents of three public sector universities in Khyber Pakhtunkhwa, Pakistan were conducted at convenient places keeping in view the pandemic time of 2020-21. Purposive sampling was applied to look for the key informants of having years of committee member experience in universities. The sampling technique had a shift between convenient and snowball sampling due to the accessibility, participation willingness and the prevailing pandemic situation. The systematically noted and audio recording data was transcribed for further analysis through qualitative content analysis method focusing on the words and concepts of the respondents (Miles and Huberman, 1994). The patterns in the data were analyzed for qualitative inferences through inductive coding process to check for the relationship between the concept or words (Elo *et al.*, 2014) in further conceptual analysis for deriving the major themes and categories as the final findings of the study (Stemler, 2015).

## Analysis & Findings

Reactions to the performance or behavior are heavily influenced by the precise activity or role an individual is performing (Goffman, 1959). The research findings of the study revealed few categorizations of the themes. However, this paper presents and discusses only one of those. One of the major findings of the study discusses the impact on the interpersonal relationships of employees being committee members of Pakistani Universities of Khyber Pakhtunkhwa province. The participants addressed and mentioned the need for a member to have a transparent and devoted relationship with his group or community, but with appropriate restrictions and boundaries in place. It is believed that the individual employee as a committee member performing the role should be as open as possible in order to help his own self and the community at a large for the interpersonal and social working relationships. Remaining in the role often requires a lot of performance limitations too. The participants viewed their profession of being a committee member as more of a lifestyle than a normal job conveying a sense that they were always open and accessible to the general public. From the responses, it is found out that performance through self-presentation is a defining characteristic for employee identification and relates to cohesion in a group and decreasing the chances of workgroup conflicts. The individual performance encouraging behavior has a positive role on the interpersonal and social relationships leading to foster the organizational commitment. Also, the consistent interaction between employees in official forums such as committees if are supportive and stable for self-presentation may enhance the employees in imparting an ideal impression required for performing the role of a committee member. Analyzing the responses made to the interview questions, the study also found out that an employee's perception of powerlessness in directing and influencing people around him can also affect the interpersonal, social and working interactions when performing in an idealized role, such as that of a committee member. A lack in presenting self and imparting an impression in a workgroup, the employees are considered of lacking performance needed to be shown for being a member. The sense of control affects the impression management and thus satisfaction to show the ideal performance is always felt as a pressure by an employee. The well-being of interpersonal relationships is regarded as a prominent element for delivering the performance through self-presentation.

## Discussion

The study explores relationship between an employee and his performance in committee meetings of Khyber Pakhtunkhwa universities. The employees who have had served in a committee of a university have been taken as sample to the study and their responses were acquired through semi-structured interviews. Making use of dramaturgical metaphor, perspectives on performance through social interactions in publicized roles such as those of a committee member were learned on the information interpreted from their interviews. An established fact of workplace stress as an inevitable factor in university context remained justified. Using Erving Goffman's (1959) theatrical metaphor, this study explores the performance of employees in committee meetings as an extended dramaturgical analogy of performance. An individual becomes so accustomed to the demands and expectations of playing a character that he becomes detached from both his performance and the audience of his performance (Goffman, 1959). An employee may consciously or unconsciously provide a performance needed for presentation and hide it if it is uncomfortable for personal safety. Committee members are expected to live up to the group's objectives and beliefs, and as a result, expectations and demands are related to his performance in that capacity. There is a possibility that members of committees executing the indicated duty will be sensitive to the manipulations mentioned by Erving Goffman (1959) since they have a greater responsibility to their communities because of the importance of their performance (Methner *et al.*, 2020; Von Hippel *et al.*, 2005). This element of limiting employee truthfulness and openness when interacting with other members of the community or workgroup was taken into consideration in current study. But there is still a space maintained by the employee by suppressing his fights for transparency. Erving Goffman suggested that people's dedication and dissociation from their roles affects their performance. Due to the psychological and emotional stress that employees endure in an organization, it is arguable that their performance during face-to-face contacts be of varied levels, just as their attachment and disengagement to their roles may be of varying intensities.

## Conclusion

The purpose of this study was to explore how university employees portray their performance through identities and impressions to others in a committee setting by using Erving Goffman's dramaturgical sociology as a guide. Performance through impression management at workgroup levels and committees with relation to universities has a significant impact on organizational outcomes. Indirectly, universities may gain from their employees' real and credible self-presentation. Additionally, employees who benefit from a true and credible self-presentation may be more satisfied with their institutions (Zhang *et al.*, 2018; Hagemester and Volmer, 2018). The committee members are often associated to other peer member without their own choice; as a result the working environment can be either effective and operational or demeaning, presenting an infinite number of alternatives for contentious or conflicted relationships. It is therefore possible that employee relationships and behavioral features will influence the decisions made in such workplaces. Further, an institution's image may be impacted if employees are forced to adopt or repress identities as a result of stress. Employees who are adept in impression management typically feel psychologically rewarded because they are perceived as more real and credible in their workplaces.

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# **Impact of Abusive Supervision on Turnover Intention with Moderating Role of Psychological Contract Breach in Medical Sector of Khyber Pakhtunkhwa**

*(Ref No. ICETEMS-21-041)*

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## **Abstract**

Purpose of this study was to examine the Impact of abusive supervision on turnover intention of employees working in medical hospital of KPK, Pakistan. The study also explores the moderating role of Psychological Contract Breach in this particular relationship of “abusive supervision and psychological contract breach. The survey was conducted on employees working in three medical hospitals of Kohat, DiK and Bannu District of KPK, Pakistan. Data was collected from 94 personnel through convenience sampling technique, using adopted questionnaires consisting of measuring each variable on five-point Likert scales. For data analysis statistical tools such as reliability, correlation and Regression were tested. Results indicate abusive supervision has positive and significant relationship with turnover intentions of employees. The moderating role of psychological contract breach between the relationship abusive supervision and turnover intentions of employees was also supported by results. Therefore, organizations should create and promote a mutually trusted environment, and psychological contract breach can be used an important buffer to reduce the negative emotions of the employees for the effective functioning of organizations in this era of globalization.

## **Keywords**

Abusive supervision, psychological contract breach, Turnover intentions of employees

## **Introduction**

Leadership has always been a prime focus of all management research, in general, and numerous positive outcomes and consequences of leadership have been reported by a number of prominent leadership theorists (Bass, 1991; Avolio & Gardner, 2005; Tepper, 2000). In the last two decades, leadership research has also ventured into exploring the negative sides of leadership like, supervisor bullying (Hoel, Rayner, & Cooper, 1999), tyrant behavior of leaders (Ashforth, 1994), and abusive supervision (Tepper, 2007). One such negative attitude of leaders i.e. abusive supervision is the focus of this study which is defined as the feelings of employees that their supervisor is displaying verbal and written aggressive behavior but not including physical contact (Tepper, 2000). Abusive supervision can be in the form of shouting at subordinates, threats of firing from the job, laughing at employees in the front of others, humiliating them and not giving them the necessary information (Keashly, 1997; Tepper, 2007). Employees supervised abusively are emotionally exhausted and they are less likely to continue their psychological contracts with the organizations (Wu & Hu, 2009). Such kinds of supervisor behaviors have serious effects on employees like, reduction in their commitment level, increased feeling of anxiety and stress both in their family as well as at work (Bies & Tripp, 1998; Tepper, 2000). All these negative outcomes are considered as a constant threat to the efficiency and performance of organizations. Thus such studies are the need of this time where the business environment is complex and competitive than ever before.

The relationship of employees and organization starts with the formulation of a psychological contract. Psychological contract refers to the employees feeling that their organization or supervisor will deal with them in a specific way (Rousseau, 1989). But when the organization fails to deliver according to the expectations of the employees, the employees feel breach of that psychological contract (Morrison & Robinson, 1997), and in response they show less commitment and are more prone to make the decision of leaving the organization (Robinson & Morrison, 2000). Regardless of whether the employees' perception about breach of psychological contract is right or wrong, it causes severe

damages to the employee attitudes toward his job and reduce their commitment level (Thoreson, Kaplan, Barsky, Warren, & De Chermant, 2003) and trust (Dunn & Schweitzer, 2005). The psychological contract breach reduces commitment, trust and organizational citizenship behavior of employees (Conway & Briner, 2002, Robinson & Morrison, 1995), and also create disturbance at organization, decrease employee loyalty and triggers the negative emotions of the employees and there are more chances of them severing their relationship with the organization (Turnley & Feldman, 1999).

Turnover intentions refer to the perceptions of employees to quit their present job (Wunder, Dougherty, & Welsh, 1982). Many researchers have concluded that the most dominant resource which can provide the long-term edge to organization over others is its human capital (Becker, Huselid, & Ulrich, 2001; Pfeffer, 1995) and all organization pay more attention to reduce the quitting intentions of the employees in order to retain their skilful employees and also to reduce the extra cost of new hiring as a result of turnover of the existing ones (Holtom, Mitchel, Lee, & Inderrieden, 2005). So, organization should pay more attentions those factors which promote such negative feelings in the employees. Turnover intentions are developed due to many reasons like psychological contract breach (Chin & Hung, 2013), Job dissatisfaction (Tett & Mayer, 1993) and workplace bullying (Simons, 2008).

As discussed by different researchers, psychological contract breach is based on the personal disposition of employees i.e., the personality of employees has a significant role in the formulation and breach of psychological contract (Raja, Johns, & Ntalianis, 2004).

## **Literature Review and Hypothesis Development**

### ***Abusive supervision and turnover intentions of employees***

Rayner and Hoel (1997) define abusive supervision in term of hostile, damaging, scary, pernicious or offending behavior of supervisor, misuse of power, which makes the employees irritated, undermined, embarrassed or defenseless and make them pessimistic and may make them endure stress". It's an issue which has been for a really long time pushed away from plain view. Organizations where abusive supervision is affirmed to happen frequently overlook it or they link it to the performance of naturally competent employees (Hannabuss, 1998).

Supervisory abuse is found to reduce the employee loyalty and trust in organization as well in supervisor which ultimately decrease the commitment level of employees (Hoel & Cooper, 2000). Abusive supervision and social undermining by supervisor weaken the relationship between employees and their supervisor (Duffy et al., 2002; Tepper, 2000). The negative effects of supervisory abuse on organization are, overall efficiency and productivity of organization is reduced, employee absenteeism and misuse of organizational property, decrease employees job satisfaction, and pushed their intentions to leave the organization (O'Moore & Kirkham, 2001).

A sufficient number of studies have demonstrated the negative outcomes of abusive supervision (Tepper, 2000). Poilpot-Rocaboy (2006) conclude the summary of negative effects of abusive supervision or workplace aggression on organization these are "organization have to bears the cost of employees turnover (e.g. cost of recruitment and selection, training and development, cost of losing skilled employees), reduction of organization as well as employee performance, psychological distress of employees, loss of organizational goodwill in the market, etc. and all these findings are consistent to the prior studies (Dacin, 1997; Glendenning, 2000).

The effect of workplace aggression has been very much reported in the literature. From a organizational point of view, Abusive behavior are found to create such a climate which promote employees turnover. Abusive supervision has in this manner been a hot debate construct in the literature of social sciences. Heames and Harvey (2006) concluded that if organizations still stay detached and abusive supervision and workplace bullying is not specifically managed than it can increase revenge behavior of employees, and can put in danger the organizational existence.

Many studies are conducted to see the impact of abusive supervision on different variables. The repetition of abusive supervision at work negatively affect the performance of employees and the employees are likely to terminate their relationship with the organization. So the intention to leave the organization is deeply related to continuance of abusive behavior of supervisors. Abusive supervision

triggers the negative behavior of employees. Zellars, Tepper and Duffy (2002) conclude that abusive supervision decreases the citizenship behavior of employees, decrease level of trust and satisfaction (Tepper, Duffy, Henle, & Lambert, 2006), decrease employees' motivation and performance (Zapta-Phelan, Colquitt, Scott, & Livingston, 2009). Turnley and Feldman (1999) proposed EVLN typology and states that abusive supervision decrease the commitment level and loyalty of employees, increase turnover intentions and deviance behavior at both organization and individual levels. Read and Bullis (2009) conclude that the employees quit the job due to behavior of their supervisors and their decision of staying at job or leaving the job is totally dependent on their supervisor behaviors. On the basis of the prior studies the following hypothesis is generated.

**H1:** There is a positive association between abusive supervision and turnover intention of employees.

#### ***Moderating role of psychological contract breach between abusive and turnover intentions***

Lapalme, Simard and Tremblay (2011) reported that abusive supervision increase the organizational cynicism, the supervisory abuse develop and increase the negative feelings of employees, they want to take revenge and involved in negative practices. Mitchell and Ambrose (2007) conclude that abusively supervised employees are frustrated and depressed which result to feel them retaliation, while the kind behavior of supervisors decrease the organizational cynicism and negative practices at work. As Tepper, Schurer, Henle, Giacalone and Duffy (2008) found that in group employees react intensively to the supervisory aggressive behavior, and in response to abusive supervision they are more likely to engage in negative practices and quit their present job. Employees having emotional attachment with the organization will be more vulnerable to the breach of psychological contract because of their higher expectations. The psychological contracts are formal on the base of some reciprocal obligations, but in the abusively supervised organizations these obligations are not fulfilled on the course of employee end. The employees feel that their interest in side lined and psychological contract is likely to violate or breached (Aggarwal & Bhargava, 2010).

The continuous and breach of psychological contracts is totally dependent on the supervision style of supervisors. The psychological contract is formed due to mutually trusted environment, but when their trust is broken due to abusive supervision the employees feel the violation of psychological contract, in return they exhibit organizational deviance and turnover (Dulac, Coyle-Shapiro, Henderson, & Wayne, 2008). As Robinson, Kraatz and Rousseau (1994) stated that when the supervisors and also organizations as whole does not meet expectations of employees, then they mentally detached themselves from organizations and exhibits organizational deviances or their intention to leave the organization become stronger. So abusive supervision increases the chance of psychological distress, because the abusively supervised employees feel anxiety, stress and are frustrated (Johnson & Oleary, 2003).

Morrison and Robinson (1997) concluded two reasons of psychological contract breach, renegeing; the violation of psychological contract on the part of supervisor, incongruence; breach perceived by employees due to their unmet expectations. Renegeing is due to abuse supervision, when supervisor deliberately violates the employee's rights and terms of psychological contract, which in turns reduce the employee commitment to the organization. (Lester, Turnley, Bloodgood & Bolino, 2002).

Aggressive supervisor doesn't care about employees' rights and their subordinates often feels psychological contract breach. (Tepper et al, 2009). Bies and Tripp (1998) conclude the behavior of supervisor creates the feeling of mistrust in the employees, and the breach of mental contract is likely to happen. Tepper, Duffy, Henle and Lambert (2006) also found that when supervisor ignore the employees in the important decision the employee feels injustice which became the reason of terminating psychological contracts (Skarlicki, Folger & Tesluk, 1999).

In most cases the psychological contract breach is the result of misuse of power by the supervisor (Ashforth, 1997). Psychological contract breach is employee perception which depends upon the action and practice of their supervisor and these perceptions of employees lead to feeling of organizational cynicism and reduce the citizenship behavior of employee. (Chen, Tsui, & Zhong, 2008). Employees experiencing abusive supervision are more engaged in feeling of psychological contract breach than those who are not supervised abusively (Hoobler & Brass, 2006).

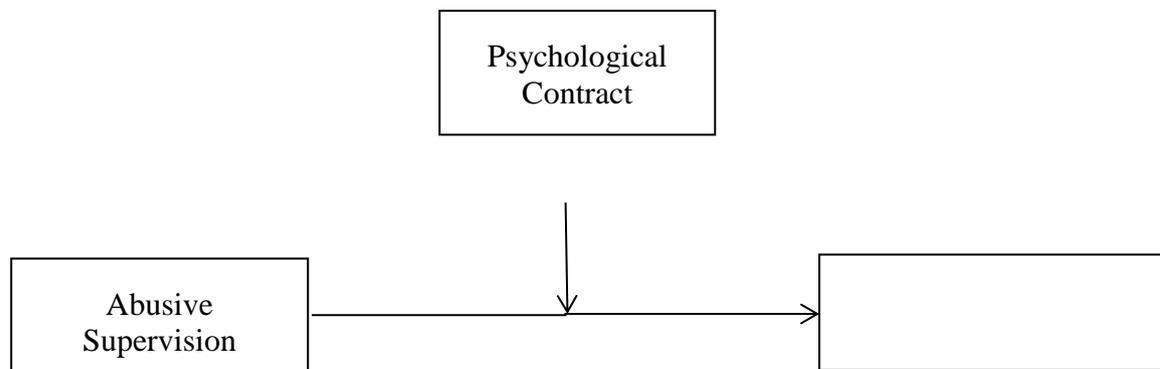
Suazo, Turnley and Mai-Dalton (2005) reported that psychological contract breach leads to turnover intentions of employees. If the necessary and required actions are not taken at that time it results in actual turnover, decrease employee commitment and organizational citizenship behavior of employees. The Broken promises by the supervisor results in the reduction of employee trust and loyalty, increase their deviance behavior, increase unnecessary breaks at workplace and turnover intentions (Turnley& Feldman, 1999). When the employee perceives that their expectations are not met then they withdraw their emotional attachment and organizational commitment (Grimmer &Oddy, 2007). BAL, DeLange, Jansen and Velde (2008) found a significant impact of age on the breach of psychological contract and conclude that breach of psychological contract increases the turnover intention is younger employee more than older employees perceived. Breach of psychological contract reduce job satisfaction, affective commitment and increase chronic stress in employee which leads to turnover (Gakovic&Tetrick, 2003), such perception of employees about violation of psychological contract breach give birth to negative feelings in employee, and they feel them valueless, as a result withdraw their efforts (Kietwitz, Restubog, Zagenczyk, &Hochwarter2009).

According to leader member exchange theory there is a mutual exchange relationship between leaders and followers, when the leader fails to meet the expectations of employee then the employees also withdraw their efforts from the fulfillment of their duties (Graen& Cashman, 1975; Robinson, Kraatz& Rousseau, 1994). So, the psychological contract is based on the obligation of both parties and its violation is not result of single party actions. In this particular relation of social exchange when one part fails to fulfill the requirements of the contract the other part also response in form of retaliation or revenge behavior, which results in actual turnover of employees. There is a positive correlation between psychological contract breach and employee intention to quit their job (Suazo, Turnley& Mai, 2005).

On the base of previous literature, the following hypothesis is generated:

**H2:** Psychological contract breach plays a role of moderator between abusive supervision and turnover intentions of employees.

***Theoretical Research Model***



**Research Methodology**

The present study focusses on abusive supervision and turnover intention in medical sector of KPK, Pakistan, therefore population of the study was supervisors (MS and Doctors) and their subordinates (Nurses and Medical Technicians) working in medical sector. The sample mainly consists of managerial level of different Hospitals including Khyber Teaching Hospital Peshawar, Lady Reading Hospital Peshawar, KDA Hospital Kohat, Khalifa Gulnawaz Teaching Hospital Bannu and so on. Data was collected through distribution of questionnaires. The convenience sampling technique was used due to time limitations. The cover letter attached to questionnaires was explicitly indicating that the study is being conducted for academic research purposes only. Participants will be assured of the confidentiality

of their responses and anonymity so that the respondents feel free to fill in the questionnaire without hesitation.

For data collection, questionnaires for measuring four variables of concern i.e., Abusive supervision, psychological contract breach, and Turnover intentions, in English language were distributed and explained according to their education level for the better understanding among 127 employees. A total of 103 filled responses were received back with a 81% response ratio. The filled questionnaires were screened for correctness and 9 of these questionnaires were found to be incomplete or inappropriately filled, and were not appropriate to be used for the study’s analysis. This screening left the researcher with a valid set of 94 responses i.e., an adjusted response ratio of 74%.

To analyze the data collected through questionnaire, IBM SPSS (Statistical Package for the Social Sciences) was used. The data has been tested for examining the correlation, regression and moderation analysis. To evaluate how independent variable is connected with the dependent variable, correlation analysis is used. While to regression is used to examine that how much change in independent variable caused change in dependent variable. Hierarchical regression analysis is used in case of multiple factors that may result in variations in the causal relation.

## Results

### *Descriptive Statistics*

Descriptive statistics provides summaries about the sample size and the observations that have been made about the data. It tells us the basic details of the data that has been collected such as sample size, minimum value, maximum value, mean value and standard deviation of the data. Descriptive statistics also present large sum of data into arranged and summarized form. The details of data collected under this research investigation are presented in the table as below.

Table 4.1: Descriptive Statistics

<b>Variable</b>	<b>Sample Size</b>	<b>Minimum</b>	<b>Maximum</b>	<b>Mean</b>	<b>Std. Deviation</b>
Gender	94	1	2	-	-
Age	94	1	5	-	-
Education	94	1	4	-	-
Experience	94	1	3	-	-
Abu Supervision	94	2	4.5	3.4	0.67
Employ turnover	94	3.3	3.7	3.5	0.07
Psy Contract	94	8.2	16.6	12.9	2.26

This table gives the descriptive statistics of the variables under study. The table shows the data related to minimum, maximum and average values for each variable and also shows the mean and standard deviation. The first column of the table contains the detail of variables, the second column inform about the sample size of the study, third & fourth column show the minimum and maximum mean values for the data collected. Maximum value for Gender is 2 as the gender has been measured on two factor categories where 1 is for male & 2 denotes female. All three variables of this study were measured in values from 1 to 5. The independent variable i.e., abusive supervision has a mean of 3.40 and a standard deviation of 0.64. The dependent variable (Turnover intentions) shows a mean and standard deviation values of 3.5 and 1.07 respectively. Whereas the moderator of this study, psychological contract breach turned up a mean of 3.21 and a standard deviation of 1.49.

### *Internal Consistency*

The step one is needed to check the scale inner consistency (Henseler et al., 2014). The scale inner consistency can be measured by checking the value of Cronbach’s alpha (Cronbach, 1951). The Cronbach alpha assessment is extensively used to assess the consistency of items of questionnaire (M. L. Mitchell & Jolley, 2012), and It offers an approximation of reliability built on correlation between

indicators (Henseler et al., 2014). According to (Cronbach, 1951), Alpha values greater than 0.60 are satisfactory. The items in the scale are considered with greater consistency if the Cronbach's alpha value is closer to the 1.0 (Gliem & Gliem, 2003).

In Table 1, we can get the outcomes of Cronbach alpha of all the item in questionnaire after the analysis is performed by SPSS software.

Table 1: Instrumentation sources, Items & Reliabilities

Variable	Source	No. of Items	Cronbach Alpha
Abusive supervision (IV)	Tepper (2000)	15	.80
Psychological Contract Breach (Mod)	Robinson and Morrison (2000)	5	.67
Turnover Intentions (DV)	Kelloway, Gottlieb, and Barham (1999)	4	.65

### Correlation analysis

The very purpose of correlation is to indicate the relation between two variables or to examine whether the two variables move in similar or opposite directions. It is different from regression analysis in a way that it does not consider causal linkages for the variables under study. The relation is analysed in view of variables moving in the same or opposite direction while not including the zero correlation. Negative values refer the extent to which increase in either of the variable varies with each other. The correlation analysis used under this study is the widely used coefficient for assessing correlation among relation. Usually, Pearson correlation analysis is used to calculate correlation coefficient is the most common method to measure reliance among two quantities. The values of correlation range from -1.00 to +1.00. Where +1.00 values reveal a positive correlation, while negative values indicate negative correlation among the variables. However, the value range -1.0 to -0.5 or 1.0 to 0.5 is strong/High correlation, the value range -0.5 to -0.3 or 0.3 to 0.5 is moderate correlation and the value range -0.3 to -0.1 or 0.1 to 0.3 is ranked weak/low correlation, but when the value of correlation is 0 this means that there is no correlation among the variables being studied.

Table 4.2: Correlation

Variables	1	2	3
1 Employee Turnover	1		
2 Abu Supervision	0.17	1	
3 Psy Contract	0.32	0.27	1

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

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

Table 4.2 shows the correlation between the variables of this study. All the variables are positively correlated and values are within the limit. Correlation between Abusive supervision and employee turnover intention is 17% while correlation of psychological contract breach with employee turnover intention is 32%. Finally, correlation between psychological contract breach and Abusive supervision is 27%.

### Regression Analysis

A correlation analysis does not provide enough evidence for inferring the relationships between variables. For drawing conclusions regarding the dependence of one variable on another, regression analysis is used. Regression shows the extent to which a variable depends on another, independent variable on which it is being regressed. When two variables are linearly related, the variation in the dependent variable is explained by two factors: the regression line itself and other factors which are not taken into account when regressing the dependent on the independent variable. In other words, the variation in the dependent variable, if termed as ‘total variation’, which is the variation in the dependent variable described by the regression line with the independent variable as well as other factors not explained by the regression line. The statistical coefficient most often used for assessing regression is the coefficient of determination, and shows the variation in the dependent variable explained by its linear relation with the independent variable; depicted as  $R^2$ .

Table 4.4. Regression analysis for direct effect of abusive supervision on employee turnover

Variables	Beta	SE	T.Stat	P
Contant	2.17	3.4	0.634	0.027
Abu Supervision	.458	0.28	1.6	0.046

n=94, Control variables were, Gender, Age, Experience and Qualification, \*  $P < .05$ ; \*\*  $P < .01$

Hypothesis 1 predicts a positive association between abusive supervision and turnover intentions. In table 4.4, regression analysis was used to measure the extent to which a unit change in Abusive supervision (IV) brings about a change in Turnover intentions (DV) a regression coefficient ( $\beta$ ) of .458 was found significant with 5% level of significance. The overall fitness of the model (F) is 21.95 with a significance of .000 which satisfies the conditions of a highly significant relationship between Abusive supervision and Turnover intentions. So, Hypothesis 1 is accepted.

### Moderation Analysis

Preacher & Hayes (2008) moderation method has been used in this study to see the moderating role of psychological contract breach on the relationship between abusive supervision and turnover intentions.

The moderation was performed through model no. 4 of Preacher & Hayes (2008) macros. The results of the mediation analysis for this study are as follows:

Table 4.4. Regression analysis for moderating role of psychological contract on abusive supervision on employee turnover

Variables	Beta	SE	T.Stat	P
Contant	0.534	3.33	0.16	0.087
Abu Supervision	0.798	0.967	0.82	0.041
Psy Contract	0.589	0.201	2.92	0.004
Abu * Psy	0.303	0.163	1.85	0.034

n=94, Control variables were, Gender, Age, Experience and Qualification, \*  $P < .05$ ; \*\*  $P < .01$ . (IV= abusive supervision, Mod= psychological contract breach, DV= turnover intention).

Hypothesis 2<sup>nd</sup> of the study predicts that psychological contract breach moderates the relationship between Abusive supervision and employee turnover intention; such that if Psychological contract breach is high than the relationship between Abusive supervision and employee turnover intention would be stronger. From Table 4.5, it can be observed that interaction term of “Abusive supervision and psychological breach” effect on the relationship of “Abusive supervision and Employee turnover” has the upper and lower limits of -.155 and -1.01 and zero is not present in the 95% confidence interval, thus we can conclude that psychological contract breach moderates’ Abusive supervision and employee turnover intention relationship. The positive sign indicates that moderator change the direction of the relationship such that if psychological contract breach is high than the relationship between Abusive supervision and employee turnover intention would be stronger. Hence it fully supports the acceptance of 3<sup>rd</sup> hypothesis. Overall model is also highly significant where  $F=19.81$  and  $p=.000$ .

Table 4.7: Hypothesis Results Summary

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**H1: There is a significant impact of abusive supervision on employee's turnover intention. (Accepted)**  
**H2: Psychological contract breach plays a moderating role between abusive supervision and employee's turnover intentions. (Accepted)**

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## Limitations

The current study tried to overcome and remove existing flaws in all aspects but still it has some limitations that must be considered and applied in future.

The very first limitation of the current study is that the sample size was small due to short time period. So, big size of population is the key limitation of the present study. Data was collected from the organizations working in Kohat and its adjacent cities of Pakistan. It might not represent the whole culture of Pakistan, whereas employees working in different cities exhibit different behavior due to environment and geographical changes.

The second limitation is that, data was collected from the organization working on developmental projects in Kohat city of Pakistan. So, the results of the present study cannot be generalized for the organization not working on such projects. The structure of organization working on such project is specific for such tasks hence it differs from the structure of other organization. So, these finding cannot be interpreted for employees working in other organization. Thirdly the scale used in the present study were self-reported, in measuring the attitudinal aspects of respondents the self-reported data is mostly recorded biased.

## Conclusion

The aim of present study was to find the relationship between abusive supervision and turnover intentions. It also studied the moderating role of breach of psychological contract in relationship between Abusive supervision and employee turnover. The study was conducted on employees working in medical colleges in Kohat, Bannu, and, Peshawar district of Pakistan with TDPs positive relationship between abusive supervision and turnover intentions. Moreover, it is argued that breach of psychological contract moderates the relationship between abusive supervision and turnover intentions. These findings seem to be consistent with the previous studies.

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# Pharmaceutical Marketing also depends upon Marketing Mix Elements: A Myth or Reality: Quantitative on Prescription Behavior of Physicians

(Ref No. ICETEMS-21-144)

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## Abstract

Recently each and every industry is under severe competition. Especially after the outbreak of COVID-19 the decrease in income and opportunities to consumers are making the competition much stiff. However, that is not the case for the pharmaceutical industry where panic and fear of disease resulting in an increase in purchases. However, the competition requires efforts in the form of sales as well as marketing and therefore use of marketing mix strategies looks compulsory in this regard. However, there is no recent study that highlights the use of marketing mix elements for the pharmaceuticals sector of Pakistan. On the other side, most of the studies under this vein are qualitative and rare focus found towards inferential testing and incorporation of the full range of criterion-related with marketing mix strategies. Therefore, this study will uncover the use of marketing mix strategies on prescribing behavior associated with prescription-only medicines by general physicians practicing in Karachi. The sample size for the study is 150 and analysis has been conducted through using SMART-PLS in order to support the theory-building approach. Results indicated that the use of marketing mix strategies has a significant impact on the prescription behavior of general physicians practicing in Karachi. However, the moderation of gender also has an impact on prescription behavior.

## Keywords

Marketing Mix Strategies, Prescription Behavior. Prescription only medicines & General Physicians

## Introduction

Marketing of pharmaceutical companies is related not only with the economic aspects but also with the social-welfare. Although the literature is keep on growing in association with the marketing practices of pharmaceutical companies and therefore resulting in generation of interesting facts (Campo, Staebel, Gijbsbrechts & Van Waterschoot, 2005).. Physician's prescription behavior is one of the most discussed topics in the vein of pharmaceutical marketing where it has been discussed in order to have solutions which may suit best under different circumstances. On the other side pharmaceutical companies allocated significant budgets to promotional efforts and promotional campaigns which aim towards consumers are getting more complex. Therefore, a major part of the budget is directed towards the physician's hence marketing mix strategies are often used to influence physician's prescription behavior (Ahmed et al., 2016). Thus legitimate to quote Khazzaka (2019) to relate this study with theories related with multiple disciplines like adoption and diffusion theory, advertising theory, agency theory and role theory. The reason to link studies with theories from multiple disciplines is that the study relates the impact of marketing efforts to modify prescription behavior on the adoption of medicine in society. Therefore, the adoption of ideas by physicians will lead to the process of diffusion & resulting in adoption of medicines by the society.

## Statement of Problem

Factors which are potent in shaping the prescription behavior of health care consultants are required to be studied (Shah, Khan, Ayub & Anwar, 2017). On the other side there is a lot to be discovered regarding the mechanism by which marketing mix efforts affect physician's prescription behavior. However, marketing strategies used by pharmaceutical companies are getting even more flexible due to the presence of massive opportunities. Therefore, further investigation is required in order to clarify the relationships (Ahmed et al., 2016) as marketing efforts from pharmaceutical companies are seems to be much critical (Shah et al., 2017).

### ***Theoretical Framework***

Model based on marketing-mix elements (i.e. 4 P's) is applicable to the entire range of industries including the pharmaceutical industry. However, in the pharmaceutical sector these strategies tend to address consumer's needs, wants and demands through the satisfaction of physician (Murshid, Halim & Usman, 2014). Though Murshid Mohaidin and Nee (2016) indicated that prescription habits might be different and further studies might be conducted through considering contextual factors. Therefore this study includes physician's gender as the moderator with promotion to understand the role of promotions in marketing mix strategies. However, there are some studies which indicate that there is no relationship of prescription with the prescription of drug with the gender of patient (Cockburn & Pit, 1997). Though the study of Ahmed (2014) does not use gender as a moderating variable and hence the outcome of the impact was found to be insignificant. Therefore, the variable has been used as a moderator with the promotional strategies of marketing mix.

### **Literature Review**

Physicians are perceived as the primary actor that has the ability to affect the consumer purchase of medicine. Therefore the major aim of marketing strategies from pharmaceutical companies is to affect the physician's prescription behavior. The aim of marketing mix strategies in the pharmaceutical industry is to make physicians differentiate the company's product in comparison to the competitor. Thus marketing mix strategies are not only there to influence the prescription behavior but also to make physicians understand that the drug is worthy enough to be purchased (Murshid et al., 2014).

**Product:** In terms of drugs the product of pharmaceutical companies are defined as any substance that is produced to produce physical or psychological change in the human body. Although the company must emphasize on core dimensions of the product, actual dimensions of the product and augmented dimensions of the product. In fact, in the pharmaceutical sector products are marketed as the combination of efficacy, safety, branding and qualities in order to create value for the physicians and make them inclined towards prescription (Murshid et al., 2014). Study conducted in Srilanka indicated the product occupies the second place among the marketing mix elements. Therefore the element must always be considered by marketers & they must focus on improvement of all the elements associated with this dimension of marketing mix strategy (Sayandhan, Kodithuwakku & Gunaratne, 2008).

**Price:** Price is defined as anything a customer bears to have a desired set of benefits. In fact, customers are willing to pay premium prices for better medicine. However, pricing must be observed closely in connection to the other marketing mix like promotion, as pricing strategies must assure required returns to the company (Murshid et al., 2014). Therefore, physicians are observing strengths and weaknesses of different types of drugs & relative costs in order to select the best medicine for different types of patients (Hailu, Workneh & Kahissay, 2021).

Study conducted in Srilanka indicated that physicians perceive price as the most important factor in the marketing mix elements of a drug as affordability of medicine and relative cost bear by patient are very important. That means physicians have to consider the patient's ability to pay while recommending any medicine (Sayandhan et al., 2008).

**Place:** The availability of the right quantity at the right place at the right time is the major objective behind the place strategy of marketing mix. This strategy actually uses several channels in order to achieve the objective. Strategy has a significant impact on customer's satisfaction (Murshid et al., 2014). Ahmed (2014) does not mention place as the important variable to predict prescription behavior but Shamim-ul-Haq Ahmad Ahmed Khoso and Parmar (2014) indicated availability is the important tool for shaping prescription behavior.

**Promotion:** Promotion of any sort of medicine encompasses both information and persuasive activities which may foster the purchase of medicine. However, most of the time pharmaceutical marketing campaigns are based on gifts (Sayandhan et al., 2008) though in recent times giant companies are using giveaways while smaller are focusing on gifts (Albarq & Suleiman, 2021). In fact, study of Alowi and Kani (2018) indicated that in Sudan pharmaceutical companies are using extensive promotional strategies to raise their market share. In fact, pharmaceutical companies in Sudan are not only using informative material but also the support team to deal with the queries of physicians. However, Murshid

et al., (2016), indicated that physician's use information associated with drugs in order to justify their prescription and the information can be grasped from leaflets, medical journals and the internet etc. Although use of giveaways has more influence on prescription behavior and very few studies e.g. Albarq and Suleiman (2021) highlighted the negative impact of promotion on prescription behavior. Similarly Spurling et al (2010) and Zahrani (2014) are one of the few studies that highlighted no effect of giveaways.

### ***Research Design:***

Study has a purpose to increase knowledge regarding prescription behavior with reference to Pakistan. Therefore follows the indication of Sunders Lewis and Thornhill (2009) to use epistemology as the research philosophy. To proceed towards data collection and conduct study in a comprehensive manner this study uses the indication of Zukauskas Vveinhardt and Andriukaitiene (2018). The use is potent as studies like Murshid et al., (2014); Sayandhan et al. (2008) and Hailu et al., (2021) etc already provided a rich source of information. However, through linking Saunders et al (2009), the research strategy was survey and time horizon was cross-sectional.

### ***Sampling Design***

Study of Murshid et al., (2016b), indicated the physicians are the most suited participants for the study and therefore included all the physicians in the study through obtaining a list from the concerned authorities. However, there is no official list available in Pakistan which may distinguish physicians working in the country and in different cities. In fact, the previous study of Ahmed (2014) was formulated through the opinion of sales personnel and thus to include best suited respondents there is a need to use a different sampling plan. Therefore, this study takes the reference of Ali and Muzaffar (2016) to use quota sampling that includes all the physicians running their own medical center or Dispensary in the urban areas of Karachi. Urban areas are selected due to the indication of Hasan et al (2019) which highlighted that people with higher income may have more knowledge about the use and impact of drugs. However, during the days of pandemic the data collection was much difficult as initially 275 questionnaires were circulated however due to restricted time and circumstances the study takes on a sample of 150.

### ***Questionnaire***

The questionnaire used in this study is a hybrid of Sayandhan et al. (2008) etc. The study uses elements from Sayandhan et al. (2008) for devising elements for marketing mix. The study also takes the reference of Shah et al (2017) and Aikin, Swasy, Braman (2004) to devise indicators associated with prescription behavior and consumer preference of drugs. Moreover, all the elements were linked with the Likert scale as used by Ali and Muzaffar (2016) as the scale is used to gauge the attitude (Johns, 2010) and applicable to a variety of constructs (Jebb, Ng & Tay, 2021).

## Statistical Analysis

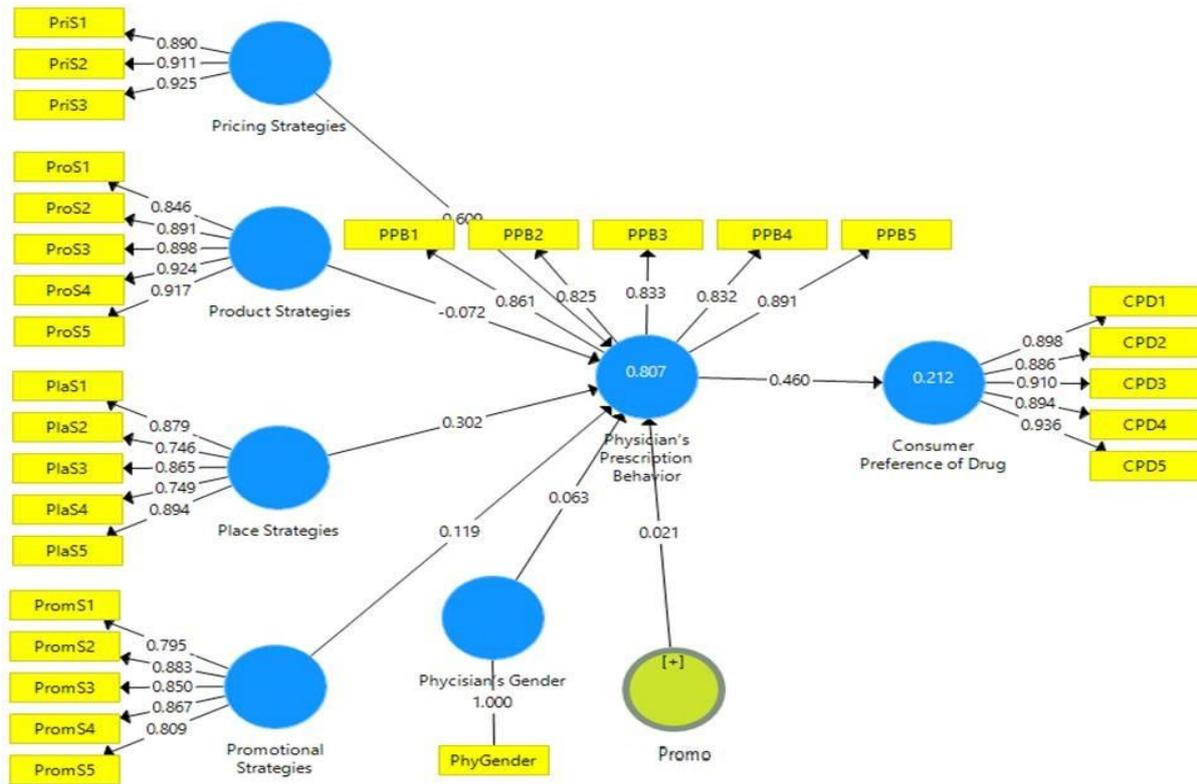


Figure 1: CFA and Outer Loading

Figure 1 is indicating outer loading and according to Afthanorhan (2014) the outer loading of any indicator must be equal to or greater than 0.6 and values became more effective with their progression towards 1 (Khan, Sarstedt, Shiau, Hair, Ringle & Fritze, 2019). Although here the minimum weight is 0.746, hence fulfill the required criteria for outer loadings and hence all the variables and their indicators (elements) are adequate enough to be included in the study.

Table 1 is indicating R-Square that is the prediction of variance caused by independent variables in dependent variables (Hair, Black, Babin & Anderson, 2010). Although the minimum threshold is 0.1 (Falk & Miller, 1992), with 0.26 is considered as weak, 0.5 is moderate and 0.75 or above is considered as substantive relationship (Hair, Ringle & Sarstedt, 2011).

However, in this study the Physician Prescription Behavior has been influenced by 0.807 and Consumer preference of Drug has been influenced by 0.712. Thus, the earlier one is substantive and later one is moderately affected by the selected variables.

Table 1: R2 (Predictive Accuracy/ Quality Criteria)

	R Square	R Square Adjusted
<b>Consumer Preference of Drug</b>	0.712	0.686
<b>Physician's Prescription Behavior</b>	0.807	0.799

Table 2: Construct Reliability and Convergent Validity

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
Consumer Preference of Drug	0.945	0.947	0.958	0.819
Mod-Promo	1.000	1.000	1.000	1.000
Physician's Gender	1.000	1.000	1.000	1.000
Physician's Prescription Behavior	0.903	0.904	0.928	0.720
Place Strategies	0.888	0.917	0.916	0.687
Pricing Strategies	0.895	0.898	0.934	0.826
Product Strategies	0.938	0.938	0.953	0.802
Promotional Strategies	0.901	0.938	0.924	0.708

Table 2 s indicating construct reliability and convergent validity. Construct reliability is indicated through  $\alpha$  and rho, were rho is a better reliability indicator (Ravand & Baghaei, 2016). On the other hand convergent validity is indicated through composite reliability and AVE which are treated as the major tool for assessment (Sijtsma, 2009 a&b). Thus the values of  $\alpha$ , rho, Composite Reliability and VE all assures that the models is reliable enough.

Table 3: Discriminant Validity (Heterotrait-Monotrait Ratio)

Heterotrait-Monotrait Ratio

	Consumer Preference of Drug	MW Promo	Phycisian's Gender	Physician's Prescription Behavior	Place Strat.	Pricing Strat.	Product Strat.
Consumer Preference of Drug							
Mod-Promo	0.072						
Physician's Gender	0.059	0.006					
Physician's Prescription Behavior	0.497	0.029	0.074				
Place Strategies	0.235	0.066	0.084	0.849			
Pricing Strategies	0.357	0.018	0.175	0.760	0.801		
Product Strategies	0.087	0.063	0.097	0.618	0.825	0.604	
Promotional Strategies	0.191	0.082	0.152	0.762	0.812	0.757	0.790

The criterion in table 3 is used to indicate that variables of same construct are different and thus are not over lapping each other (Cheung & Lee, 2010). Hair Jr Sarstedt Ringle and Gudergan (2017) indicated that 0.85 or lesser values are required to assure the criterion. Thus, in the light of values highlighted through table 3 the discriminant validity exists and hence there is no overlapping of data or multi-collinearity and hence appropriate for inferential testing.

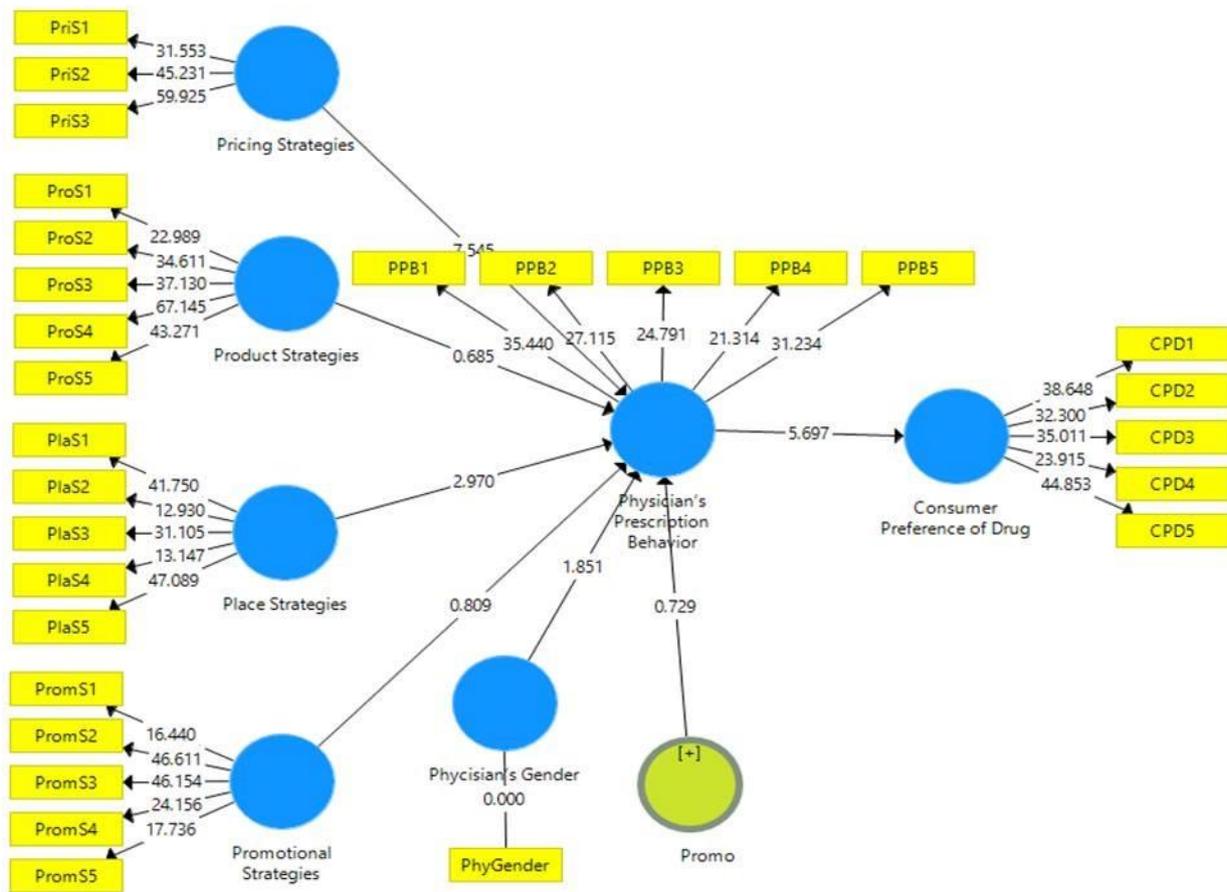


Figure 2: Boot Strapping (Total Effects)

Figure 2 indicating that two variables (Product and Promotions) do not have impact on physician's prescription behavior. Moreover, the gender of physician which has also been used as moderator does not have any impact on prescription behavior. These indications are consistent with Hair Risher Sarstedt and Ringle (2019) inferential statistics is one of the most significant parts for the reflective models in SMART-PLS. Statistics are based on t-values (Duarte & Amaro, 2018) and p-values (Kock & Hadaya, 2018). The detail description and impact might be observed figure 2 which indicated that there is a definite impact of place and pricing strategies on physicians' prescription behavior.

Table 3: Specific Indirect Effect

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics ( O/STDEV )	P Values
Promo -> Physician's Prescription Behavior -> Consumer Preference of Drug	0.010	0.010	0.013	0.728	<b>0.467</b>
Physician's Gender -> Physician's Prescription Behavior -> Consumer Preference of Drug	0.029	0.028	0.017	1.718	<b>0.086</b>
Place Strategies -> Physician's Prescription Behavior -> Consumer Preference of Drug	0.139	0.137	0.052	2.658	<b>0.008</b>

<b>Pricing Strategies -&gt; Physician's Prescription Behavior -&gt; Consumer Preference of Drug</b>	0.280	0.275	0.061	4.586	<b>0.000</b>
<b>Product Strategies -&gt; Physician's Prescription Behavior -&gt; Consumer Preference of Drug</b>	-0.033	-0.037	0.050	0.666	<b>0.506</b>
<b>Promotional Strategies -&gt; Physician's Prescription Behavior -&gt; Consumer Preference of Drug</b>	0.055	0.060	0.070	0.782	<b>0.435</b>

Table 3 indicated that place and pricing strategies are the most effective which are creating effect on consumer preference of drug even with the mediation of physician's prescription behavior. Thus appropriate to indicate in the scenario of Pakistan price and place are the most potent among marketing mix strategies specifically for prescription only drugs.

## Conclusion and Discussion

The study has been consistent Sayandhan *et al.*, (2008) as price yields the highest t-value and thus confirms that price has been considered by physicians before recommending the medicine. Thus also legitimate to relate the study with Hailu et al (2021) that physicians also consider relative strengths and weaknesses of medicine in comparison to the cost bearded by patients'. Moreover study is also consistent with the indications of Shamim-ul-Haq et al (2014), as the findings indicated that place is an important predictor for the prescription behavior. That means physicians also consider availability of the drug in patients nearby locations for prescribing the drug. In fact, these two elements of marketing mix are also found to be affecting consumer's preference of drug through the mediation of physician's prescription behavior. Thus legitimate to indicate the effect of prescription behavior is really significant and has the ability to transform the prescriptions into purchase. However, the study shows some extraordinary consistency as compared to the previous studies as it indicates no relationship of product and promotion with the prescription behavior. Thus appropriate to indicate the study is diverging from Sayandhan et al., (2008) which marked product as the second top ranked element in marketing mix strategies for influencing prescription behavior. Similarly when study highlights no effect of promotion on the prescription behavior then it is diverging from Albarq & Suleiman (2021) and Alowi and Kani (2018).

Hence in terms of promotions as the tool of marketing mix elements for affecting prescription behavior the study is actually consistent with Spurling *et al* (2010) and Zahrani (2014) as there is no effect of promotion on the prescription behavior of the physicians.

## Research Implications and Nee of Future Research

It was difficult to understand that there is no effect of product and promotion on physician's prescription behavior. Although the findings of the study are for prescription only medicine, hence there is no objection on the findings of previous studies as the studies haven't mention the type of medicine and further studies might be conducted through comparing the findings of different type of medicine through using control variables.

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# Outbreak of Covid-19 and Sustainability in Hospitality Industry: A Quantitative Analysis on Use of Crises Management Strategies

(Ref No. ICETEMS-21-146)

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## Abstract

COVID-19 created serious issues for all sorts of industries. However, the tourism and hospitality industries are top-ranked industries in terms of the hit produced by the outbreak of COVID-19. Researchers all over the globe are concentrating on these veins but most of the studies are related to tourism rather than the hospitality industry. On the other sides, there are very few studies that indicate the strategies and their role for the organization in the eve of COVID-19. However, there are some studies that reflected strategies for combating the prevailing situation though not thoroughly relate strategies with the organizational performance. Therefore, this study will uncover the use of crises management strategies with reference to the hospitality industry of Karachi. Thus, study tries to uncover the significance of strategies in attaining sustainability. The sample size for the study is 100 which have been collected from managerial level employees of well-known restaurants of Karachi.

## Keywords

Marketing Mix Strategies, Prescription Behavior. Prescription only medicines & General Physicians

## Introduction

Since the dawn of twenty first century the world experienced several pandemics like Influenza in 2003 Ebola virus in 2004, Western Africa Ebola virus in 2013 & Zika virus in 2015. Although none of these are found be more influential and horrifying than the recent COVID-19. This alarming conditions force several countries to impose lockdown and restrict movement in order to avoid further spread of disease. Hence affected tourism and hospitality industries significantly and resulted significant decline in international as well as local tourism which causes closure of several hotels and restaurants. In fact, world also evidence transformation of hotels and resorts in to quarantine centers due to lack of quarantine facilities (Hoang, Troung & Nguyen, 2021).

Therefore, legitimate to include disaster and crises in the study which is affecting tourism and hospitality industries. Studying the problem is much critical when the crisis has the ability to harm not only the above mentioned industries but also their employees and customers (Ghazi, 2016). Previously crises Management has been investigated from several angles e.g. terror, violence & natural disasters etc. Although reduction of cost is always a potent tool for survival during crises (Breier et al., 2021), the postulate seems to be effective as during crises there are very few chances of investment in strategic opportunities. Therefore the major purpose of crises management strategies is to provide safeguard to organization and also to its reputation (Dwiedienawati *et al.*, 2021).

## Statement of Problem

Crises Management strategies in the eve of COVID-19 are closely associated with the corporate sustainability. However there is severe lacking of literature regarding the use of these strategies. In fact studies which pay concern towards the crises management during COVID-19 were found to be focusing towards banking, airline and universities (Bioral, Brotherton, Rivaud & Guillaumie, 2021). Therefore, legitimate to declare there is almost no study which devises systematic literature review on strategies from hospitality industry in the eve of COVID-19 (Davahli, Karwowski, Sonmez & Apostolopoulos, 2020). On the other side the sector is having massive significance in Pakistan (Kazmi & Shah, 2020) & previous studies e.g. Davahli et al. (2020); Kazmi and Shah (2020) and Shaikh Sultan Mushtaq and

Tunio (2021) etc. have not discussed organizational strategies. Thus need to discuss the role of crises management strategies with reference to the hospitality industry of Pakistan.

### ***Theoretical Framework***

Sultan et al. (2021) indicated that there are very lesser chances of profitability in hospitality industry as COVID-19 is restricting mass gathering & tourism etc. Therefore most of the organizations in hospitality industry are operating only with essential operating services. Hence to sustain in difficult times as mentioned by Dwiedienawati et al., (2021), companies are need to implement crises management strategies (Bioral *et al.*, 2021). Therefore, criterion of Sultan et al. (2021) has been used in order to gauge the predictors of crises management strategies on firms associated with hospitality industry. However the research is specifically based on restaurants therefore suitable to use giving unpaid leaves, down-sizing, down-scoping, breaking of restaurant services and breaking of banquet services.

### ***Significance and Scope***

Study reflects the use of crises management strategies to make manager understand the best mix of strategies which may be selected by organizations in hospitality industry. Therefore, seems to be beneficial for students, academicians, managers, entrepreneurs and researchers as study indicates parameters which must be used for further studies as well as in organizations during pandemic. However, data has been collected from the managers of well-known restaurants of Karachi to reflect crises management strategies with reference to the segment which provide facilities of eating out as well parties (Sharif, Jamil & Nasir, 2018). Hence the strategies discussed in the study are mainly beneficial for the managers dealing with restaurants rather than any other example of hospitality industry.

### **Literature**

COVID-19 posited multi-dimensional issues associated with social, economic & environmental concerns for corporates and therefore corporates are facing severe difficulties in managing there interrelated issues (Bioral, et al., 2021). However, it has also been predicted that the pandemic may cause severe downsizing in hotels, restaurant and airline industry (Jaipuria, Pardia & Ray, 2020). Though research work associated with the hospitality industry during pandemic are still in infancy stage & inductive method was used to determine initial framework and parameters associated with the industry. On the other side several organizations under the industry are planning to implement defensive strategies in order to cope up with the scenario (Shaikh et al., 2021). Though, COVID-19 is much different from previous pandemics and resulted in different scenario for different forms of organization working in different geographical locations and industries. However, most of the research work highlighted about the threats caused by the spread of pandemic. At another end most of research work covering organizational strategies during pandemic is related with human resource management. Although strategies associated with corporate social & environmental responsibility & crises management are also included in area of interest for researchers from all over the globe (Bioral, et al., 2021).

However, among these very few are consistent with organizational level strategies for crises management in hospitality industry (Sultan, Zafar & Jatoi, 2021). Hence there is still lacking of studies associated with the crises management in hospitality industry. Thus need to generate specific model which may relate with the crises management strategies for different types of industries is still required (Lai & Wong, 2020). However, conditions of most of the hotels in Pakistan are not good and they observe severe lacking of customers (Sultan *et al.*, 2021). Thus, Davahli (2020) highlighted that restaurants must reduce their focus from indoor dining and prefer takeaway and delivery options. In fact, some of the studies also indicating that restaurants in Pakistan are forced to remain close due to practices of social distancing and partial lockdowns (Burhan *et al.*, 2021). On the other side strict policy to reduce labor cost has been observed by the organizations from hospitality industry (Lai & Wong, 2020). Reason behind these policies is drastic impact of COVID-19 on tourism sector which causes

significant decline tourism plans and fixtures & hence produces severe hit to the hospitality business (Hoang, Truong & Nguyen, 2021).

### Research Design

This study uses epistemology as the philosophy as the purpose of the research is to investigate the impact of crises management strategies used by restaurants that are functional in Karachi. This this purpose is coincides with the indications of Saunders Lewis and Thornhill (2009) which indicates epistemology is the study of knowledge and deals which transfer of knowledge. The stance used to relate the philosophy with research strategy and data collection is post-positivism as it is preferred for quantitative studies (Zukauskas, Vveinhardt & Andriukaitene, 2018). Although methodological choice and research strategy are mono-method and survey respectively (Saunders et al., 2009), thus research has been done quantitatively and time horizon for this purpose is cross-sectional (Sekaran & Bougie, 2016 & Saunders et al., 2009)

### Sampling Design

Study use Non-Probability sampling as used by Ghazi (2017). This method aids researchers in to collecting data from top management of restaurants operating in Karachi. However initially 150 questionnaire were distributed although due to COVID-19 and difficult working scenario the study has been based on 100 respondents only.

### Questionnaire

Study uses the reference of Israeli (2007); Kapiki (2012) and Sultan et al (2021) to devise closed ended questionnaire on the bases of likert scale which is applicable on attitudes (Johns, 2010) and also on variety of constructs (Jebb, Ng & Tay, 2021)

### Statistical Testing

Figure 2 indicated that the minimum value of any indicator is (0.757) and that is higher that the threshold criteria of 0.708 mentioned by Hair Sarstedt Ringle and Mena (2012). Thus the model is effective and all the indicators are legitimate to be included in the research model.



Figure 1: CFA and Outer Loading

Table 1: R2 (Quality Criteria/ Predictive Accuracy)

	R Square	R Square Adjusted
Break of Ban. Ser.	0.699	0.697
Break of Rest. Ser.	0.546	0.544
Down-scoping	0.598	0.595
Downsizing	0.543	0.530
Survival of Organization	0.364	0.338
Unpaid Leaves	0.727	0.725

Table 1 has the purpose to highlight predictive accuracy (Quality Criteria), this is indicated through the variation caused by dependent variable through any change in independent variable (Benitez, Henseler, Castillo & Schubert, 2020). However, according to Cheah et al (2018), the least value which may indicate the variance is 0.26 which is higher than any of the case mention in table 2. Therefore, legitimate to believe that the variance in independent variables(s) is causing the variance in dependent variable(s) & model is effective enough to be used.

Table 2: Construct Reliability & Convergent Validity

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
<b>Break of Ban. Ser</b>	<b>0.926</b>	<b>0.929</b>	<b>0.944</b>	<b>0.772</b>
<b>Break of Rest. Ser.</b>	<b>0.908</b>	<b>0.949</b>	<b>0.928</b>	<b>0.722</b>
<b>Down-scoping</b>	<b>0.893</b>	<b>0.926</b>	<b>0.918</b>	<b>0.693</b>
<b>Downsizing</b>	<b>0.931</b>	<b>0.932</b>	<b>0.948</b>	<b>0.785</b>
<b>Outbreak of COVID-19</b>	<b>0.893</b>	<b>0.896</b>	<b>0.921</b>	<b>0.702</b>
<b>Survival of Organization</b>	<b>0.931</b>	<b>0.938</b>	<b>0.947</b>	<b>0.782</b>
<b>Unpaid Leaves</b>	<b>0.882</b>	<b>0.891</b>	<b>0.927</b>	<b>0.808</b>

Table 3: Discriminant Validity (Heterotrait –Monotrait Ratio)

	Break of Ban. Ser	Break of Rest. Ser.	Down-scoping	Downsizing	Outbreak of COVID-19	Survival of Organization	Unpaid Leaves
Break of Ban. Ser.							
Break of Rest. Ser.	<b>0.775</b>						
Down-scoping	<b>0.780</b>	<b>0.750</b>					
Downsizing	<b>0.690</b>	<b>0.548</b>	<b>0.833</b>				
Outbreak of COVID-19	<b>0.654</b>	<b>0.767</b>	<b>0.828</b>	<b>0.632</b>			
Survival of Organization	<b>0.357</b>	<b>0.214</b>	<b>0.241</b>	<b>0.115</b>	<b>0.540</b>		
Unpaid Leaves	<b>0.825</b>	<b>0.762</b>	<b>0.796</b>	<b>0.635</b>	<b>0.795</b>	<b>0.380</b>	

Table 2 has objective to reflect convergent validity through composite reliability and AVE and both are indicating sufficient values to make the model reliable. However, values of AVE that are over 0.5 are sufficient enough to indicate convergent validirt (Benitez et al., 2020). Moreover table also has three different tools for assessing reliability that are Cronbach’s alpha ( $\alpha$ ), Dillon-Goldstein rho & Composite Reliability and all have values 0.7 or above (Sijtsma, 2009 a&b) thus assuring the criterion of reliability as well.

Table 3 is used to indicate discrimnat validity through HTMT and this is treated as the most important tool to indicate the discrimnant validity. That means variabels are treated as different (Cheung & Lee, 2010). Hair Jr Sarstedt Ringle and Gudergan (2017) indicated that 0.85. Thus according to the table discriminant validity has been assured.

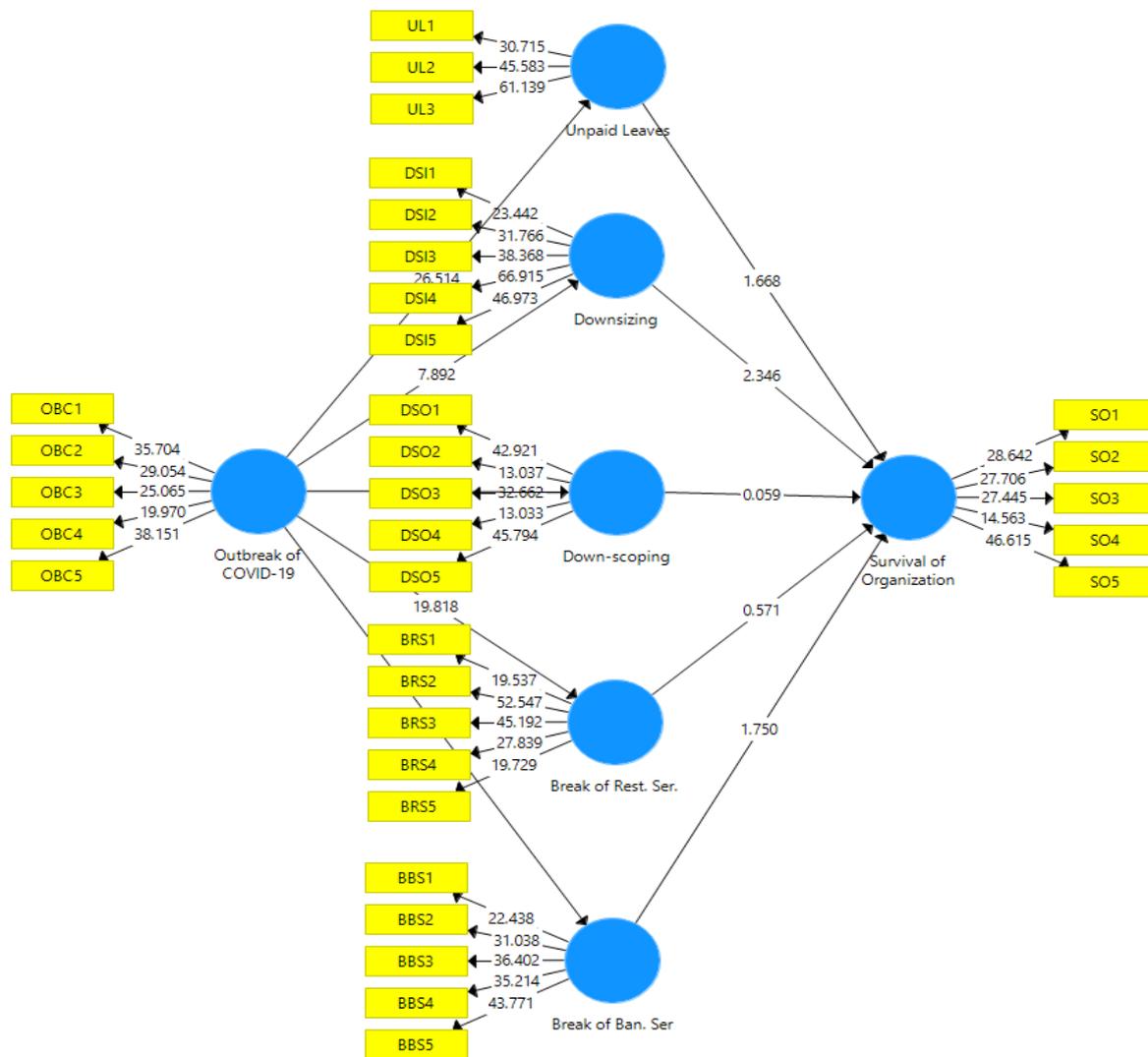


Figure 2: Boot-Strapping (Total Effect through t-values)

Figure 2 is indicating the impact of independent variables over the dependent variables through t-values and that needs to be equal or greater than 1.97 (Duarte & Amaro, 2018), thus down-sizing is the only variable which is found potent to affect the survival of the organizations from hospitality industry.

Although there is one more criteria to reflect the impact i.e. p-value and the maximum value that may reflect the relation is 0.05 (Kock & Hadaya, 2018). These values are also used in the table 4 in order to shoe mediation through (specific indirect effect).

Table 4: Specific Indirect Effect

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics ((O/STDEV))	P Values
<b>Outbreak of COVID-19 -&gt; Break of Ban. Ser -&gt; Survival of Organization</b>	0.220	0.217	0.129	1.710	<b>0.088</b>
<b>Outbreak of COVID-19 -&gt; Break of Rest. Ser. -&gt; Survival of Organization</b>	0.066	0.073	0.117	0.560	<b>0.575</b>
<b>Outbreak of COVID-19 -&gt; Down-scoping -&gt; Survival of Organization</b>	-0.006	-0.004	0.104	0.059	<b>0.953</b>
<b>Outbreak of COVID-19 -&gt; Downsizing -&gt; Survival of Organization</b>	-0.165	-0.164	0.068	2.406	<b>0.017</b>
<b>Outbreak of COVID-19 -&gt; Unpaid Leaves -&gt; Survival of Organization</b>	0.199	0.202	0.123	1.620	<b>0.106</b>

Table 4 is used to reflect that down-sizing is the only potent mediator which affects the survival of the firm from hospitality industry during the days supplemented with COVID-19. This has been highlighted through t-values and p-values.

## Conclusion, Policy Implication and Area for Future Research

This study works on the indications of Davahli (2020) and Kazmi and Shah (2020) to devise research work not only on hospitality industry in the eve of COVID-19 but also with the reference of Pakistan. However, considering Sultan et al (2021) study have not considered any strategy of expansion and uses the dimension of crises management strategies as indicated by Dwiedienawati et al., (2021), though the variables inventory has been aligned with Sultan et al. (2021). Though results of the study are mainly consistent with Lai and Wong (2020), as the major element on which companies are found to be working is reduction of labor cost. However, there is no conflict with Sultan et al (2021), as the study provides only the framework for crises management strategies and the impact was there to be analyzed. Though, after using the model for restaurants only down-sizing is found to be effective for organizational survival. & model can still be used for hotels and well-known fast food chains.

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**MATHEMATICS**  
**&**  
**COMPUTATION**

# Effect of Newtonian Heating on the Mhd Two-Phase Fluctuating Flow Of Casson Dusty Fluid Between Two Parallel Plates

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## Abstract

This paper aims to discover the influence of the Newtonian heating effect on Casson dusty fluid in a two-phase fluctuating flow. The dusty Casson fluid of two-phase fluctuating flow is considered between two non-conducting parallel plates with MHD. The dust particles are considered of spherical shape and uniformly distributed throughout the base fluid. The heat generation/absorption has also been taken into account. The above flow regime is modeled in terms of partial differential equations. The assumed periodic solutions reduce the coupled governing partial differential equations (PDEs) to ordinary differential equations (ODEs). The perturb solutions are obtained for both the velocities (fluid and dust) by applying the Poincare-Lighthill perturbation technique (PLPT). Similarly, solutions for fluid and particle energy equations are obtained. The effect of various embedded parameters on fluid velocity, the dust particle velocity, and temperature profile are discussed and shown graphically. The rate of heat transfer and skin friction is also calculated, which are very important fluid properties for engineers. It is shown in Table 1 that increasing the value of the particle concentration parameter, the rate of heat transfer increases. Furthermore, Table 2 shows that by increasing the Casson parameter, the skin friction increases.

## Keyword

Casson fluid, MHD, Dust particles, Poincare-Lighthill perturbation technique (PLPT), Two-phase flow.

## Introduction

There are two types of fluid, Newtonian and Non-Newtonian. The Non-Newtonian liquids are signified and propagated region of analyzing because of its passionate benefaction in engineering, industrial, medical science as well as mathematics. A many mathematical model are think about owing to nonlinear connection between rate of deformation and stress. Non-Newtonian liquids have numerous examples in our daily uses such as conservation of food, manufacturing of pliable, performances of dissimilar lubricants and manufacture of newspaper. Non-Newtonians are complex in nature due to their complexity. It is a hellacious work to investigate a single model which represent all of its properties. Ahmad et al. [1] studied of Casson nanofluid with MHD shear thickening liquid over a wedge with Newtonian heating. Anwar et al [2] comparative study between second grade model and Jeffery flow model with MHD natural convective flow find out both ordinary and factional cases, and it is determined that Jeffery fluids exhibit motion in both cases. The investigation of existence of electromagnetic hydrodynamic (EMHD) waves by Singh et al. [3]. The investigation of MHD flow in porous medium of non-Newtonian fluid has attracted to attention numerous researches due to many application in the geothermic sources and the optimization of solidification processes of Alloys, Metals and nuclear fuel debris treatment by Hartmann at al. [4]. The chemical reaction and radiation effects on MHD casson fluid flow between two vertical plates in porous medium studied by Kataria, H. R., & Patel, H. R [5]. Furthermore, Arrhenius kinetics on multiphase flow between a pair of rotating circular plates is investigated by Arain et al. [6].

Multi-phase flow is the simultaneous flow of fluids with two or more thermodynamic phases in fluid mechanics. In this circumstance, there are two types of stages. One is Continuous stage and other is dispersed stage. We are addressing two-phase flow in the present proposed model, which is the most basic type of multiphase flow and can take various forms, Liquid-solid, Gas-Solid, Gas-liquid and

liquid-liquid flow. Soo [7] presented the fundamental concepts of multiphase flow for the first time in literature. Multicomponent, multiphase mixed flow includes a wide range of flow conditions and applications. A biochemical species such as nitrogen, oxygen, water, or Freon is known to as a component. The solid, liquid, or vapour state of matter is thought to as an aspect. Example of multiphase flow in single components are Steam-water flow and Freon-Freon vapor and multicomponent Air-water flow and Slurry flow is reported by Crowe *et al.* [8]. Furthermore The study of virtual mass impact in two-phase flow concerned with the so-called virtual mass force during the acceleration of a two-part mixture. The analysis of the primary difficulties in the mathematical modelling of two-step flows is the complexity of the interfacial transfer phenomena is investigated by Drew *et al* [9]. The peristaltic transport of an MHD dusty three-dimensional bio rheological Casson fluid in a channel reported by Zeeshan *et al.* [10]. Keeping in mind the above literature, the mathematical study of three basic multiphase flows across various channels Jeffrey fluid is used as the base liquid, which is embedded with tiny spherical Hafnium particle (Hf) is studied by Firdous *et al.* [11]. Recently, the experimental and numerical studied of two-phase flow pumping is presented by Rosettani *et al.* [12]. Using the PLPT show the effect of wall shear stress on two phase fluctuating flow of dusty fluids investigated by Khan *et al.* [13].

Dusty fluid is defined as the dispersion of solid particles in a fluid. Based on the fluid essence, dusty fluids may include freely distributed particles or formed dust particles. Dusty fluids have a wide range of applications in engineering sciences and industries. The dusty fluid may also be seen in processes like as nuclear reactor cooling, atmospheric fallout, powder technology, dust collecting, acoustics, paint spray, rain erosion, sediment, solid fuel rock nozzle performance, and guided missiles. The theoretical investigation of natural convection oscillating MHD flow of viscoelastic fluid with suspended conducting particles with heat production in a horizontal tube controlled by a fluctuating pressure gradient, as well as a separate heat equation for the conducting dust particles by Ali *et al.* [14]. The turbulent energy is important in research and industry. The analysis of the turbulent flow of fiber suspensions exhibits random motion due to fluctuating components of fluid velocity and average motion due to average fluid velocity. Fiber suspensions of turbulent flow in the presence of solid (dust) particles is reported by Ahmed *et al.* [15]. The investigation of the Simultaneous flow of Casson fluid and dust particles across a parallel stretching / shrinking sheet is presented by Kasim *et al.* [16]. Moreover, the study of quadratic convective transportation of dusty Casson and Carreau fluids through a stretching sheet with nonlinear thermal radiation, convective condition, and non-uniform heat source/sink by Mahanthesh *et al.* [17].

Casson fluid models are non-Newtonian fluids with yield stress. When the yield stress applied to the Casson fluid is greater than the shear stress, it behaves like a solid; when the yield stress is less than the shear stress, it behaves like a fluid. Casson fluids include tomato sauce, jelly, soup, honey, concentrated fruit liquids, and blood. Many materials, including collagen, aqueous-based plasma globulin, fibrinogen, and human red blood cells, can combine to create a chain-like structure known as aggregates. Mukhopadhyay *et al* [18] investigates the unsteady two-dimensional flow of a non-Newtonian fluid over a stretching surface with a specified surface temperature. In the presence of thermal radiation, Casson fluid flow and heat transfer across an exponentially porous stretching surface is studied by Pramanik *et al.* [19]. Keeping in view, the fractional model for Casson fluids Tassaddiq *et al.* [20] are investigated a fractional model with Mittag–Leffler memory for MHD flow of a generalised Casson fluid with Newtonian heating. The modern fractional operator is used to investigate the Newtonian heating effects in generalized Casson fluid flow.

Many scientists have focused attention on Newtonian heating instead of constant surface temperature because constant temperature assumption at the surface fails to work in many physical problems. Newtonian heating is the procedure in which internal resistance is negligible in comparison to surface resistance. Newtonian heating (NH) has several uses, including heat exchangers, conjugate heat transfer around fins, the petroleum industry, and solar radiation etc [21]. Merkin [22] was the first to examine four categories of temperature distributions near walls, Newtonian heating being one of them. Hady *et al.* [23] investigated The flow of an unsteady free convection of a non-Newtonian Casson fluid model loaded with dusty particles over a vertical wavy plate is numerically treated. The analysis of MHD Casson nanofluid flow with dust particles across a deformable cylinder has been researched thus far is

scrutinized by Ramzan et al [24]. Recently, the radiation effects on MHD oscillatory convective flow of a heat exchange viscoelastic dusty fluid enclosed in a parallel channel is reported by Shanthi [25].

The literature mentioned above, the researchers examined Newtonian, incompressible, electrically conducting dusty fluids flowing with free convection MHD flow. To our knowledge, no work has been published in literature that connects the fluid's energy equation with the dust particle's energy equation for viscoelastic Casson dusty fluid by solving Light-Hill technique. It's difficult to investigate the analytical solutions while integrating the individual energy equation for the dust particle. As a consequence, the present work, we used a separate heat equation for the conducting dust particles to explore the impact of Newtonian heating on two-phase fluctuation flow of Casson dusty fluid between two parallel plates with MHD of viscoelastic fluid with suspended conducting particles. Furthermore, this work investigated the effect of various physical parameters and heat absorption on the dusty flow of viscoelastic Casson fluid. In the present work, we have determined to analysis the different behavior of velocity of the problem both theoretically and graphically.

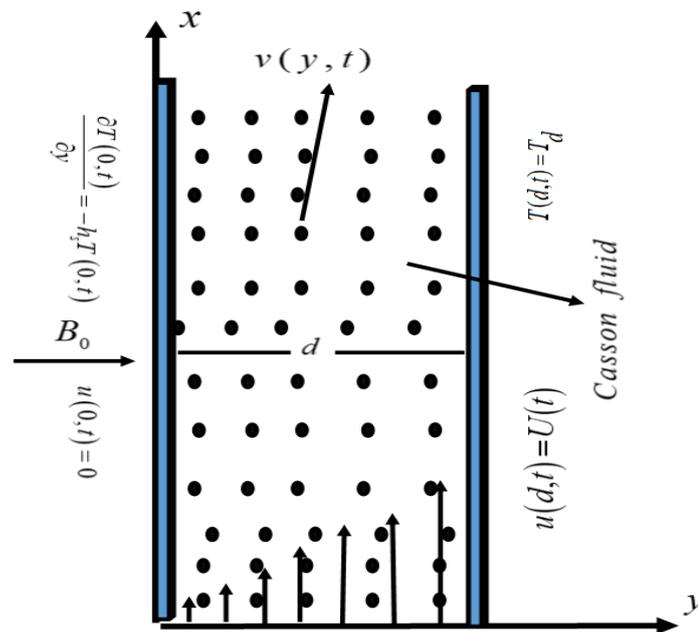


Fig.1. The Geometry of the Problem.

### Mathematical Formulation

In this study, incompressible, the fully developed free stream fluctuating, unidirectional unsteady flow of electrically conducting viscoelastic Casson dusty fluid in a vertical channel is investigated. The transverse magnetic field applied to the flow of viscoelastic Casson dusty fluid. The induced magnetic field and the electric field due to charge polarisation are omitted because of the small magnetic Reynolds number i.e  $Re_m \ll 1$ . . Flow generation is caused by the application of buoyancy, the motion of the

right plate with free stream velocity,  $U(t) = u_0 \left( 1 + \frac{\varepsilon}{2} (e^{i\omega t} + e^{-i\omega t}) \right)$  which is independent of space

variable and heat transfer. One-dimensional flow has been investigated along the  $x$ -axis between two parallel plates. The right plate oscillating with free stream velocity  $U(t)$  while the left plate has zero velocity.  $u(y,t)$  and  $v(y,t)$  show the velocity of Casson fluid and velocity of dust particle. The left

plate having taken the Newtonian heating condition (NHC) while  $T_d$  is the temperature of the right plate, and  $T_p$  represents the particles temperature as shown in Fig. 1The effect of the equations of energy radiation and particle energy are also being described. The equation of fluid momentum and mass of a particle, as well as the energy of fluid and particle, can be found by using the assumptions of Bossiness resemblance in order to avoid similarities.

The velocity and temperature fields are shown below:

$$\vec{V} = \{u(y, t), 0, 0\}, \quad (1)$$

$$T = \{T(y, t), 0, 0\}, \quad (2)$$

The constitutive equations for the Casson fluid are;

$$\nabla \cdot \vec{V} = 0, \quad (3)$$

$$\frac{\partial u}{\partial t} = \left(1 + \frac{1}{\beta}\right) \nu \frac{\partial^2 u}{\partial y^2} + \frac{K_0 N_0}{\rho} (v - u) - \frac{\sigma B_0^2 u}{\rho} + g \beta_T (T - T_d), \quad (4)$$

$$m \frac{\partial v}{\partial t} = K_0 (u - v), \quad (5)$$

$$\frac{\partial T}{\partial t} = \frac{k}{\rho c_p} \frac{\partial^2 T}{\partial y^2} - \frac{\rho_p c_s}{\rho c_p \gamma_T} (T_p - T) - \frac{Q_0}{\rho c_p} (T - T_d), \quad (6)$$

$$\frac{\partial T_p}{\partial t} = \frac{1}{\gamma_T} (T - T_d). \quad (7)$$

The physical conditions are;

$$\left. \begin{aligned} u(y, t) \Big|_{y=0} &= 0, \quad u(d, t) = U(t) \\ \frac{\partial T(y, t)}{\partial y} \Big|_{y=0} &= -h_s T(0, t) \\ T(d, t) &= T_d \end{aligned} \right\}, \quad (8)$$

Where  $U(t) = u_0 \left(1 + \frac{\mathcal{E}}{2} (e^{i\omega t} + e^{-i\omega t})\right)$ .

The answer of the dust particles velocity we suppose the velocity as [14]:

$$v(y, t) = v_0(y) e^{i\omega t}, \quad (9)$$

Using (9) in equation (5), we have

$$v(y, t) = \left(\frac{K_0}{mi\omega + K_0}\right) u(y, t), \quad (10)$$

Put equation (10) in equation (4). So equation (4) becomes,

$$\frac{\partial u}{\partial t} = \left(1 + \frac{1}{\beta}\right) \nu \frac{\partial^2 u}{\partial y^2} + \frac{K_0 N_0}{\rho} \left\{ \left(\frac{K_0}{mi\omega + K_0}\right) - 1 \right\} u - \frac{\sigma B_0^2 u}{\rho} + g \beta_T (T - T_d), \quad (11)$$

Using dimensionless variables.

$$u^* = \frac{u}{u_0}, y^* = y h_s, t^* = \nu h_s^2 t, \theta^* = \frac{T - T_d}{T_d}, \theta_p^* = \frac{T_p - T_d}{T_d}, \left. \right\}. \quad (12)$$

For simplicity (\*) sign has been ignored. So equation (6), (7) and equation (11) becomes,

$$\frac{\partial u}{\partial t} = c_1 \frac{\partial^2 u}{\partial y^2} - (M + K_1 - K_2)u + Gr\theta, \quad (13)$$

$$\frac{\partial \theta}{\partial t} = \frac{1}{Pe} \frac{\partial^2 \theta}{\partial y^2} + \frac{R}{Pe} (\theta_p - \theta) - \phi\theta, \quad (14)$$

$$\frac{\partial \theta_p}{\partial t} = \gamma (\theta - \theta_p). \quad (15)$$

with dimensionless physical conditions are:

$$\left. \begin{aligned} u(y,t)|_{y=0} &= 0, & u(y,t)|_{y=1} &= U(t) \\ \frac{\partial \theta(y,t)}{\partial y} \Big|_{y=0} &= -(1 + \theta(0,t)) \\ \theta(1,t)|_{y=1} &= 0 \end{aligned} \right\}, \quad (16)$$

$$\therefore U(t) = 1 + \frac{\varepsilon}{2} (e^{i\omega t} + e^{-i\omega t}) \quad \text{Where,}$$

$$M = \frac{\sigma B_0^2}{\rho \nu h_s^2}, \quad Gr = \frac{g \beta_T T_\infty}{u_0 \nu h_s^2}, \quad K_2 = \frac{K_0^2 N_0}{\rho \nu h_s^2 (m i \omega + K_0)}, \quad K_1 = \frac{K_0 N_0}{\rho \nu h_s^2}, \quad Pe = \frac{\nu \rho c_p}{k},$$

$$c_1 = 1 + \frac{1}{\beta}, \quad \gamma = \frac{1}{\nu h_s^2 \gamma_T}, \quad R = \frac{\rho_p c_s}{k h_s^2 \gamma_T}, \quad \phi = \frac{Q_0}{\nu h_s^2 \rho c_p}.$$

Where,

$h_s$  is a heat transfer coefficient,  $M$  is a magnetic parameter,  $Gr$  is Grashof number,  $K_2$  and  $K_1$  dusty fluid parameter,  $Pe$  Peclet number,  $\beta$  is Casson parameter,  $\gamma$  is a non-dimensional temperature relaxation time parameter,  $R$  is a Particle concentration parameter,  $\phi$  is a Heat absorption coefficient.

The solution of equation (15), we suppose [14];

$$\theta_p(y,t) = \theta_p(y) e^{i\omega t} \quad (17)$$

$$\theta_p(y,t) = \left( \frac{\gamma}{i\omega + \gamma} \right) \theta(y,t), \quad (18)$$

Put equation (18) in equation (14) get Eq. (19);

$$\frac{\partial \theta}{\partial t} = \frac{1}{Pe} \frac{\partial^2 \theta}{\partial y^2} + \frac{R}{Pe} \left( \left( \frac{\gamma}{i\omega + \gamma} \right) - 1 \right) \theta - \phi\theta, \quad (19)$$

The answer of equation (19) we suppose [14]:

$$\theta(y,t) = \theta_0(y) + \theta_1(y) e^{i\omega t}, \quad (20)$$

From equation (19), we get;

$$\theta(y,t) = \frac{\sinh(\sqrt{m_0} - y\sqrt{m_0})}{\sqrt{m_0} \cosh(\sqrt{m_0}) - \sinh(\sqrt{m_0})}, \quad (21)$$

By integrating equation (21) in equation (13), we get;

$$\frac{\partial u}{\partial t} = c_1 \frac{\partial^2 u}{\partial y^2} - (M + K_1 - K_2)u + Gr \left\{ \frac{\sinh(\sqrt{m_0} - y\sqrt{m_0})}{\sqrt{m_0} \cosh(\sqrt{m_0}) - \sinh(\sqrt{m_0})} \right\}, \quad (22)$$

### Solution of the Momentum Equation

The solution of equation (22) the Light Hill Technique [14] is used.

$$u(y,t) = F_0(y) + \frac{\varepsilon}{2} (F_1(y)e^{i\omega t} + F_2(y)e^{-i\omega t}) \quad (23)$$

$$\left. \begin{aligned} F_0(0) = 0, \quad F_1(0) = 0, \quad F_2(0) = 0 \\ F_0(0) = 1, \quad F_1(0) = 1, \quad F_2(0) = 1 \end{aligned} \right\} \quad (24)$$

By integrating equation (24) in equation (23), we have the following values  $F_0(y)$ ,  $F_1(y)$ , and  $F_2(y)$ .

$$F_0(y) = -H \cosh(y\sqrt{B}) + \left( \frac{1 + H \cosh(\sqrt{B})}{\sinh(\sqrt{B})} \right) \sinh(y\sqrt{B}) + B \cdot Gr \left\{ \frac{\sinh(\sqrt{m_0} - y\sqrt{m_0})}{\sqrt{m_0} \cosh(\sqrt{m_0}) - \sinh(\sqrt{m_0})} \right\},$$

$$F_1(y) = \frac{\sinh(y\sqrt{m_2})}{\sinh(\sqrt{m_2})} \quad \text{and} \quad F_2(y) = \frac{\sinh(y\sqrt{m_3})}{\sinh(\sqrt{m_3})}$$

$$\text{Where } H = \frac{B \cdot Gr \cdot \sinh(\sqrt{m_0})}{\sqrt{m_0} \cosh(\sqrt{m_0}) - \sinh(\sqrt{m_0})}, \quad A = M + K_1 - K_2, \quad B = \frac{A}{c_1},$$

$$m_0 = \frac{Ri\omega + Pe\phi(i\omega + \gamma)}{i\omega + \gamma}, \quad m_2 = \frac{A + i\omega}{c_1}, \quad m_3 = \frac{A - i\omega}{c_1}.$$

In last we putting the values of  $F_0(y)$ ,  $F_1(y)$ , and  $F_2(y)$  in equation (23), we have the form of;

$$\left. \begin{aligned} u(y,t) = -H \cosh(y\sqrt{B}) + \left( \frac{1 + H \cosh(\sqrt{B})}{\sinh(\sqrt{B})} \right) \sinh(y\sqrt{B}) + B \cdot Gr \left\{ \frac{\sinh(\sqrt{m_0} - y\sqrt{m_0})}{\sqrt{m_0} \cosh(\sqrt{m_0}) - \sinh(\sqrt{m_0})} \right\} \\ + \frac{\varepsilon}{2} \left( \frac{\sinh(y\sqrt{m_2})}{\sinh(\sqrt{m_2})} \right) e^{i\omega t} + \frac{\varepsilon}{2} \left( \frac{\sinh(y\sqrt{m_3})}{\sinh(\sqrt{m_3})} \right) e^{-i\omega t} \end{aligned} \right\}, \quad (25)$$

Equation (25) satisfies the given physical conditions represents the validity of our computations.

### Skin Friction And Nusselt Number

The shear stress of the upper plate as:

$$\tau = \mu \left( 1 + \frac{1}{\beta} \right) \frac{\partial u}{\partial y}. \quad (26)$$

By using a dimensionless variable and ignore the (\*) sign we get :

$$Cf = c_1 \frac{\partial u}{\partial y} \Big|_{y=0} = c_1 \left\{ \begin{aligned} & \left( \sqrt{B} \right) \left( \frac{1 + H \cosh(\sqrt{B})}{\sinh(\sqrt{B})} \right) - B.Gr \left( \frac{\sqrt{m_0} \cosh(\sqrt{m_0})}{\sqrt{m_0} \cosh(\sqrt{m_0}) - \sinh(\sqrt{m_0})} \right) \\ & + \frac{\varepsilon}{2} \left( \frac{\sqrt{m_2}}{\sinh(\sqrt{m_2})} \right) e^{i\omega t} + \frac{\varepsilon}{2} \left( \frac{\sqrt{m_3}}{\sinh(\sqrt{m_3})} \right) e^{i\omega t} \end{aligned} \right\} \quad (27)$$

Across the plates, the rate of heat transfer as given below,

$$Nu = \frac{\partial \theta}{\partial y} \Big|_{y=0} = \left( \frac{\sqrt{m_0} \cdot \cosh(\sqrt{m_0})}{\sqrt{m_0} \cosh(\sqrt{m_0}) - \sinh(\sqrt{m_0})} \right). \quad (28)$$

Equation (27) shows skin friction and equation (28) shows Nusselt number of the dusty fluid.

## Results and Discussion

This present study discusses the impact of various physical parameters on the velocity profile of a Casson fluid, the velocity profile of dust particles, skin friction, and the rate of heat transfer. Figures 2, 4, 6, 8, 10, 12, 14 and 16 show the effect of various physical parameters on fluid velocity, while Figures 3, 5, 7, 9, 11, 13, 15 and 17 show the parametric influence of the dust particle velocity profile, while Figures 18, 19, 20 and 21 show the variation of temperature profile, while Nusselt number and skin friction show that in table 1 and 2. About the relation of  $Gr$  with velocity, it has observed that increase in  $Gr$  bringing a decrease in viscosity, this decrease in viscosity occurs due to the increase of bouncy forces and as a result velocity of the Casson fluid and dust particle are increases, so increase in  $Gr$  brings an increase in both velocity, labelled in Fig. 2 and 3. Figures 4 and 5 depicts variation in velocity profiles due to variation in  $\beta$  and the rest of parameters are kept constant. Increase in  $\beta$  enhances viscous forces as compared to thermal forces that tend to decrease Casson fluid and dust particle velocities. As  $Pe$  represent the ratio of viscous to thermal forces, due to the dominant nature of viscous forces, the increment to  $Pe$  increase viscous forces which de-accelerates the boundary layer velocity of the Casson fluid and dust particles show in Fig 6 and 7. In figures 8 show that the coefficient of heat absorption  $\phi$  have the same behavior with boundary layer velocity like  $Gr$ , increasing the numerical values of  $\phi$  the fluid absorb more heat which decreases the viscous forces as a result increase occurs in Casson fluid velocity. The increasing values of the mass of dust particles retardation occur in the velocity of the dust particles as well as the temperature. The value of heat absorption parameter  $\phi$  increase the particle velocity and temperature decreases shown from Figure 9 and 19. The value of temperature relaxation time parameter  $\gamma$  increases both velocity profiles of fluid and dust particle enhanced. The temperature relaxation time parameter  $\gamma$  is the inversely proportion of dynamic viscosity, if the value of  $\gamma$  is increases the dynamic viscosity is retards then the Cassan fluid, dust particle velocity and temperature profiles enhanced show in Fig 10, 11 and 18. The value of magnetic parameter  $M$  is increases Casson and dusty fluid velocity profiles are decrease. The electric and magnetic fields are collectively called Lorentz forces. The electrical conductivity increases, when the magnetic induction decreases so the viscosity becomes decrease. When the magnetic field increases, so observed the fluid velocity and dust particle velocity decreases as highlighted in Fig 12 and 13. The concentration of the dust particle  $R$  is inversely related to the velocity of the fluid because increasing the concentration of the dust particles generates extra collisions in the dusty-phase, which increases the internal resistive forces, and therefore increasing values of  $R$  reduce the Casson fluid's boundary layer velocity plotted in figure 14. Figure 15 and 20 explains the physical behaviour of the velocity of the

dust particle and temperature with increasing values  $R$ . When  $R$  increases it leads the internal motion of the dust particles to extra collisions, which causes retardation in the velocity of the dust particles and temperature. This article investigated the relationship between the density of dust particles. The shape of the dust particle has been considered to be spherical, so by Stocks drag formula ( $k = 6\pi r\mu$ ), as clear from this relation by increasing the dusty parameter  $K$ , the viscous forces of viscoelastic dusty fluid decreases as a result velocity increases, so by increasing the number of dust particles velocities of fluid and dusty fluid increases clearly from Figures 16 and 17. By analyzing it has been observed that the beginning the  $Pe$  increases the temperature is reduced but finally the temperature converges to 1 as highlighted in Fig.21.

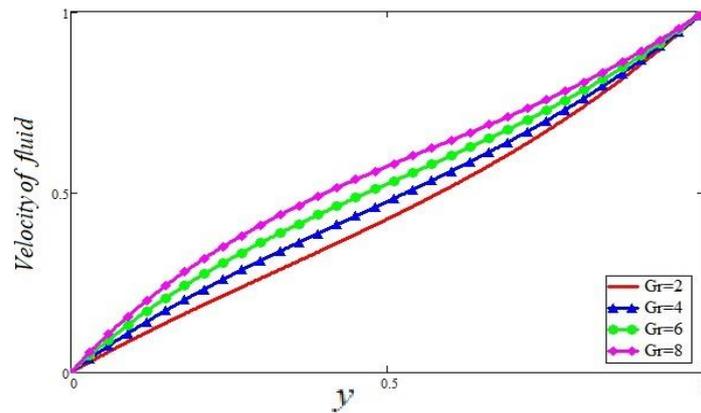


Fig. 2 Variations in velocity profile against  $y$  if different value  $Gr$ .

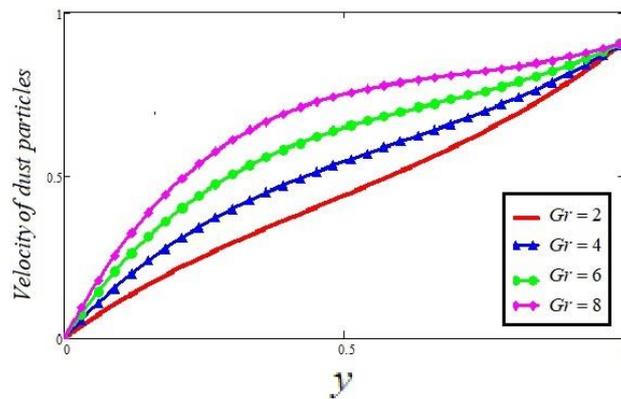


Fig. 3 Variations in dust particle velocity profile against  $y$  if different value  $Gr$ .

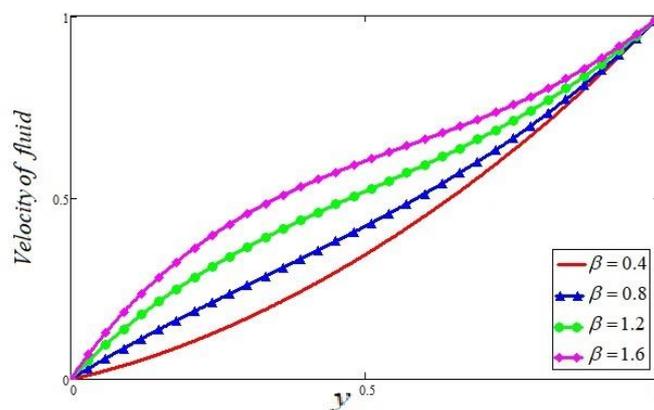


Fig. 4 Variations in velocity profile against  $y$  if different value  $\beta$  .

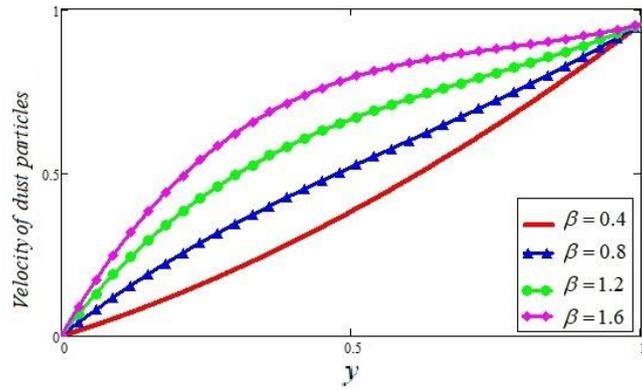


Fig. 5 Variations in dust particle velocity profile against  $y$  if different value  $\beta$  .

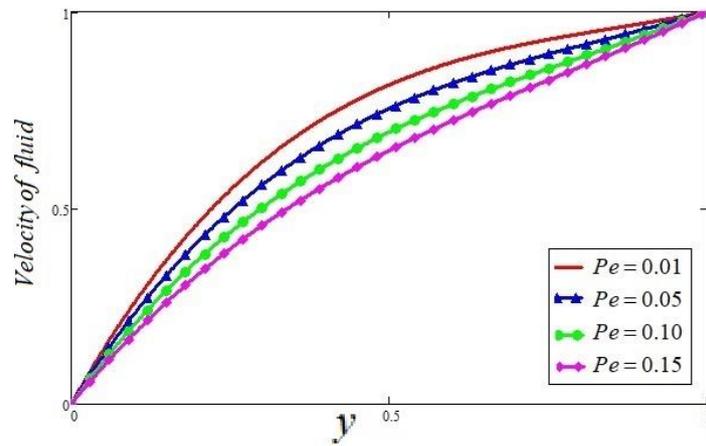


Fig. 6 Variations in velocity profile against  $y$  if different value  $Pe$  .

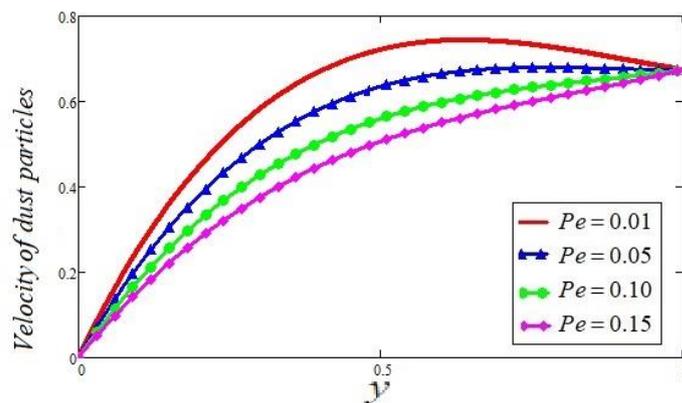


Fig. 7 Variations in dust particle velocity profile against  $y$  if different value  $Pe$

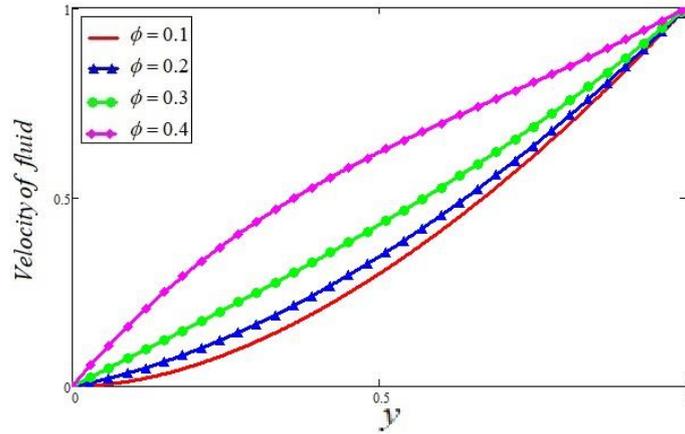


Fig. 8 Variations in velocity profile against  $y$  if different value  $\phi$ .

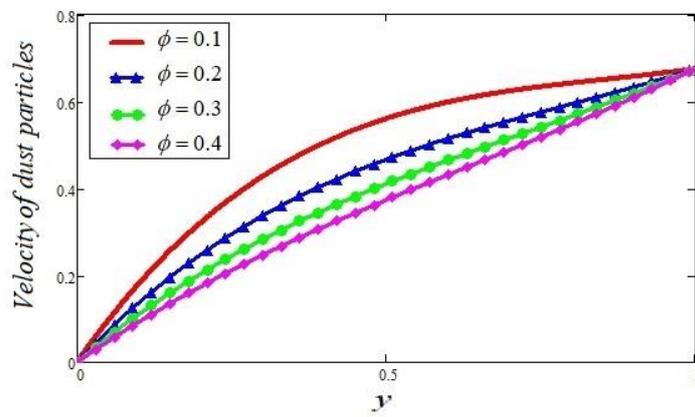


Fig. 9 Variations in dust particle velocity profile against  $y$  if different value  $\phi$ .

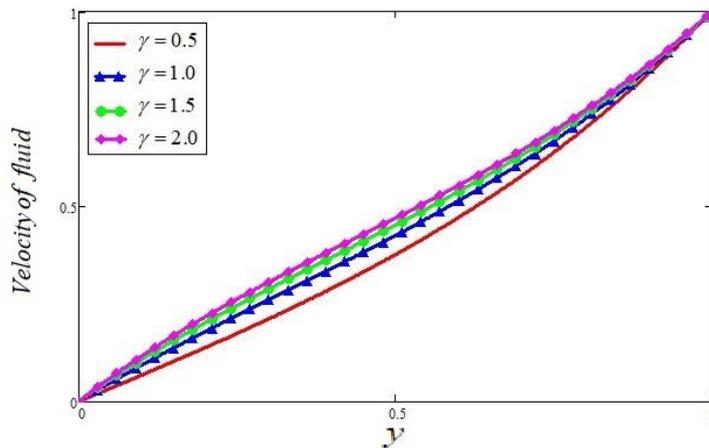


Fig. 10 Variations in velocity profile against  $y$  if different value  $\gamma$ .

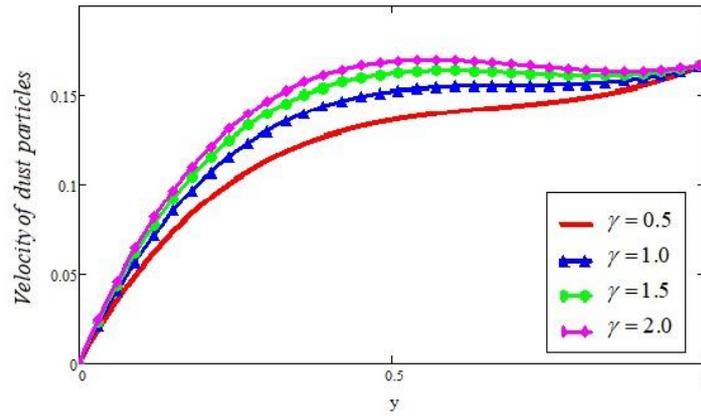


Fig. 11 Variations in dust particle velocity profile against  $y$  if different value  $\gamma$ .

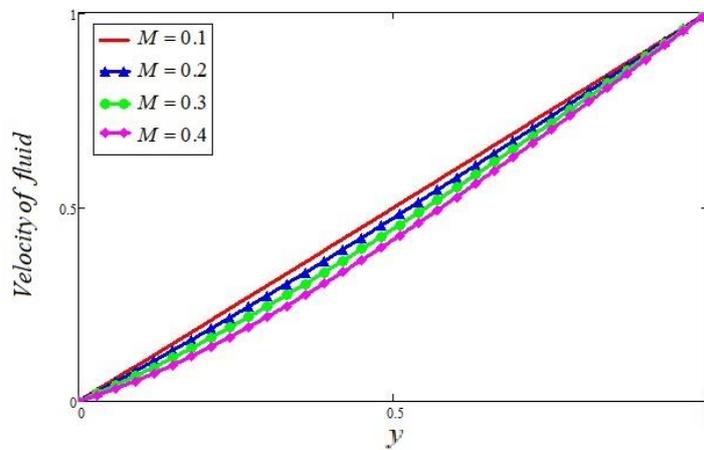


Fig. 12 Variations in velocity profile against  $y$  if different value  $M$ .

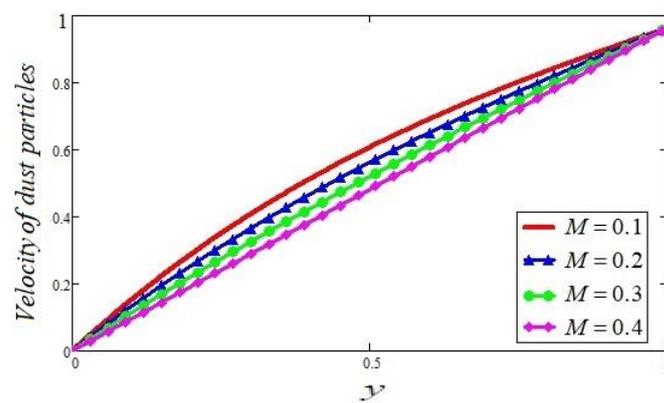


Fig. 13 Variations in dust particle velocity profile against  $y$  if different value  $M$ .

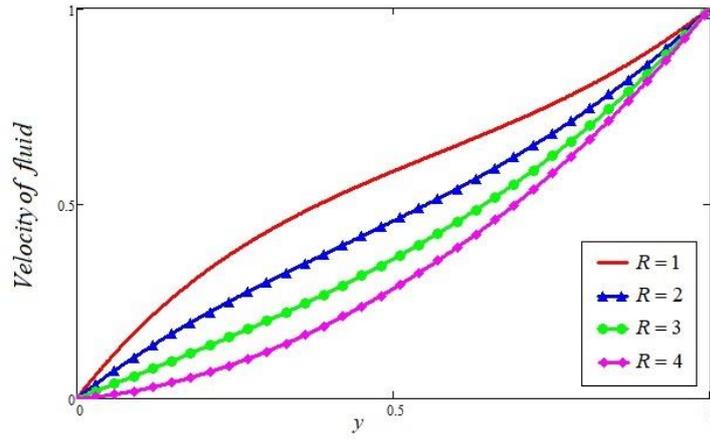


Fig. 14 Variations in velocity profile against  $y$  if different value  $R$ .

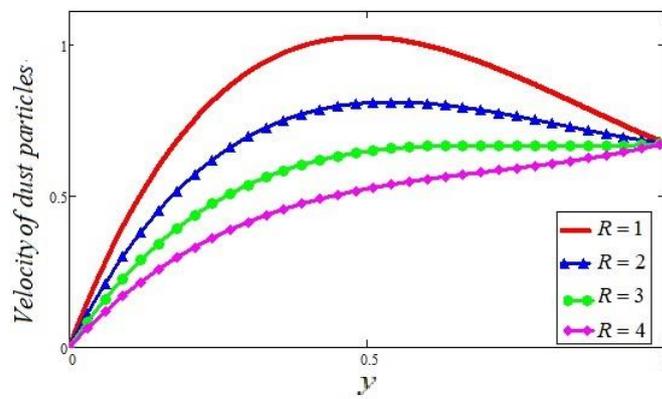


Fig. 15 Variations in dust particle velocity profile against  $y$  if different value  $R$ .

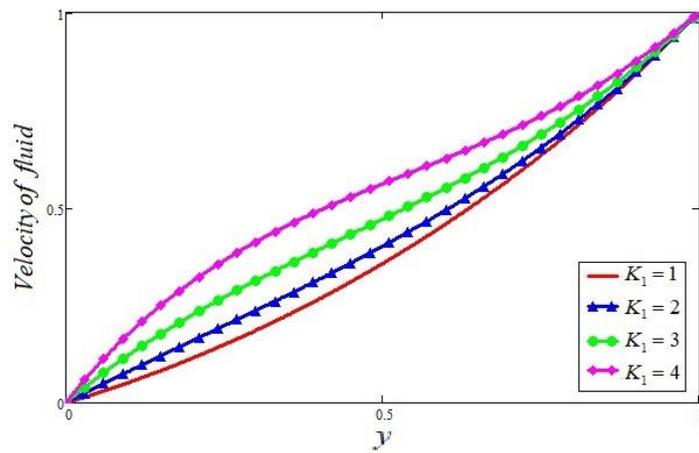


Fig. 16 Variations in velocity profile against  $y$  if different value  $K_1$ .

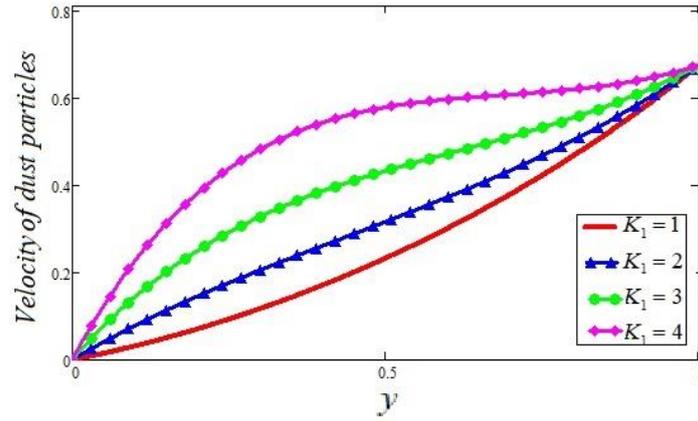


Fig. 17 Variations in dust particle velocity profile against  $y$  if different value  $K_1$ .

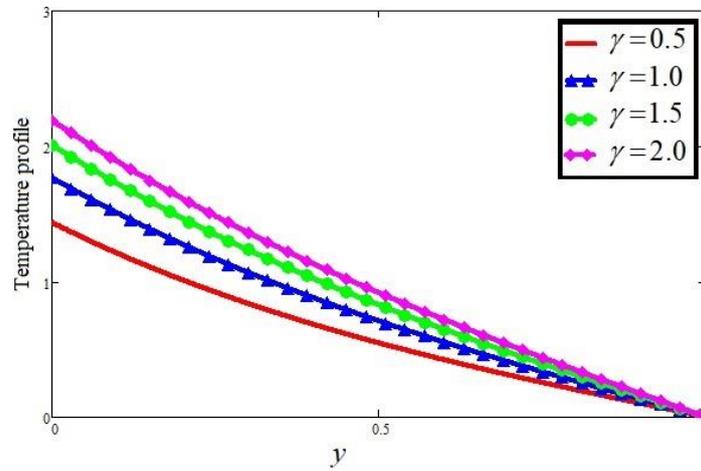


Fig. 18 Variations in temperature profile against  $y$  if different value  $\gamma$ .

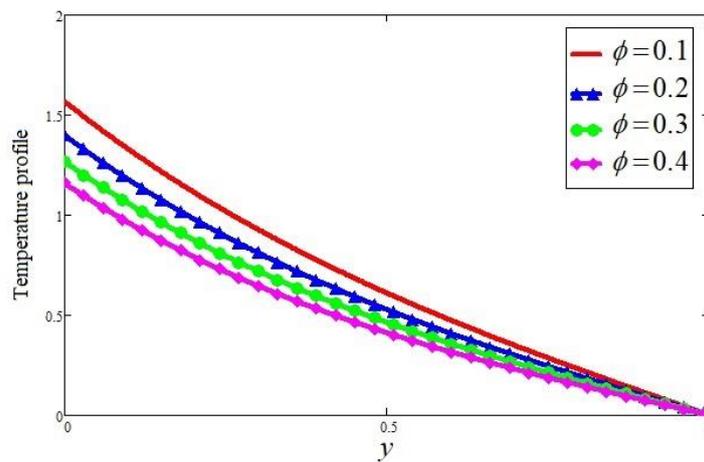


Fig. 19 Variations in temperature profile against  $y$  if different value  $\phi$ .

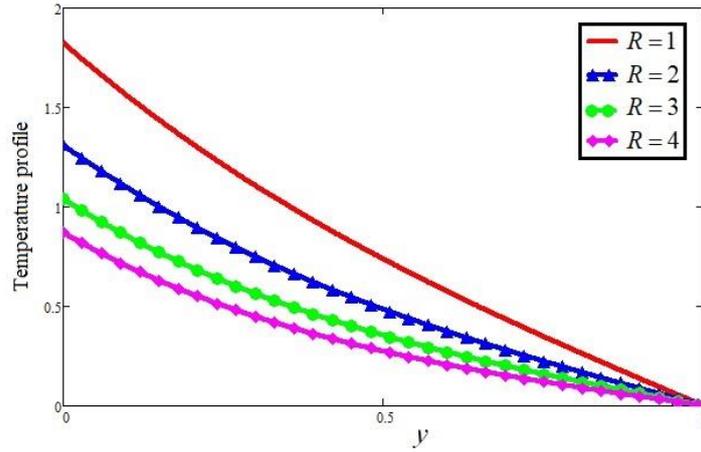


Fig. 20 Variations in temperature profile against  $y$  if different value  $R$ .

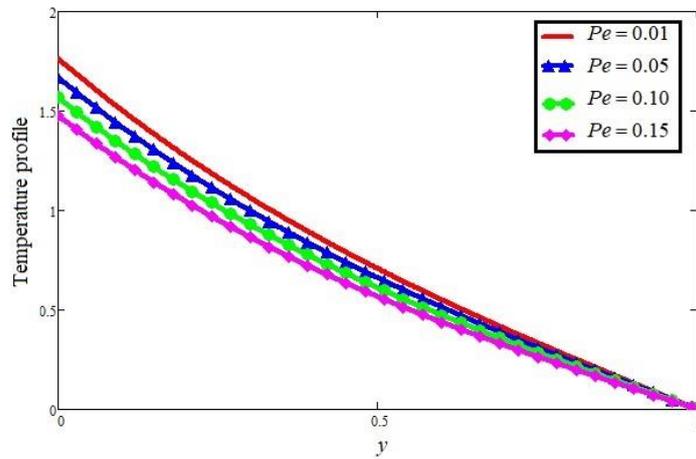


Fig. 21 Variations in temperature profile against  $y$  if different value  $Pe$ .

**Table 1.**

$Pe$	$R$	$\phi$	$\gamma$	$Nu$
<b>3</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>1.625</b>
<b>6</b>	<b>4</b>			<b>1.391</b>
	<b>5</b>			<b>1.611</b>
		<b>3</b>		<b>1.598</b>
		<b>4</b>		<b>1.460</b>
			<b>4</b>	<b>1.383</b>
			<b>6</b>	<b>1.392</b>
				<b>1.396</b>

**Table.2**

$t$	$Pe$	$R$	$\phi$	$\gamma$	$M$	$\beta$	$K_1$	$Gr$	$\omega$	$\varepsilon$	$Cf$
<b>1.0</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>1</b>	<b>4</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>0.5</b>	<b>0.001</b>	<b>1.984</b>
<b>1.0</b>	<b>1.1</b>	<b>1</b>	<b>2</b>	<b>1</b>	<b>4</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>0.5</b>	<b>0.001</b>	<b>0.623</b>
<b>1.0</b>	<b>1.2</b>	<b>1</b>	<b>2</b>	<b>1</b>	<b>4</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>0.5</b>	<b>0.001</b>	<b>0.307</b>
<b>1.0</b>	<b>1</b>	<b>1.5</b>	<b>2</b>	<b>1</b>	<b>4</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>0.5</b>	<b>0.001</b>	<b>0.680</b>
<b>1.0</b>	<b>1</b>	<b>2.0</b>	<b>2</b>	<b>1</b>	<b>4</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>0.5</b>	<b>0.001</b>	<b>0.407</b>

1.0	1	1	1.0	1	4	1	1	2	0.5	0.001	4.485
1.0	1	1	1.5	1	4	1	1	2	0.5	0.001	2.264
1.0	1	1	2	2.0	4	1	1	2	0.5	0.001	1.275
1.0	1	1	2	3.0	4	1	1	2	0.5	0.001	1.407
1.0	1	1	2	1	5.0	1	1	2	0.5	0.001	0.441
1.0	1	1	2	1	6.0	1	1	2	0.5	0.001	0.112
1.0	1	1	2	1	4	2.0	1	2	0.5	0.001	4.509
1.0	1	1	2	1	4	3.0	1	2	0.5	0.001	5.774
1.0	1	1	2	1	4	1	2.0	2	0.5	0.001	4.191
1.0	1	1	2	1	4	1	4.0	2	0.5	0.001	7.023
1.0	1	1	2	1	4	1	1	4.0	0.5	0.001	2.607
1.0	1	1	2	1	4	1	1	6.0	0.5	0.001	3.231

The numerical interpretation of the rate of heat transfer with various physical parameters of our interest has been shown in Table 1, The increasing values of  $Pe$ ,  $R$  and  $\phi$  retards the rate of heat transfer, while this rate of heat transfer enhance with the increase in  $\gamma$ . Similarly, Table 2, shows the effect of skin friction with different values of various physical parameters. The findings of this work conclude that the increasing values of  $Gr$ ,  $K_1$  and  $\beta$  enhances skin friction, while the increasing values of  $Pe$ ,  $M$ ,  $R$ ,  $\gamma$ , and  $\phi$  the skin friction decreases.

## Conclusion

The theoretical investigation of the influence of numerous physical parameters and Newtonian heating conditions on the unsteady MHD two-phase fluctuating flow of Casson dusty fluid flowing in the vertical parallel plates has carried out in this paper. It is considered that the flow is free stream fluctuating, incompressible, unidirectional and one-dimensional, electrically conducting, and the heat transfer with free convection mood has also taken into account. The embedded dust particles are assumed to be conducting and homogenously distributed in the Casson fluid. The concluding points of the current study are:

- The effect of  $M$ ,  $R$ ,  $Gr$ ,  $Pe$  and  $K_1$  on the velocity profile of fluid, and the velocity profile of dusty fluid studied in detail.
- The parametric influence of physical parameters on Casson fluid velocity profile, particle velocity profile, and temperature has discussed in detail. It is found that the increasing values of Casson parameter  $\beta$  increasing the velocities of both the fluid and dust phases.
- The heat absorption coefficient  $\phi$  enhances the Casson fluid velocity, also reduces the skin friction furthermore it retards the velocity of the particle.
- Unlike  $Gr$  the concentration of the dust particles  $R$  reduces the velocities of both phases.
- The heat transfer is reduced if the value of increasing values of  $Pe$ ,  $R$  and  $\phi$ .

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# SUSTAINABLE ARCHITECTURE

# Use of Agriculture Waste for Development of Green Concrete

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## Abstract

Concrete is a mixture of coarse aggregates, fine aggregates and water-cement ratio. Green concrete is a concept of using eco-friendly materials in concrete, to make the system more reliable, efficient and sustainable. Agricultural wastes can be utilized as supplementary cementitious materials (SCMs) in concrete manufacturing might contribute to global environmental and economic efficiency of construction. In this study, the blend of agricultural wastes such as wheat straw ash (WSA), rice husk ash (RHA) and Bagasse ash (BA) was used as a partial replacement of cement by 15% and 21 % in the production of green concrete. Several Tests including workability, compressive strength, splitting tensile strength, flexural strengths were performed at the age of 7 and 28 days to understand the behavior of concrete. In substitution level of 15% the incremental trend in compressive strength was observed as 5.43% and 2.81% in comparison with the control sample at the age 7 and 28 days respectively. Workability was observed in decreasing trend with increasing the replacement of agricultural wastes. Also, with the increasing replacement level the strength properties were observed in decreasing pattern in comparison to the control sample. Furthermore, 15% replacement provided good results. Hence, this study provides a sustainable construction material which will conserve the earth natural resources and provide a better use of agricultural wastes.

## Keywords

Agricultural Wastes Ashes, Green Concrete, Workability, Strength Properties.

## Introduction

Concrete is the most widely used building material on planet. Cement, aggregates, water, and admixtures are used to make concrete. The hardening process occurs owing to hydration of cement and water once all these ingredients have been mixed together. Ordinary Portland Cement (OPC) is the most extensively used cement in more than 80 nations. Cement manufacturing is a major source of CO<sub>2</sub> emissions, resulting in severe environmental degradation. Supplementary cementitious materials (SCM) are now being utilized as a partial replacement for cement to build concrete with the required strengths in order to decrease or eliminate the global warming problem. Agricultural wastes such as Bagasse ash, Rice husk ash are now being used to make cost-effective, environmentally friendly concrete. In this study a mixture of agricultural wastes, such as wheat straw ash, rice husk ash, and bagasse ash, are used as a partial replacement for cement.

### *Agriculture wastes as SCM*

Global ecological warming is currently regarded as the world's most pressing issue. Solid waste products have been detected all over the place, including in the rural civilization of the town and agriculture. The usage of these wastes in construction material will acknowledge numerous advantages described above as an influence of environmental waste on agriculture. Agricultural waste has been discovered to have improved thermal properties, which could result in significant points being added to the Energy and Environmental Design Assessment (LEED) atmosphere and energy class, according to research. Furthermore, due to high prices and restricted availability of essential components in concrete, particularly in developing countries, agricultural waste utilized as SCMs in concrete manufacturing might contribute to global environmental and economic efficiency of construction.

### *Rice husk ash (RHA)*

One of the waste items that can be used as a cement substitute is rice husk ash. Rice husk ash is an agricultural waste product that is produced in the millions of tonnes per year by burning rice husk in open fields or under controlled incineration conditions. This is because the particle size and surface area

of rice husk ash, which is a highly reactive rice husk ash, are dependent on the controlled temperature and burning conditions. Shows how rice husk ash is made till it becomes powder. Basically, many academics have looked into using waste materials as a cement substitute in the manufacturing of concrete. Waste materials have also been demonstrated to be a cement replacement due to their chemical and physical properties in concrete performance, such as compressive strength, flexural strength, tensile strength, and the durability of test findings. Aside from that, waste material has been shown to be a good pozzolanic material, giving it an advantage as a cement substitute. When it chemically combines with calcium hydroxide at room temperature during the hydration of Portland cement, it is said to have an excellent pozzolanic property.

### ***Wheat straw ash (WSA)***

Wheat straw ash (WSA) has been studied as a potential pozzolana active additive for mixed cements. WSA and binder paste were thoroughly investigated using various analytical methods to investigate chemical and mineralogical structure, morphology, elemental distribution, pozzolana activity, fundamental physical properties, mechanical parameter, and pore size distribution. Because of the high carbon content of the water, we looked into heat therapy (WSA). The heat treatment process was monitored using concurrent thermal analysis and Fourier transforming infrared spectroscopy. In addition, the leach ability of chlorides, nitrates, sulphates, and alkalis from paste samples was investigated. The potential use of WSA derived from the combustion of packed wheat straw as SCMs in mortar and concrete has been investigated with the goal of recovering valuable raw materials from industrial waste and enabling the development of "green concrete" with lower embodied energy and lower environmental impacts than current concrete.

### ***Bagasse ash (BA)***

In emerging countries such as India, Thailand, Brazil, Pakistan, Columbia, Philippines, Indonesia, and Malaysia, massive amounts of bagasse ash are being formed annually. Bagasse ash is a substance produced through cogeneration and burning of sugarcane bagasse at a specific temperature. The mineral was discovered to be a promising pozzolanic material that may be employed effectively in both mortar and concrete as additional Portland cement components.

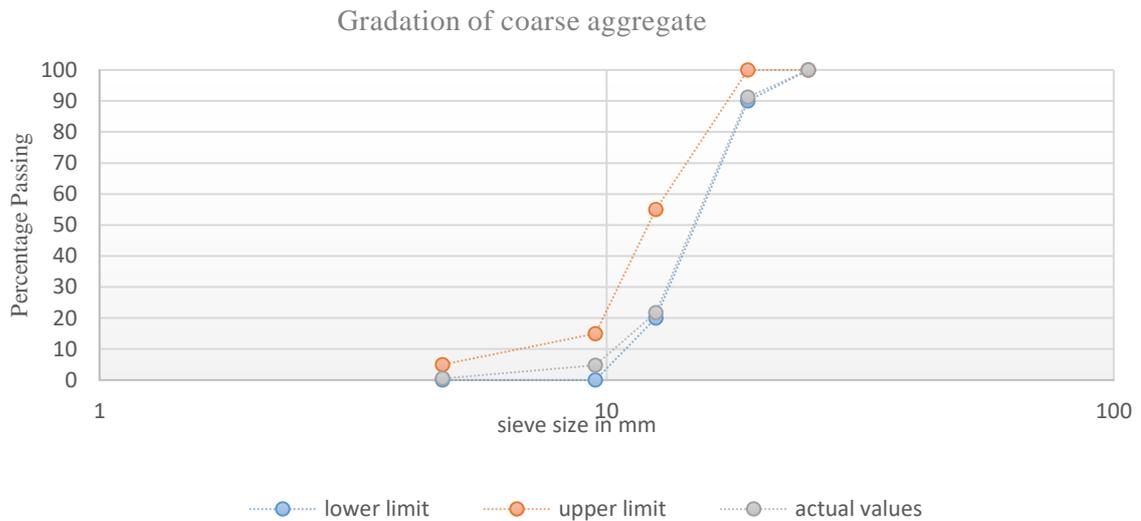
## **Research Methodology**

### ***Materials***

#### ***Cement***

For all concrete mixes, 43-grade cement Ordinary Portland Cement (OPC) was used locally accessible. The cement used was fresh and free of moisture, without lumps. The glue used was Type I cement-like (ASTM C 150). The cement had a uniform color, that is, grey.

## Coarse aggregate



Coarse aggregates were collected locally in Peshawar, Pakistan. Sieve analysis and different quality control tests were performed for the selection of coarse aggregate. The physical properties of coarse aggregate are listed in Table 1.

Table 1: Physical Properties of Coarse Aggregates

S.NO	Characteristic	Value
1	Type	Crushed 1 inch
2	Specific Gravity	2.68
3	Rodded density	1605 kg/m <sup>3</sup>
4	Total Water Absorption	1.641 %
5	Moisture Content	0.81%
6	Fineness modulus	6.44

## Fine aggregate

Fine aggregates were collected locally in Peshawar, Pakistan. Sieve analysis and different quality control tests were performed for the selection of fine aggregate. The physical properties of Fine aggregate are listed in Table 2.

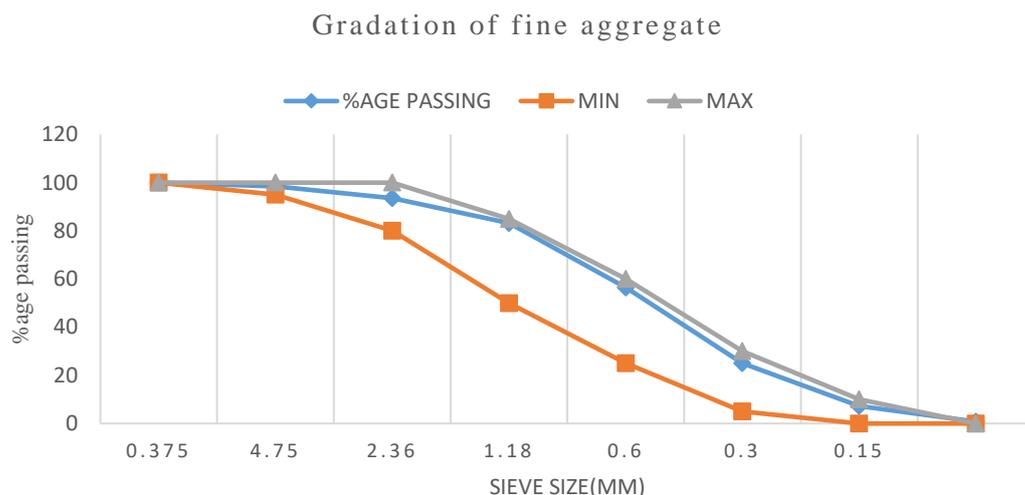


Table 2: Physical Properties of Fine Aggregates

S.NO	Characteristics	Value
1	Type	Uncrushed(natural)
2	Specific gravity	2.61
3	Rodded density	1630 kg/m <sup>3</sup>
4	Total Water Absorption	1.02%
5	Moisture Content	0.16%
6	Fineness Modulus	2.76

## Tests and Results

### *Workability*

Workability was determined via slump method in accordance with ASTM C143/C143M. The results are listed below in the Table 3. The slump value was kept constant.

### *Compressive strength Test (CST)*

The compressive strength of concrete cylinders is determined using the ASTM C 39 Test Method after 7 and 28 days of curing. The compressive strength of a cylinder is calculated by dividing the load at which it fails by the cylinder's area. The results are mentioned in table 3.

### *Splitting Tensile strength (STS):*

The ASTM C 496 test method was used to determine the concrete specimen's split tensile strength.

The tensile strength of concrete is determined using this test. Because concrete is weak in tension and applying load in uniaxial tension to a concrete specimen is difficult, the tensile strength of the concrete is determined indirectly using the split cylinder test. The following formula can be used to compute the cylinder's tensile strength.  $f = 2P/DL$ ,  $f$  = tensile strength split,  $P$  = load,  $D$  is the cylinder's diameter.

The results are mentioned in the table 3.

### *Flexural strength (FS)*

Flexural strength is the tensile strength of plain concrete beams or slabs by resisting the loads in bending. It is about 10-20 % of the compressive strength of concrete. It is measured by loading 20in\*6in\*6in unreinforced concrete beams using three-point loading. It is also called as modulus of rupture or bend strength. The flexural test on concrete can be conducted using either

three-point load test (ASTM C78) or center point load test (ASTM C293). Results are mentioned in table 3.

Table 3: Results

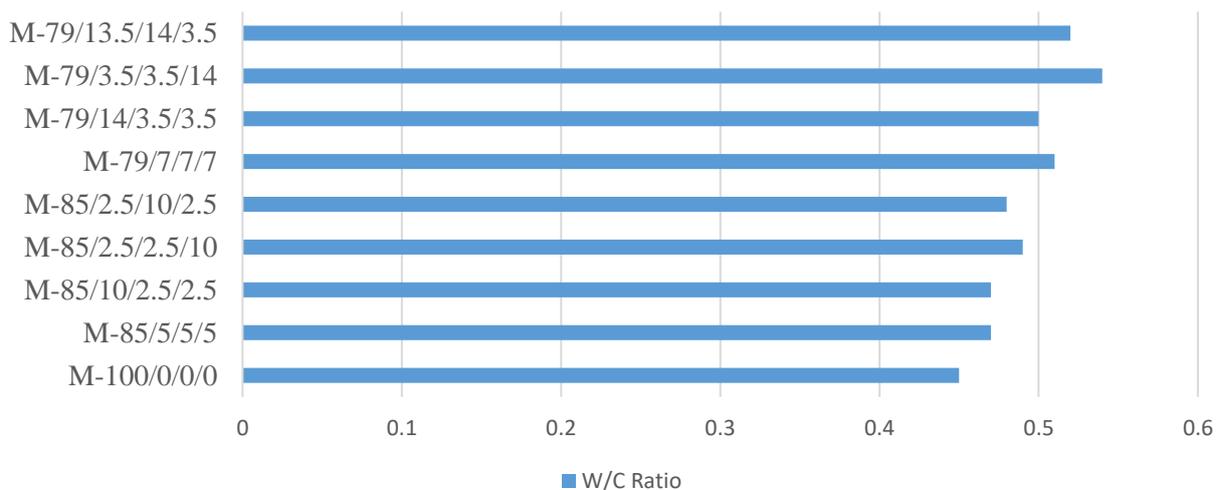
## Results and Discussions

### *Fresh Properties (Workability)*

MIX PROPORTION M- OPC%/RHA%/WSA% /BA%	Workability		Compressive Strength		Split Tensile Strength		Flexural Strength	
	Slump (inches)	w/c Ratio	strength (psi) 7-days	Strength (psi) 28-days	strength (psi) 7-days	Strength (psi) 28-days	strength (psi) 7-days	Strength (psi) 28-days
M-100/0//0/0	1	0.45	2012.8	3007.75	263.63	401.45	657.09	1011.66
M-85/5/5/5	1	0.47	2122.2	3092.18	294.28	453.36	567.57	864.83
M-85/10/2.5/2.5	1	0.47	1940.55	2898.29	246.33	343.54	487.56	801.82
M-85/2.5/2.5/10	1	0.49	1921.64	2656.17	234.17	290.24	498.79	625.72
M-85/2.5/10/2.5	1	0.48	1956.32	2741.13	216.96	285.37	544.23	586.37
M-79/7/7/7	1	0.51	1853.14	2491.39	195.67	276.56	549	643.02
M-79/14/3.5/3.5	1	0.50	1824.23	2405.8	167.11	209.78	345.64	559.21
M-79/3.5/3.5/14	1	0.54	1439.21	2024.33	180.93	251.98	401.64	539.87
M-79/3.5/14/3.5	1	0.52	1598.23	2143.55	190.74	269.34	348.36	553.12

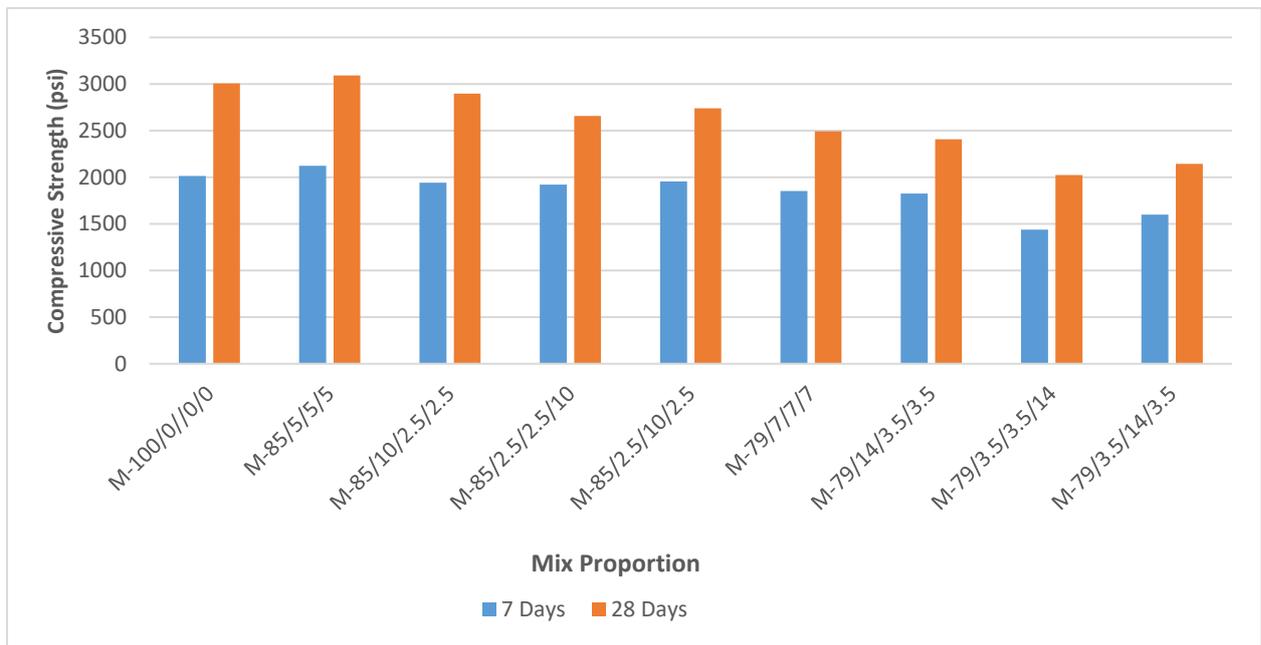
From our results it is concluded that when we partially replaced the following ashes with cement at different percentages then the fresh properties of concrete reduced slightly and also concluded that by increasing the replacing percentage of bagasse ashes effected (decreased) the workability of green concrete compared to other ashes we used.

Impact of different ashes on Workability



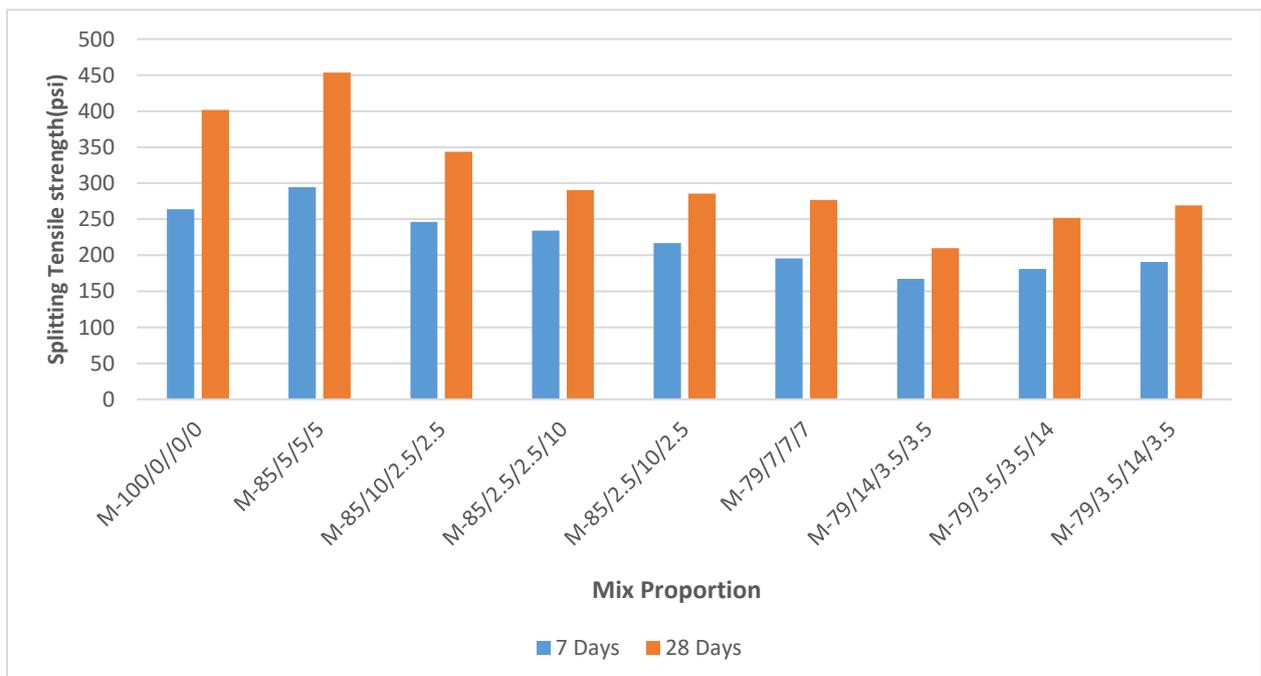
### Compressive strength (CS)

At the age of 7 days and 28 days the (CS) of green concrete was the highest when cement was replaced with ashes (i.e. RHA, WSA, and BA) at same ratio (i.e. 5% each) with cement.



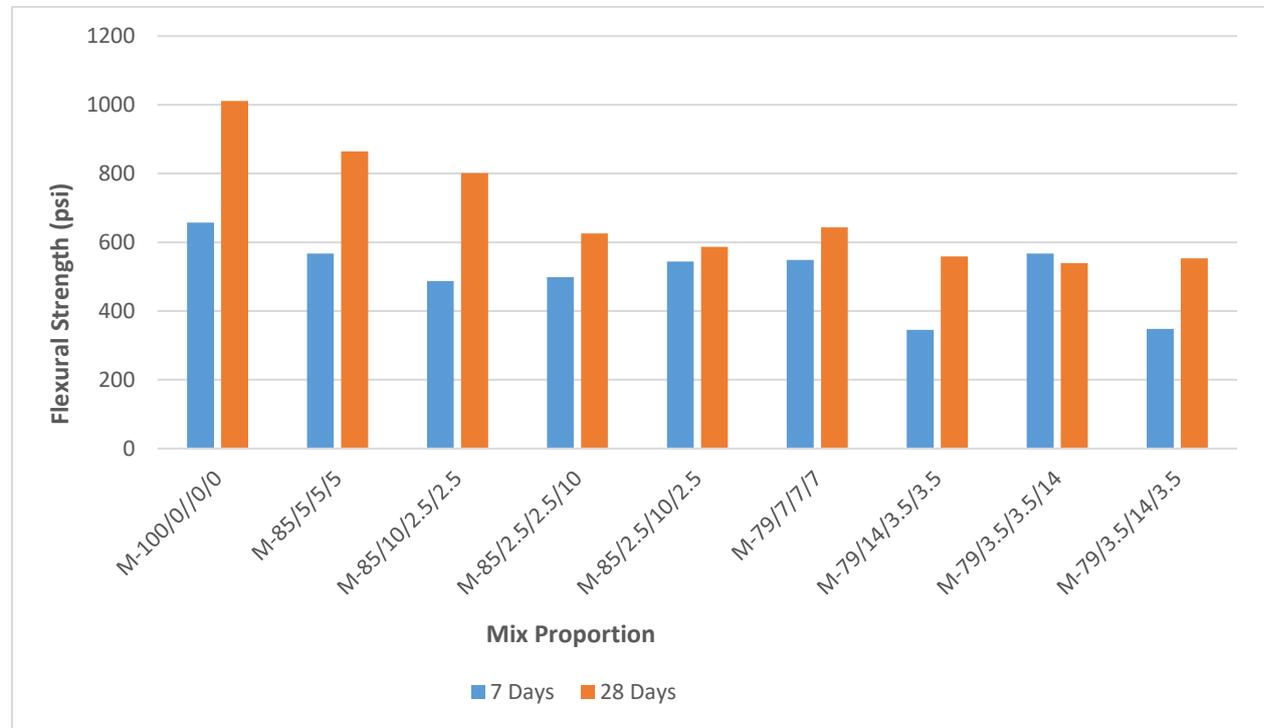
### Splitting Tensile strength (STS)

At the age of 7 days and 28 days the (STS) of green concrete was the highest when we replaced the following ashes (RHA, WSA, and BA) at same ratio (5%, 5%, and 5%) with cement.



### ***Flexural strength (FS)***

At the age of 7 days and 28 days the (FS) of green concrete was the highest when we replaced the following ashes (RHA, WSA, and BA) at same ratio (5%, 5%, and 5%) with cement. With the substitution of agricultural waste with cement, flexural strength has been decreased.



### **Conclusion and Recommendations**

The use of RHA, WSA, and BA in concrete saves cement and solves the problem of disposal of these agricultural wastes, as well as solving environmental problems which is cause due to dumping the agricultural wastes. The use of agricultural wastes in concrete as a partial replacement of cement is economical because the disposal costs of agricultural wastes are reduced when used in concrete. Hence, this study provides a sustainable construction material which will conserve the earth natural resources and provide a better use of agricultural wastes.

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