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## Editorial

As technology continues to evolve, research across various domains reveals innovative solutions to longstanding challenges. The three studies discussed here highlight significant advancements in antenna design, image compression techniques, and the hybrid work models emerging in the post-pandemic era. These papers not only push the boundaries of their respective fields but also offer practical implications for real-world applications.

The first paper explores the design and optimization of a broadband monopole antenna using complementary split ring resonators (CSRR). The researchers investigated various geometrical shapes to identify the radiator with the highest return loss bandwidth potential, ultimately finding that a semi-circularly shaped microstrip radiator provided the widest  $VSWR < 3$  bandwidth. However, to enhance the  $VSWR < 2$  bandwidth, hexagonal CSRR structures were employed. By incorporating multiple equilateral hexagonal CSRRs and modifying the ground plane of the antenna, the proposed design achieved an operating frequency range from 320 MHz to 1100 MHz with an average gain of 3.05 dBi and a total efficiency of 94%. This work significantly enhances antenna performance, demonstrating a promising approach for improving broadband monopole antennas in various applications [1].

In the second paper, the authors address challenges in image compression, presenting a novel scheme based on bi-orthogonal wavelet transform and Discrete Cosine Transform (DCT). This combined approach involves four key steps: splitting image data into sub-bands using the wavelet transform, de-correlating data with DCT, scalar quantization, and finally, LZW encoding. The performance of this scheme was evaluated using several image test samples, with results indicating substantial improvements in peak signal-to-noise ratio (PSNR), compression ratio (CR), and compression gain (CG). The findings suggest that this hybrid transformation and encoding technique can effectively reduce image file sizes while maintaining high resolution, making it a valuable contribution to the field of lossy image compression [2].

The third paper examines the evolving landscape of workplace models in the wake of the COVID-19 pandemic. The study explores the potential of hybrid work models by utilizing the Delphi and SWOT methods to conduct in-depth interviews with IT professionals. The research aims to identify critical success factors (CSFs) for the successful implementation of hybrid work models, reflecting the shift in business practices necessitated by the pandemic. By focusing on employee opinions and collaboration with organizational leaders, the study provides insights into balancing work and life while maintaining productivity and innovation. The findings offer valuable guidance for business leaders in Taiwan and beyond, as they navigate the transition to more flexible and adaptive work environments [3].

Collectively, these studies exemplify the innovative spirit driving contemporary research. From improving technical performance in communication systems and data compression to reimagining workplace dynamics, each paper contributes to the advancement of knowledge and the development of practical solutions for complex problems. As we continue to embrace technological advancements and adapt to changing global conditions, the insights provided by these studies will undoubtedly play a crucial role in shaping the future.

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# Hexagonal CSRR Based Broadband Monopole Antenna at UHF-Band

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**ABSTRACT:** In this work, complementary split ring resonators (CSRR) based broadband monopole antenna is proposed. A variety of geometrical shapes are studied as a radiator to find out the radiator with the highest possible return loss bandwidth potential. It has been found that the semi-circularly shaped resonator has the widest VSWR<3 bandwidth. Therefore, a monopole antenna constructed by a semi-circularly shaped microstrip radiator which is excited with a 50-ohm microstrip line is proposed. It has been seen that a semi-circularly shaped microstrip radiator does not have adequate broadband performance in terms of VSWR<2 bandwidth. Therefore, CSRR structures that are shaped like hexagons are employed in order to enhance the VSWR<2 bandwidth of the proposed antenna. It has been seen that a single CSRR only influences a limited frequency range. In order to make the proposed monopole antenna operate within a much larger frequency bandwidth and achieve return loss enhancement along the whole frequency band, multiple equilateral hexagonal CSRRs are utilized. The ground plane of the monopole antenna is modified such that three CSRR structures having different dimensions are inserted behind the 50-ohm feeding line. The resulting manufactured monopole antenna operates from 320 MHz to 1100 MHz while having an average gain of 3.05 dBi gain. Moreover, the total efficiency of 94% is achieved along the operating frequency band.

**KEYWORDS** Broadband, UHF, CSRR, Monopole

## 1. Introduction

Nowadays, there is a continuously expanding demand for wireless and mobile broadcasting technologies. They rapidly became a vital part of our lives. These technologies utilize the UHF frequency band extensively. Aside from television broadcasting, the UHF frequency band is also used for marine and airborne navigation systems. All major global navigation satellite systems operate in the UHF band. What's more, in addition to Wi-Fi and Bluetooth, there are a lot of wireless sound systems, and radio frequency identification (RFID) applications that operate at the UHF frequency band. Other than wireless communications, even the latest mobile communication networks such as 5G still operates in the UHF band. For long-range and low bandwidth applications especially in rural areas UHF frequency band provides a cost-effective alternative to operating at higher microwave frequency bands. UHF radio signals are also used for satellite communications. Especially CubeSat satellites which is a class of miniaturized satellites prefer the UHF frequency band due to its cost-effective and

highly accessible nature. Tracking, telemetry data communication, and command subsystems of a satellite can all be managed successfully at UHF frequency bands. Most of the time monopole antennas are preferred to operate at the UHF frequency band. Monopole antennas are preferred extensively because of their omnidirectional radiation properties. In addition to having omnidirectional radiation, their broadband performance capability and ease of construction make them a very popular antenna type to be used in the UHF frequency band.

Several studies have been performed to enhance printed monopole antenna's return loss bandwidth. A meander-shaped radiator that utilizes couplings between feeding lines is proposed in [1]. Another planar monopole antenna that is shaped like a Spirograph is mentioned in [2]. In order to enhance bandwidth, rf pin diodes are placed between the edges of the monopole antenna. In [3], wideband performance is achieved by employing an exponentially shaped patch radiator. The feeding of this radiator is accomplished by a capacitively coupled

stripline structure. In another study, a fan-shaped radiator along with a trapezoidal ground plane is exploited in order to construct a half-sized unbalanced dipole antenna [4]. In [5], broadband circular polarization is acquired by inserting triangular notches into the rectangular resonator. 50-ohm coplanar line fed elliptical monopole antenna is proposed by [6]. In order to enhance bandwidth, a trapezoidal ground plane is utilized. Another study that employs a z-shaped monopole antenna is performed by [7]. In this study, a monopole antenna is constructed on a paper substrate while the antenna is printed on paper with silver and copper ink. Moreover, in the study performed by [8], a hexagonal CSRR structure is inserted into a hexagonal radiator in order to enhance the frequency bandwidth.

In this paper, the structure proposed in [9] is studied further. The frequency bandwidth of the equilateral hexagonal CSRR-based broadband monopole antenna that is proposed in [9] decreases by 130 MHz as a result of the insertion of the SMA connector into the model. Measurement results of the manufactured antenna indicate that the proposed antenna operates from 323 MHz to 1100 MHz after insertion of the SMA connector. Although the frequency bandwidth is affected negatively by the SMA connector, the average realized gain and percent total efficiency increase to 3.05 dBi and 94% consecutively after insertion of the SMA connector into the antenna model.

## 2. Design and Results

In Figure 1, the proposed antenna's geometry is presented. The antenna is built on a material whose electrical properties are  $\epsilon_r = 3.55$  and  $\tan\delta = 0.0027$  while the thickness of the substrate is chosen to be 0.81mm. The proposed antenna comprises of patch radiator that is semi-circularly shaped. Feeding of the patch radiator is realized by a 50-ohm transmission line. The ground plane of the proposed monopole antenna is modified such that three different CSRR structures that are hexagonally equilateral, are inserted onto it. The proposed antenna's geometry is shown in Figure 1 while the proposed antenna's dimensions are depicted in Table 1.

The initial design goal was to design a monopole antenna that has a 50-ohm feed line and fits within 300 mm of height. The operating frequency band is chosen to be 300 MHz to 1200 MHz for this design and the target VSWR is chosen as  $<3$ . Various microstrip resonators are studied in order to achieve the initial design goals. Circular, triangular, rectangular, and hexagonal shapes are chosen to be radiators of the monopole antenna and the structures are optimized to determine the best radiator. CST Microwave Studio environment is used for all the simulations.

In Figure 2, monopole antennas with different patch radiators' optimized return loss results are given. It is seen from Figure 2 that the widest S11 bandwidth of -6 dB is achieved by the monopole antenna that has a semi-circular patch radiator. Although the antenna with a semi-circular radiator satisfies  $VSWR < 3$  within the frequency range of 300 MHz to 1200MHz, its frequency bandwidth where  $VSWR < 2$  i.e. frequency range where S11 is less than -10dB, is divided into two sub-frequency ranges. These frequency ranges are 300 MHz to 420 MHz and 560 MHz – 770 MHz.

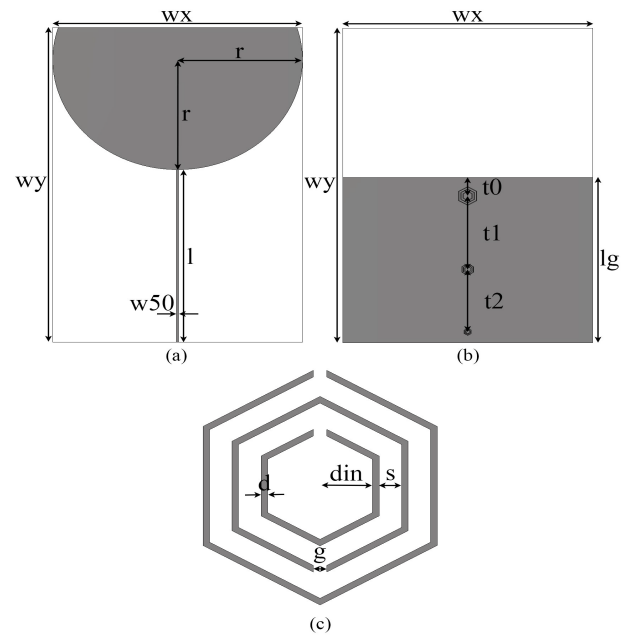


Figure 1: (a) The proposed antenna's front view. (b)The proposed antenna's back view. (c) Hexagonal CSRR structure's geometry.

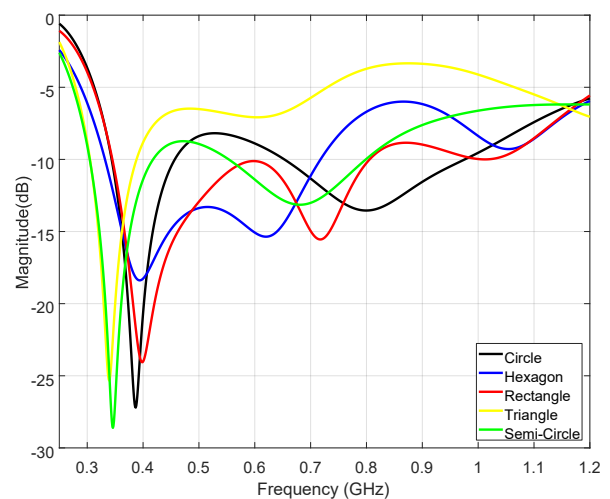


Figure 2: Monopole antennas with different patch radiators' optimized return loss results

To be able to enhance the operating bandwidth of the monopole antenna that has a semi-circularly shaped radiator, CSRR structures are integrated into the ground plane of the monopole antenna. To achieve a broadband matching, operating frequency bandwidth is divided into three sections. For each frequency section, a different CSRR structure is used to enhance the matching. During the design process, three different equilateral hexagonal CSRR structures are utilized. For the sake of design

simplicity, the largest CSRR is scaled down to obtain the other CSRR structures.

The scaling factors of the CSRR structures are inversely proportional to CSRR structures' operating frequency. As the scaling factor reduces, the frequency of operation that a CSRR structure operates increases. Optimizations are performed by changing the dimensions of the largest CSRR and scale factors of the other CSRR structures. Optimal dimensions along with scale factors for the other CSRR structures are presented in Table 1.

Table 1: The proposed antenna's dimensions.

Parameter	Value (mm)
$w_x$	209.4
$w_y$	300
$w_{50}$	1.8
$r$	104.7
$l$	164.5
$lg$	157.71
$d_{in}$	3.49
$d$	0.43
$s$	1.5
$t_0$	17.7
$t_1$	70
$t_0$	59.4
$g$	0.91
$scalefactor1$	0.62
$scalefactor2$	0.38

Figure 3 shows the proposed antenna's return loss results with and without CSRR structures. It is seen from Figure 3 that after insertion of the CSRR structures, broad frequency bandwidth from 300 MHz to 1210 MHz has been achieved.

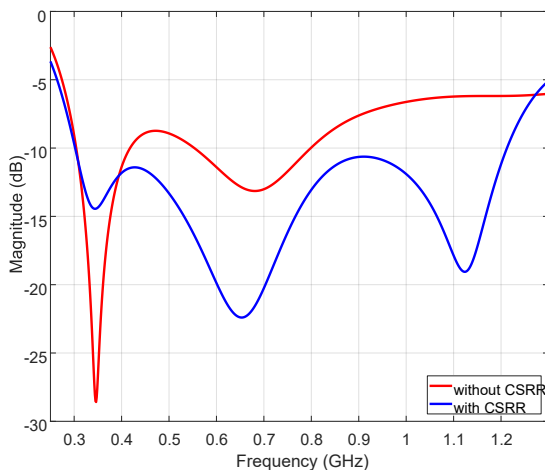


Figure 3: The proposed antenna's return loss results with and without CSRR structures.

So as to acquire more realistic results, the SMA connector model that is used during measurements is

added to the antenna model. In order to avoid any conduction problems, grounding vias has been inserted between the antenna's ground plane and radiator surface where the center pin of the connector touches the 50-ohm transmission lines. In Figure 4, the proposed antenna's return loss results without and with the SMA connector are provided. It is seen from Figure 4 that the insertion of the SMA connectors causes the frequency bandwidth of the monopole antenna to decrease by 130 MHz. Moreover, the lack of any unwanted ripples along the frequency band indicates that there is no conduction problem related to the integration of the SMA connector to the antenna model.

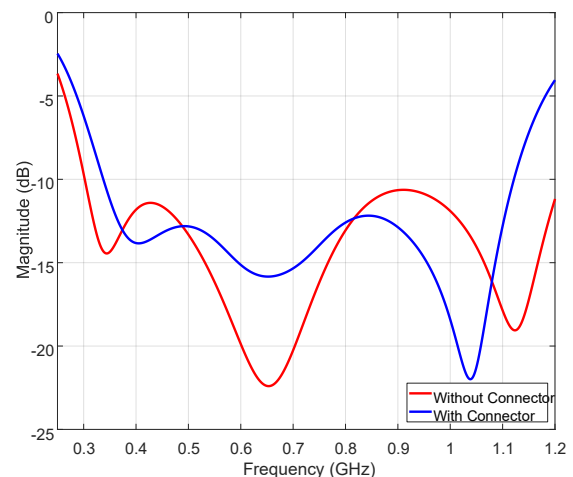
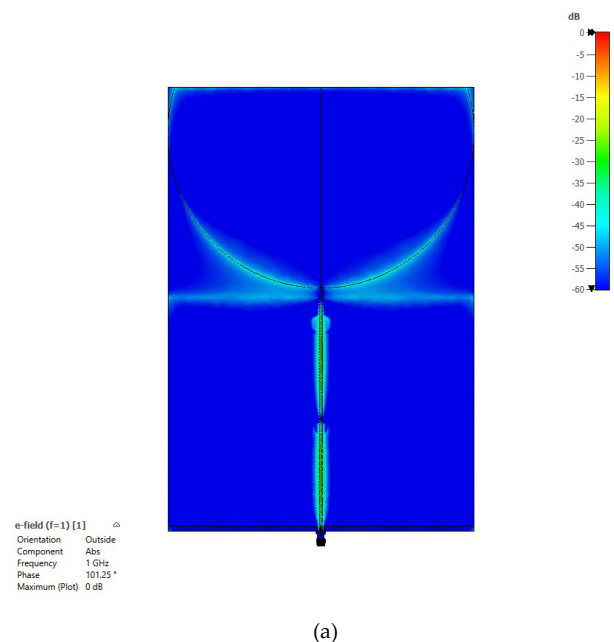


Figure 4: The proposed antenna's return loss results without and with the SMA connector.

In Figure 5, the front view and back view of the electric field distribution are presented. Electric field density around the hexagonal CSRR structures in Figure 5 indicates that CSRR structures are effectively utilized for bandwidth enhancement. A closer look at the area where the SMA connector is located demonstrates no sign of conduction problems as it is also predicted by looking at Figure 4.





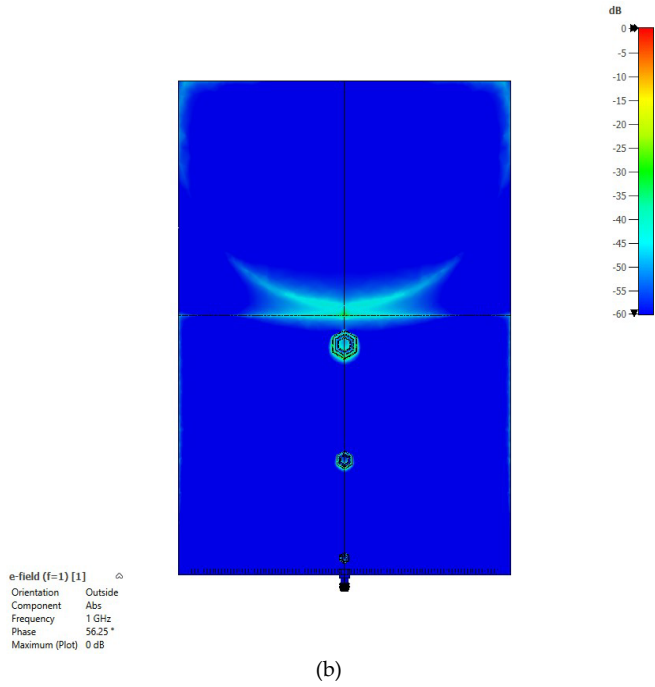


Figure 5: (a) Front view of the electric field distribution. (b) Back view of the electric field distribution.

In Figure 6 and Figure 7, 3D realized gain patterns of the proposed monopole antenna with SMA connector at 300 MHz, 500 MHz, 700 MHz, 900 MHz, 1000 MHz, and 1100 MHz are given.

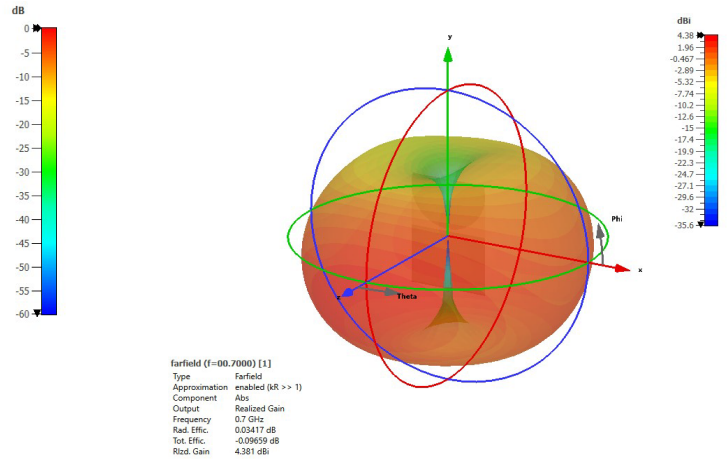
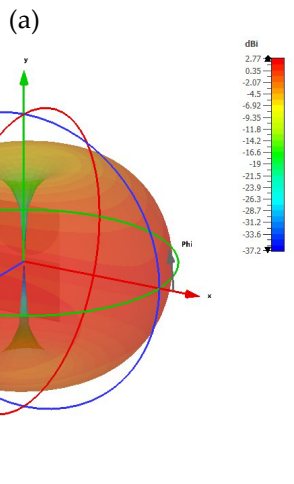
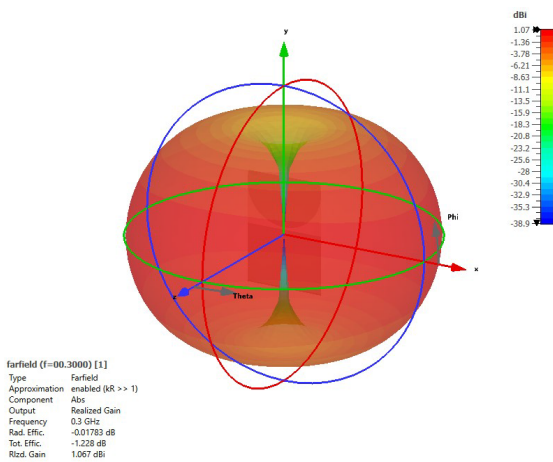
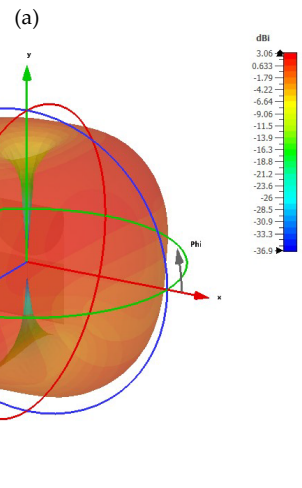
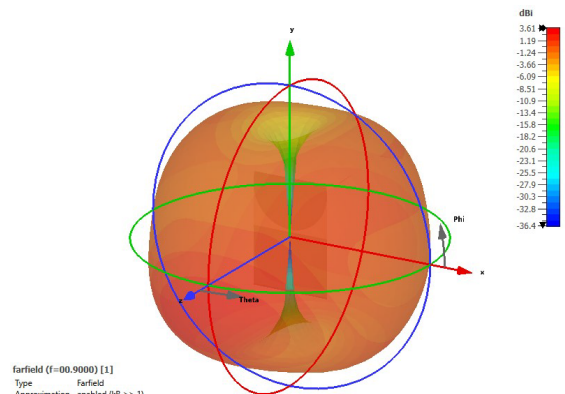


Figure 6: 3D realized gain patterns of the proposed monopole antenna with SMA connector at (a) 300 MHz. (b) 500 MHz. (c) 700 MHz.

It is seen from Figure 6 that the proposed monopole antenna has an omnidirectional radiation characteristic. Especially up until 700 MHz, the proposed antenna indicates an ideal omnidirectional monopole antenna pattern. It is also seen from Figure 6 and Figure 7 that as the frequency of operation increases, the max gain of the antenna begins to shift towards the upper hemisphere of the 3D realized gain pattern. The tendency of the gain concentrating in the upper hemisphere also seems to affect the lower hemisphere where the null at the center of the lower hemisphere begins to disappear.



(b)



(b)

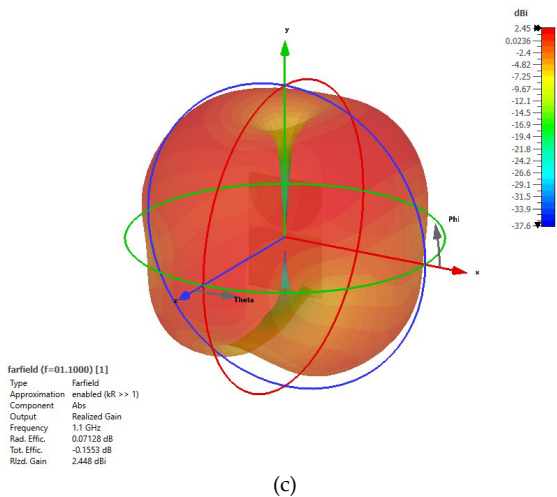


Figure 7: 3D realized gain patterns of the proposed monopole antenna with SMA connector at (a)900 MHz. (b)1000 MHz. (c) 1100 MHz.

is seen from Figure 11 that simulated and measured results agree very well with each other. The frequency bandwidth of the measured monopole antenna is found to be from 320 MHz to 1100 MHz. However, slight differences between simulated and measured results are observed in terms of frequency bandwidth and notch depths. One of the reasons for these differences could be attributed to the environmental reflections. As the frequency of operations decreases, it becomes more challenging to avoid or suppress reflections and interference. Although these reflections have more effect on antenna pattern, they also affect the return loss of the antenna. Another reason for the differences between measured and simulated results would be the manufacturing tolerances.

Figure 8 demonstrates the proposed antenna's realized gain with the SMA connector, along the whole frequency band. Figure 8 shows that realized gain of the proposed antenna is around 1dB at the beginning and end of the frequency band. Max realized gain reaches up to 4.4 dBi at the center of the frequency band. It is also seen from Figure 8 that the antenna's average realized gain is around 3.05 dBi.

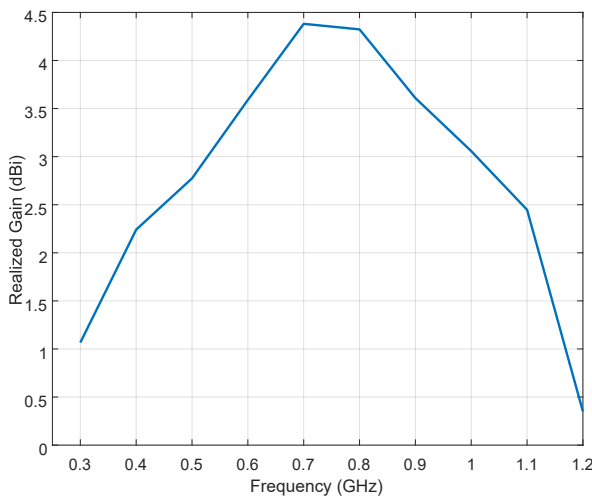


Figure 8: The proposed antenna's realized gain with the SMA connector, along the whole frequency band.

In Figure 9, the proposed antenna's total percentage efficiency with the SMA connector, along the whole frequency band, is provided. Figure 9 depicts that although the total percentage efficiency at the end and beginning of the frequency band is around 70%, it increases up to 97% at the middle of the frequency band. Moreover, Figure 9 also shows that an average of 94% total efficiency is accomplished within the whole frequency band.

In Figure 10, the front and back view of the manufactured antenna is shown. The return loss of the manufactured monopole antenna is measured with a network analyzer. Figure 11 shows measured and simulated return loss results of the proposed antenna. It

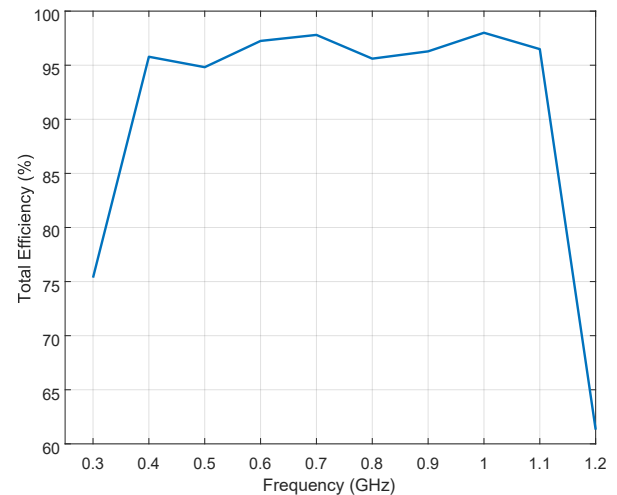
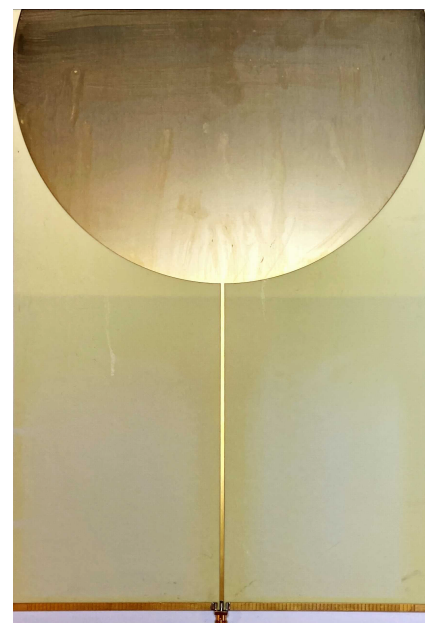


Figure 9: The proposed antenna's total percentage efficiency with the SMA connector, along the whole frequency band.



(a)



Figure 10: (a) Front view of the manufactured antenna. (b) Back view of the manufactured antenna.

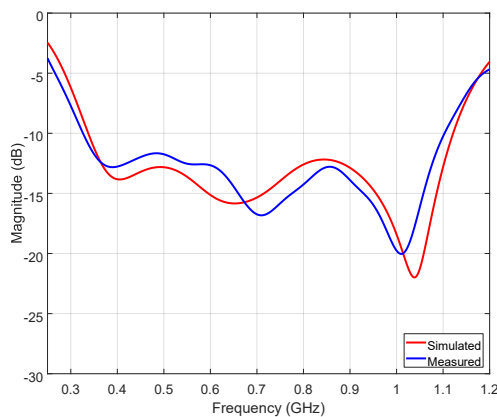


Figure 11: Simulated and measured return loss results of the proposed antenna.

The performance of some of the broadband monopole antennas that are mentioned in the literature and the proposed design are presented in Table 2. Compared to other studies mentioned in Table 2, the proposed structure has the widest operating bandwidth where return loss is below -10dB. One of the essential parameters that indicate the performance of an antenna is the realized gain. In order to evaluate the performance of a wideband antenna, it is better to make an evaluation by using average realized gain. When the average realized gain of the proposed structure is compared with others mentioned in the table, it is seen that the proposed structure performs better than other structures with an average realized gain value of 3.05 dBi except for work in [8]. The reason why the gain of the work in [8] is higher is due to the fact that the aperture of the antenna in [8] is five times larger than the antenna proposed in this work. Another important parameter of an antenna is its size. Although the proposed structure isn't made to be

compact, the final dimensions of the antenna are smaller than the dimensions of most of the antennas mentioned in Table 2.

Table 2: Performance comparison of monopole antennas and proposed monopole antenna.

References	Frequency (MHz)	Average Gain (dBi)	Size ( $\lambda \times \lambda$ )
[1]	901-930	0.85	0.24x0.19
[2]	1070-2920	2.70	0.41x0.22
[5]	2550-3740	1.00	0.51x0.41
[6]	750-1750	2.50	0.38x0.35
[7]	860-940	0.20	0.22x0.29
[8]	5700-16000	4.00	1.10x1.10
[This Work]	320-1100	3.05	0.22x0.32

### 3. Conclusion

In this paper, a broadband-printed monopole antenna is proposed. Hexagonal CSRR structures are used to achieve ultrawideband performance. Omnidirectional radiation performance is achieved along the whole frequency band. Realized gain with an average of 3.05 dBi and total efficiency of 94% is attained within the whole frequency band. In order to verify the design, the proposed antenna is manufactured and measured. Simulated and manufactured results agree very well with each other, and the operating bandwidth of the proposed antenna is found to be 320 MHz to 1100 MHz.

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# Images Compression using Combined Scheme of Transform Coding

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**ABSTRACT:** Some problems want to be solved in image compression to make the process workable and more efficient. Much work had been done in the field of lossy image compression based on wavelet and Discrete Cosine Transform (DCT). In this paper, an efficient image compression scheme is proposed, based on a common encoding transform scheme; It consists of the following steps: 1) bi-orthogonal (tab 9/7) wavelet transform to split the image data into sub-bands, 2) DCT to de-correlate the data, 3) the combined transform stage's output is subjected to scalar quantization before being mapped to positive, 4) and LZW encoding to produce the compressed data. The peak signal-to-noise (PSNR), compression ratio (CR), and compression gain (CG) measures were used to perform a comparative analysis of the performance of the whole system. Several image test samples were used to test the performance behavior. The simulation results show the efficiency of these combined transformations when LZW is used in the field of data compression. Compression outcomes are encouraging and display a significant reduction in image file size at good resolution.

**KEYWORDS:** Wavelet Decomposition, DCT De-correlation, Scalar Quantization, String Table Encoding

## 1. Introduction

Images demand a lot of storage space, a lot of transmission bandwidth, and a lot of transmission time since they contain a lot of information. To reduce the number of bits required to represent an entity to match the actual situation, it is beneficial to compress the image by keeping only the information necessary to rebuild the image [1]. Data compression is a method for reducing redundant data representations, which lowers the need for data storage and, in turn, lowers communication costs. Increasing the capacity and transmission bandwidth of the storage media is comparable to decreasing the amount of storage required. Therefore, creating effective compression methods will remain a design problem for advanced multimedia applications and communication systems. Redundancy and information are combined to represent data and to appropriately evaluate the meaning or purpose of the data, information is a part of data and must be permanently kept in its original form [2].

Redundancy is the part of the data that can be eliminated when it is not required or reinserted to help analyze the data when it is required. To produce the original data in its original form, the redundancy is typically reinserted. Data compression is the practice of reducing data redundancy. Decompression of the data is the process of reducing redundancy in data representation so that it can later be reinserted to recover the original data [3, 4].

The goal of this work is to develop a color image compression system that is effective and efficient and is based on wavelet transformation and DCT. The image is split into four subbands where the wavelet processing is applied. For a specified number, the wavelet transform is repeated. After then, each subband is split up into a set of blocks, and each block is subjected to a DCT transformation. For each block, adaptive scalar quantization was used. By taking advantage of the fact that these high-frequency blocks can be treated separately from low frequencies to produce better compression, the

level of the quantization values varies according to the block feature, whether it is high frequency detailed blocks or low frequency correlated blocks. LZW is used to compress the data in the end. Compression ratio (CR), peak signal to noise ratio (PSNR), compression gain (CG), and encoding and decoding times are frequently used to estimate an image compression system's efficiency.

## 2. Literature Review

Review of the compression methods using the DCT section (2.1) and wavelet transformation section (2.2).

### 2.1. Image Compression with DCT

In [5] the authors suggested image compression strategies employing the DCT method with various blocks and quantization methods for lowering the blocking artifacts in reconstruction images. The maximum image dimension is divided into a maximum block size in the suggested approach, which then compresses the image. The proposed method divides the image into blocks (4×4, 8×8, 16×16, and 32×32). A PSNR score is produced using different quantization matrices to compare the performance of the original and reconstructed pictures. Based on the data, it can be concluded that the restored image becomes deformed as the quantization matrix's maximum value lowers. According to [6], the RGB to YCbCr color transformation process is used to carry out the proposed compression technique. Second, blocks are divided into the edge and non-edge blocks using canny edge detection. Each Y, Cb, and Cr color variable is compressed, quantized, and coded by the (DCT) method using adaptive arithmetic coding. The fast JPEG image compression technique based on DCT was proposed by [7]. The algorithm describes how to encode and decode images for JPEG. The image's encoding component can use JPEG to process images in the BMP format and compress them into binary files for real-time storage. The related decoding program can decompress the image. Additionally, the JPEG format can be used to encode a static image, and the color RGB of the JPEG image can be transformed into brightness  $y$ , Chroma Cr, and CB, which can efficiently minimize Chroma data and achieve compression. This is possible since human vision is not sensitive to Chroma.

### 2.2. Image Compression with Wavelet

To produce better-decompressed image output than the compression approach DWT+DCT [8], the authors introduced the Hybrid Integer Wavelet Transform (IWT) and Discrete Cosine Transform (DCT). In comparison to DWT-based and hybrid DWT DCT-based image compression approaches, the proposed combination IWT + DCT-based compression methodology decreases

fractional loss and hence offers a higher image quality of the decompressed image on high compression ratios. According to [9] the proposed approach begins by separating the image into sub-images and uses a high-level discrete wavelet transform, multiple levels of compression are used. With high-quality reconstructed images, the Huffman code with non-uniform Quantizer has also been employed to reduce the compression data rate. The suggested method's encouraging simulation results met the most important criteria, which are represented by the great image quality and a high image compression ratio. As an illustration, the PSNR and compression ratio (CR) of the Lena image achieved by the proposed approach simulation were 42.4094 dB and 47.5435, respectively. In [10] for effective and economical image compression, the discrete wavelet transforms (DWT) based on HAAR wavelets is used. Since the coefficient of HAAR DWT is either 1, or -1, it offers a simple method of compression. The temporal and frequency analysis employs wavelet transforms. After three levels of decomposition, a greater compression ratio is obtained in this paper. By taking into account both the image's overall quality and specific visual elements, the results are encouraging.

## 3. Image System Model

Image compression algorithms have been used with four connected stages in the suggested compression system to produce a high compression ratio with high image quality. A. Load image file, B. Transform Coding, C. Quantization, and D. Entropy Encoder are the steps in this process. To acquire the image data, the load image file is first used. Second, an appropriate transform (DWT and DCT) is done. Thirdly, the results are subjected to a scalar quantization operation to eliminate any psycho-visual redundancies that may still exist. It should be noted that the quantization is performed just once after applying both transforms. After mapping quantization values to positive numbers, LZW coding is used to code the data. Figure 1 indicates the structure of the system model; the following sections go into more depth about each stage of the system.

### 3.1. Load Image Data

The essential information of the image, as well as the data for the three red, green, and blue bands, are obtained by reading the image data.

### 3.2. Transformation Coding

In this stage, the image data is converted from the time domain to the frequency domain using the bi-orthogonal (Tap 9/7) wavelet transform and Discrete Cosine Transform (DCT).

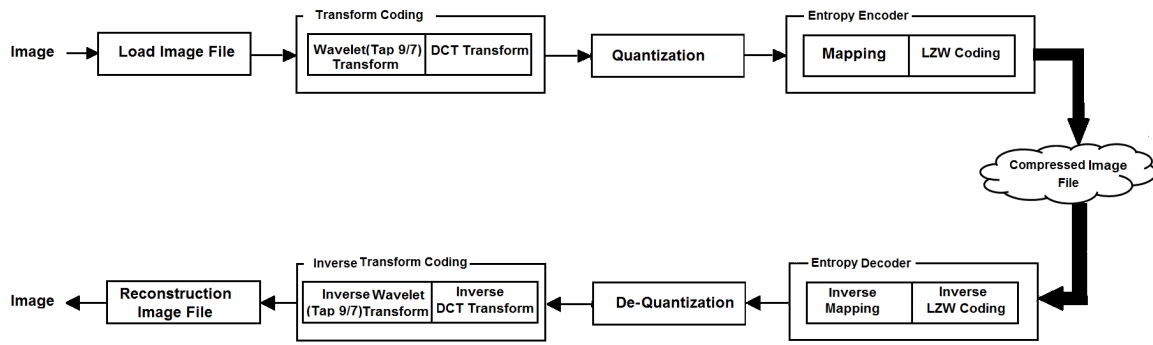


Figure 1: The System Structure

- Discrete Cosine Transform (DCT): The choice of this method as the JPEG standard has made it the most widely used image compression approach over the past few years [11]. A lossy compression technique called discrete cosine transform transforms NxN blocks from the spatial domain to the DCT domain. Concerning the visual quality of the image, the discrete cosine transform (DCT) assists in dividing the image into components (or spectral sub-bands) of varying relevance [12].
- Wavelet Transform: The wavelet transform has emerged as a key technique for image compression. Wavelet-based coding significantly improves image quality at high compression ratios, primarily because wavelet transforms have higher energy compaction properties [13]. The wavelet transform procedure is a straightforward idea. To replace the original transformed image, four new sub-images are created. Each sub-image is one-fourth the size of the original [14].

### 3.3. Quantization

Because it uses fewer bits to hold the transformed coefficient, quantization is regarded as the main source of the compression process. The quantizer reduces the accuracy of the transformed coefficient values because quantization is a many-to-one mapping [14]. In the quantization process, each coefficient in the fixed block DCT array is divided by a corresponding element  $Q_s$  that is generated adaptively using the equation [15]:

$$DCT_{Q_s}(x, y) = \text{round} \left( \frac{DCT(x, y)}{Q_s} \right) \quad (1)$$

Where the  $Q_s$  is calculated by the following equations:

$$Q_s = \begin{cases} Q_0 & \text{for DC coefficient} \\ Q_1 \times (1 + \alpha(u, v)) & \text{for AC coefficients} \end{cases} \quad (2)$$

### 3.4. Entropy Encoder

Use the right set of entropy encoders to effectively reduce any statistical redundancy that may be present in the resulting converted data. The mapping to positive and LZW are utilized at this step.

- Mapping to positive: Each positive value is transformed into an even number in the mapping stage, whereas each negative element's value is transformed into a positive odd number. The straightforward mapping equation is shown below [16] can be utilized to apply this conversion:

$$m_{\text{out}}(i) = \begin{cases} 2V(i) & \text{if } V(i) \geq 0 \\ -2V(i) + 1 & \text{if } V(i) < 0 \end{cases} \quad (3)$$

- Lempel Ziv Welch (LZW): Conceptually, LZW encoding is quite straightforward. The goal is to generate a dictionary (a table) of the strings used during the communication session at the beginning of the coding process. To decrease the amount of data communicated, previously encountered strings might be substituted by their index in the dictionary if both the sender and the receiver have a copy of it [17].

## 4. Proposed Compression System

One of the most helpful uses of this system is transform-based compression, which enables the effective transmission, storage, and display of images that would otherwise be impossible. The processes that the image goes through to be compressed are as follows:

- Red, Green, and Blue band values are calculated by reading the color image.
- Each band is subjected to the bi-orthogonal 9/7 wavelet transformation, which separates the band data into the (LL, LH, HL, HH) coefficients.
- Each subband has a certain type of image data. Depending on the value of the parameter (i.e.,  $N_{\text{pass}}$ ) for the number of wavelet transform passes, which the user has previously defined, the transform process may be repeated.
- Creating a set of pointers that denote the beginning (be) and ending (ed) of each subband of the wavelet coefficients.
- Each subband's wavelet coefficients are divided into blocks of ( $N \times N$ ). After that, each block is handled independently until the final one.



- Using the DCT transform, the data of each block (i.e., each subband of the wavelet coefficients) is independently deconstructed.
- Because the results of wavelet-DCT coefficients are real-valued, they must first be quantized to increase compression. Equations [1, 2] are used to apply uniform scalar quantization to the converted wavelet-DCT coefficients of each created block.
- To simplify the coding procedure for the following phase, equation [3] is used to map the sequence elements to be positive values.
- Encode the mapping data using the LZW compression algorithm to obtain compressed data.

4.1. Decoding

Decompression works in reverse of the steps involved in image compression and aims to restore the original image without compression. Where it contains LZW decoding, mapping to negative, dequantization, inverse DCT for each block, inverse wavelet transform, and reconstructed image data. The decoding method is shown in Figure 1.

5. Results

Various standard images were selected; all the images are square color scale images of size 256×256 pixels of 24

bit/per pixel shown in Figure 2. The effectiveness of the following system parameters was investigated:

- $N_{pass}$  the number of wavelets passes, with range {2, 3, 4, 5}.
- $Q_0$  is the quantization parameter for DC coefficients, with range {1, 2,..., 20}.
- $Q_1$  is the quantization parameter for AC coefficients, with range {10, 11,..., 30}.
- Alpha ( $\alpha$ ) is the scaling factor for AC coefficients, with range {0.01, 0.02, .., 0.1}.
- Blks the block size, with range {4×4, 8×8, 16×16}.

The values of these variables were tested on the image, and the values of the compression ratio, compression gain, and the quality of the resulting image were changed. The results of these tests are shown in the Table 1. The proposed system in the Table 2, Table 3, Table 4, Table 5, and Table 6 was tested for the impact of the parameters. Increasing the values of these variables leads to an increase in the compression ratio and compression gain with a decrease in image quality. The PSNR value verifies that the compression and reconstruction of the original image are better even at level 2 of the wavelet transform,  $Q_0=1$ ,  $Q_1=20$ ,  $\alpha=0.06$ , and  $Blks=8\times 8$ . The results were also compared between the time of compression and the time of decompression of Lena's image in the Table 7, and the table showed good results.

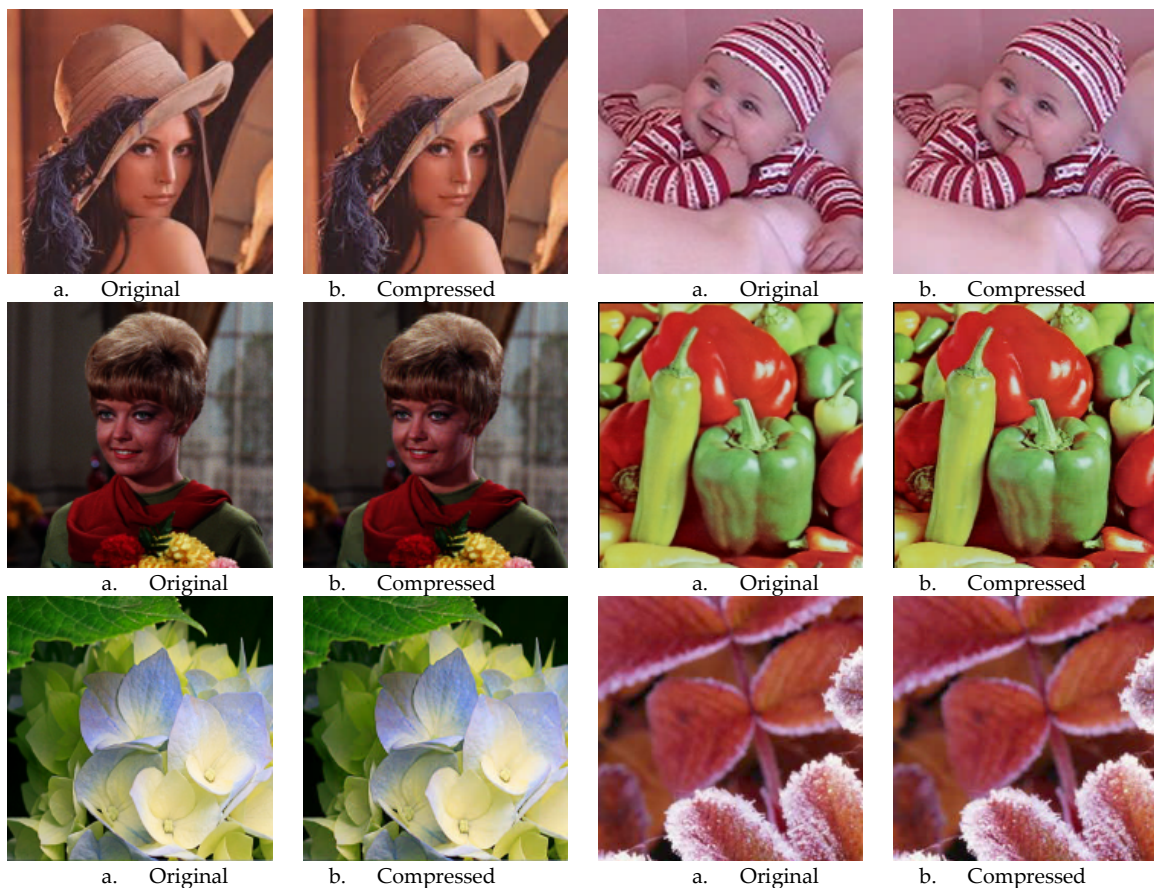


Figure 2: The Test Samples



Table 1: The Control Parameters' Default Values with the Best PSNR and CR

Sample s	$N_{pass}$	$Q_0$	$Q_1$	$\alpha$	CR	CG	PSNR
Lena	2	11	20	0.06	22.04	95.56	32.22
Child	2	23	21	0.06	15.48	94.83	32.03
Girl	2	24	20	0.06	19.60	95.18	32.15
Pepper	2	25	17	0.06	13.28	92.22	32.08
Flowers	2	25	17	0.06	16.97	93.31	32.19
Winter	2	18	21	0.06	18.84	95.15	32.00

 Table 2: The effect of  $N_{pass}$  on CR and PSNR

$N_{pass}$	CR	CG	PSNR
2	22.039	95.56529	32.225
3	23.639	95.92692	30.269
4	24.304	96.06018	29.057
5	24.544	96.10596	28.168

 Table 3: The Effect of  $Q_0$  on CR and PSNR

$Q_0$	CR	CG	PSNR
1	12.1	94.87	35.93
2	13.2	95.06	35.63
3	14.2	95.19	35.13
4	15.3	95.28	34.83
5	16.3	95.35	34.23
6	17.4	95.41	33.93
7	18.4	95.45	33.63
8	19.4	95.48	33.22
9	20.4	95.51	32.93
10	21.9	95.54	32.72

$Q_0$	CR	CG	PSNR
11	22.0	95.56	32.22
12	23.1	95.57	31.92
13	24.2	95.59	31.52
14	25.2	95.60	31.01
15	26.3	95.62	30.81
16	27.3	95.63	30.51
17	28.4	95.64	30.10
18	29.4	95.64	29.80
19	30.4	95.64	29.50
20	31.4	95.65	29.09

 Table 4: The effect of  $Q_1$  on CR and PSNR

$Q_1$	CR	CG	PSNR
10	15.2	92.15	36.67
11	15.9	92.70	36.04
12	16.7	93.16	35.45
13	17.5	93.58	34.91
14	18.3	93.96	34.45
15	19.0	94.30	34.02
16	19.8	94.59	33.60
17	20.6	94.88	33.23
18	21.4	95.12	32.87
19	21.8	95.35	32.53
20	22.0	95.56	32.22

$Q_1$	CR	CG	PSNR
21	22.8	95.75	31.95
22	23.6	95.92	31.69
23	24.4	96.08	31.44
24	25.1	96.21	31.20
25	25.9	96.35	30.98
26	26.7	96.47	30.77
27	27.5	96.59	30.56
28	28.3	96.70	30.37
29	28.9	96.80	30.12
30	29.6	96.90	30.02

Table 5: The Effect of Alpha on CR and PSNR

$\alpha$	CR	CG	PSNR
0.01	17.170	94.35	34.04
0.02	18.943	94.64	33.64
0.03	19.755	94.92	33.26
0.04	20.536	95.16	32.89
0.05	21.254	95.36	32.55

$\alpha$	CR	CG	PSNR
0.06	22.060	95.56	32.2
0.07	23.078	95.73	31.7
0.08	24.050	95.90	31.5
0.09	25.023	96.03	31.1
0.1	26.097	96.17	31.1

Table 6: The Effect of Block Size on CR and PSNR

Blks	CR	CG	PSNR
4×4	16.939	94.64518	34.027
8×8	22.039	95.56529	32.225
16×16	24.103	96.68121	29.794

Table 7: The Encoding and Decoding Time in Second

Samples	ET	DT
Lena	0.209	0.12
Child	0.218	0.182
Girl	0.239	0.140
Pepper	0.233	0.170
Flowers	0.221	0.123
Winter	0.230	0.110

Based on PSNR and CR criteria, the suggested method's performance metrics for Lena's image have been contrasted with the situation of artworks in Table 8. When compared to earlier work, the results indicated a good compression ratio.

Table 8: Comparison with Previous Works

Article	Method	CR	PSNR
[15]	1. The image compression using; DCT and bi-orthogonal (tap-9/7) wavelet transform. 2. Compression using LZW coding. 3. Comparing the results between them.	20.18	32.02
[18]	1. The image is subdivided into blocks. 2. One-D DCT is performed for each block. 3. An adaptive scalar quantization is performed. 4. The zigzag scanning. 5. An adaptive shift encoder is utilized.	12.8	32.22
[19]	1. Fast DCT is used.	20.49	36.468

	2. Removed most of the zeros and keeps their positions in a transformed block. 3. Arithmetic coding is performed rather than Huffman coding.		
[20]	1. Each block of the image is represented with a first-order second-order two-dimensional polynomial. 2. The encoded block size of the image is variable. 3. The polynomial order and the encoded block size are determined dynamically depending on the value of a threshold. 4. A prefix code of two bits is used to differentiate the encoding states. 5. Uniform quantization is applied to the coefficient matrix.	6.9977	31.0126
	Proposed method	22.039	32.225

At the end, the previous work [15] which relied on performing the wavelet transform and DCT transformation separately on the images, then compressing using LZW and comparing the results, unlike this work, which relied on the wavelet transformation procedure, then taking the resulting subbands and performing the DCT transformation on them and then LZW compressing. This work was able to progress on the previous work in terms of compression ratio with the same image quality 32db, but in terms of time only, it was close to the time of the previous work.

## 6. Conclusion

This study used wavelet, DCT, and LZW approaches to create computationally efficient and effective lossy image compression algorithms. Where the results showed that in the previous research [15] the compression ratio is 20.18, which depended on the image compression using; DCT and bi-orthogonal (tap-9/7) wavelet transform, then compression using LZW coding. While in the current research, the compression ratio shows progress reached to 22.039. Therefore, the suggested approach quickly compresses the image. Regarding the quality of the reconstructed images and the preservation of significant image elements, encouraging findings were observed. The project involves applying the bi-orthogonal 9/7 wavelet transform compression, followed by using the DCT approach and comparing results across different input

images. In terms of time compression and decompression, the effort has shown positive results. It demonstrated how changing the values of the parameters affects both the compression ratio, compression gain, and the image quality, because increasing these values leads to lowers the image quality while raising the compression ratio and gain. When compared to a variety of earlier works, the work demonstrated good compression results.

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# The Future of Work after COVID-19 from the Office to the Edge: Using the IT Industry as an Example

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**ABSTRACT:** The spread of the epidemic caused many people to believe the traditional office model is no longer appropriate for modern business, nor is it compatible with the efficiency and innovation demanded by modern business. Individual accomplishment is not measured by where one works, but by achieving a balance between work and life and establishing a connection in the world. No matter where we sit, the energy and thinking we bring to our work will help us accelerate the creation of flexible work models. In 2022, business leaders are dealing with vaccines and back-to-office issues. At the same time, we began to think about a new working model, after listening to the employees' opinions and determining what conditions must exist for collaboration with organizational leaders to succeed. The purpose of this paper is to explore the possibility of using the Delphi method (Delphi) and SWOT method to conduct in-depth interviews with current IT professionals in applying hybrid work models with critical success factors (CSFs) after COVID-19 hoping to bring new ideas and inspirations to business leaders in Taiwan.

**KEYWORDS:** COVID-19, Delphi Method (Delphi), SWOT, Hybrid Work Models, Critical Success Factors (CSFs)

## 1. Introduction

Once in a lifetime, we have the chance to re-image the way we work in the future. In the 1800s, the Industry Revolution moved people from the working places to the factory areas globally. In the 1990s, the invention of personal computers changed the work plan and make sure the office setup is indispensable in increasing workplace productivity and efficiency. The COVID-19 pandemic in 2020 prompted people to quit the office and shift to work from home or other places. Because of the appearance of the vaccination, people have another opportunity to return to the office again. Though the office was the physical setting when employees returned to the office the second time, the role of the office as a workplace has changed and become more flexible, and it is no longer a requirement for some employers, while some employees are forced to leave office and worked remotely also feel reluctant to return to office after enjoying flexible working hours.

After the COVID-19 epidemic, we have just begun to turn on a new page, and there are no fixed solutions nor fixed answers to the challenges. The goal of this research

is to look at the workplace policy, and work norms for the employees and employers to work collaboratively through the hybrid work model; in fact, a clear solution may not appear immediately and the fixed for all solutions may not appear after years to come. The study is discussed with the purpose that it might be helpful for employers and employees to learn the opportunities and challenges of hybrid work and brings both employees and employers work together and use in a test and try corrective approach by changing the way of working, in practice and mindset in the industry.

This research mainly uses the SWOT and Delphi methods as strategy-making tools in assessing office work vs remote work in the IT business.

## 2. Theory

This paper aims at conducting a comprehensive analysis of recent literature, focusing on the Delphi review approach, and investigating numinous ecosystems that organizations must address when adopting hybrid work arrangements, as well as related opportunities and challenges. Hybrid work is being viewed as a clear,



transparent, and mutually respectful approach to a flexible work schedule that would benefit employees and employers. Working from home (WFH) does not always imply that employees are working in the same locations. The expectations are managed differently and conflicts arise between employees and employers.

### 2.1. Historical Review

The term “remote work” was coined in 1972 by Jack Nilles. Nilles was referred to as the “Father of Telework.” At that time, Nilles was investigating the NASA communications project remotely. Nilles announced to the public that he was working on his project remotely, a phrase he created in 1979. The idea of remote work was first proposed in 1920, with much of the early research focusing on productivity, and cost savings while living in main cities [1].

Remote work is working outside the traditional office, which means it can work from home or any place. The distance from the corporate office is the difference between the two. Working from home is defined as working from a location that is less than 50 miles away from the workplace [2]. Remote work is divided into full-time remote (remote full-time work) and telework (remote work one to three days a week). The idea of remote work is not new. Until today, there have been some explanations and surveys in academic research:

- (i) During the 1970s Oil crisis, Frank Schiff invented the term “flexplace” for the idea of remote work [3].
- (ii) The success of remote work is reliant not only on communication technology, but also on work experience, communication skills, and task-related factors. Conflicts happened from time to time, and they must be dealt with as part of the success factors in the aspect of remote work [4].
- (iii) In Gajendran's opinion, telecommuting would not lead to major performance costs; on the contrary, it would improve employees' performance and an organization's “sense of belonging” [5].
- (iv) According to Larson and Makarius, there are two aspects to consider in launching remote work successfully. Establishing the rule of engagement and building trust are the two primary factors [6].
- (v) During the pandemic, telecommuting is technologically workable; however, there are other factors for organizations to consider for telecommuting from the labor market perspective. [7].

The history of remote work is extensive. The most recent research report shows that some experts predict that the popularity of telecommuting will increase exponentially in the coming years. More global companies

are offering remote job positions. As a result, remote work will continue to evolve in the next years.

### 2.2. Delphi Method Review

Delphi is oriented from the oracle at Delphi from Greek mythology. Ancient Greek visited the oracle at Delphi to seek consultation on either private matters or public affairs. The Delphi method is a technique for making decisions based on a weighted survey of respondents' opinions on any controversial subject. It has been widely employed for policymaking and other key issues, where different expert interviewees reveal their views before reaching a consensus. Delphi's method is also known as expert judgment. It is a scientific method to gather the opinions of experts and scholars on a specific topic or event to obtain a consistent view. Delphi's method can assess the status quo and predict the characteristics of the future.

The Delphi technique was created by Rand Corporation in the early 1950s. It used multiple questionnaires to encourage experts to produce consistent judgments in solving complex military and national defense issues [8]. Since the mid-1960s, it has gradually been applied to other research fields. Delphi is a process of organizing a group of communication, allowing a group of people to deal with complex issues. It is widely used in predicting the future, and decision-making in government departments, business, and education circles.

Delphi is about a group of communication processes, which discusses the pros and cons of specific issues, to achieve the goal or to predict the future in the event of an accident when the knowledge about the problem is incomplete. The Delphi approach is used to find the solution and form a group view and build a common goal. Delphi is to set up a series of communication processes to have a panel of individuals tackle problems that occurred. Delphi has feedback processes that are repeated until consensus is struck out. In events when the sample is not sufficient, it may require more than one round of discussion [9]. Hence, it provides qualitative and quantitative results. This study is to combine primary and secondary data in the SWOT method to explore the possibility of hybrid work development and the strategy for success.

### 2.3. SWOT Method Review

Many experts inquire about the acceptance of telecommuting to grow rapidly in near future. To provide greater adaptability, telecommuting can increase employee productivity and reduce employer costs as well, thereby resulting in better solutions for organizations. The SWOT analysis is one of the most popular management strategies. SWOT stands for four words: strength, weaknesses, opportunity, and threat. The method is

assumed that companies will operate the business by the strategies for analysis of aspects of internal and external factors [10].

SWOT analysis assesses business strengths, weaknesses, opportunities, and threats. SWOT looks at both the internal and external to achieve its company's goal or objectives. So, the company can use the SWOT model to assess the Pros and Cons of its strategic planning or the alternative for the organization. The SWOT analysis has been used in many different fields and contexts for strategic planning that has been applied to a wide range of fields and situations. In this study, the SWOT will be used in general management to seize the chance to improve business development for analysis management. It aids managers in developing a competitive strategy [11] in Table 1.

Table 1: SWOT Matrix Strategy

Strength	Weakness
SO	WO
ST	WT

(Analysis of External and Internal Factors)

### 3. Research Methods

This study will adopt a quantitative method to collect related data through the field of experts and use a semi-interview approach in the Delphi method to interview participants based on the interview guideline by the field experts' input in the questionnaires. Due to the use of qualitative methods, the results of the research may be aimed at investigating the research theme and talking about problems in a thoughtful way, in which factors affect the performance of the organization. The interviews will be conducted in a one-on-one session so that the interviews can be regarded as unbiased without other outside influencers.

#### 3.1. Delphi Method

The purpose of using the qualitative approach in the Delphi method is to gain a better knowledge of the problems and how different organizations deal with the transformation to a hybrid work model from the perspective of employers and employees. The qualitative method was chosen because it allows for a strong grasp of language that can be easily understood without complex statistics, as there are already too many surveys and data coming in every day during the COVID-19 pandemic without further analysis or guidance to the company and personnel.

The Delphi method is used to make decisions based on a weighted survey of respondents' opinions on any controversial subject. It is commonly used for policymaking and key issues, where different expert

interviewees reveal their views before reaching a consensus. Following are the steps of the Delphi method used in the study:

- Experts in Technology and related industries are identified and invited to take part in the survey. Experts are business professionals who have sufficient experience before evaluating SWOT variables.
- Researchers made improvements to these questions and follow up with continuous questionnaires.
- The participants are expected to make judgments about the advantages, disadvantages, opportunities, and threats of remote work.
- The Likert scale determined the range of participant opinions.
- The participants re-evaluated extreme opinions. Before the interview, strength-opportunity (SO), strength-threat (ST), weakness-opportunity (WO), and weakness-threat (WT) strategies are formulated.
- The success factors (CSFs) for remote work success are further sorted out.

#### 3.2. Likert Scale Method

To make specific decisions, experts' opinions on similar issues are evaluated with weighted values. Many times, the Likert scale is used to measure expert opinions. There are a variety of rating scales available for determining a respondent's ability to answer any question. These order scales measure the degree of agreement or disagreement. The Likert scale is one of the most popular rating tools for measuring the ability of interviewees. The principle of the Likert scale is by asking participants to respond to a series of affirmations on a subject and to measure their attitudes based on their degree of agreement with these affirmations, so it incorporates cognitive and stimulating components.

The Likert scale, often known as the frequency scale, employs the pre-defined response format to assess attitudes or opinions [12]. It repurposes that the intensity or strength of the experience is linear, such as from strongly agree to strongly disagree, and that attitudes can be quantified. Each respondent opts for one of five to seven or even nine pre-coded responses in which the neutral points are neither agreed nor disagreed.

#### 3.3. Research Targets

The research targets are mainly innovative leaders in different global technology service companies with extensive experience in hybrid work and who have laid down their remote policy or working norms in a remote workplace. There are four global IT companies in Taiwan being selected. These four companies including Salesforce partner company in Taiwan, IBM, Microsoft, and HPE, are the main sources, but not limited within, when

considering including a financial IT-related bank into account because of its advanced IT application and hybrid workspace.

For the participants in this study, the interviews were conducted with both employers and employees to obtain perspectives from both sides. In this study, due to confidentiality concerns with some of the subjects, the names of interviewees will be kept anonymous, however, the positions, including industry, business unit, and job title, will be disclosed.

#### 4. Research and Analysis

This chapter applied a mixed approach in the use of the Delphi method and SWOT to examine the pros and cons of remote employment post-pandemic. In the Delphi method, two rounds of interviews are planned and conducted involving experts from employees and employers in the IT-related industry with remote work exposure. In the SWOT technique, the SWOT matrix will be paired with opportunity and challenge. The Delphi method is applied because 1) the research is about the exploratory factors of remote work; 2) a group of industry experts who understand the problem individually, managerially, and organizationally, rather than individual responses; 3) the design is flexible, allowing a deep understanding of the problem in-depth interviews.

This section presents findings for two rounds of Delphi interviews, and the findings consist of 10 critical success factors (CSFs) of remote work experience. The 10 CSFs are to be identified, categorized, prioritized, and combined with the SWOT technique for further analysis.

##### 4.1. Delphi Interview Design and Analysis

This research started in the beginning by reviewing the recent literature to identify the crucial factors which impact remote work. The identified factors were further delved into through IT professionals- employers and employees, using two rounds of the Delphi method.

The first step involves going through the recent literature and latest publications, then obtaining feedback from IT-related professionals, including human resources, and academia experts with remote experience who are deeply familiar with the issue and have valuable knowledge in this area. The sampling approach is used in this survey in that the participants are named through individual connections. The questionnaire was consisting of open-ended questions based on the content of remote work extracted from the literature on remote work regarded and distributed.

According to the interviews, we collect ideas and questions one by one. As the result of round two questions, the top ten remote work factors are checked for more precise details; these will be sorted by significance so that we can narrow the scope of the statistics as the basis. In this way, the results of each interview are collected and revised to make different weightings, constrict the compass of statistics, and conclude the critical success factors (CSFs). The 10 CSFs are further revealed and grouped into four dimensions: Technology, Communication, Culture/Wellness, and Flexibility. Remote work presents limitations in time and effort, so it is difficult to consider all factors. The selected companies participating in this study met the introductory conditions and mode of operations of remote working, as well as exploratory targets.

To acquire fair perspectives, the interviews were conducted with managers and employees. The participants must have at least 3 years of work experience and remote work experience for six months at least. This section is separated into two parts to arrive at a logical and straightforward manner. The first part is based on the managers' and employees' feedback on the SWOT matrix, while the second part is based on their ranking of the critical success factors (CSFs). The survey results are based on joint feedback. It was agreed to remain anonymous in this study due to the necessity for privacy. The interviewees' industry and job titles are revealed in Table 2. Categorization of Interviewees.

Table 2: Categorization of Interviewees

Code	Company	Industry	Role	Position
M1	Company S(F)	IT Cloud	Head of the Company HR	Chairman
M2	Company I	IT Service	Head of the Company	HR Director
M3	Company M	IT	IT Department	IT Department Manager
M4	Company H	IT	Business Manager	Manager of Service
M5	Bank C	Finance	Information IT Manager	CIO
E1	Bank C	Finance	Credit Card Business	Relation Mgmt Consultant
E2	Company M	IT	Desk Site Support	Computer Specialist
E3	Company I	IT Service	Computer Technician	Computer Technician
E4	Company S(F)	IT Cloud	Financial Analyst	Financial Consultant
E5	Company I	IT	Computer Technician	Computer Data Center Operator

##### 4.1.1 Likert Scale

In this study, we use the Delphi method to listen to expert opinions and conduct investigations before making suggestions on future IT remote work strategic planning. Experts' evaluations are weighted using the Likert scale. The Likert scale is used on a scale of 1 to 5. The comments for each point are recorded in Table 3.

Table 3: Expert Evaluation of Factors in the Likert Scale

Scale	Result	Result Interpretation
1	Strongly agree	Strongly influenced
2	Agree	Influenced
3	Neutral	Neutral or do not know
4	Disagree	Not influenced
5	Strongly disagree	Strongly not influenced

The opinions of experts in the areas of strengths, weaknesses, opportunities, and threats are quantified by the Likert scale. As industry experts reported multiple variables for each factor: strengths, weaknesses, opportunities, and threats. By considering the Likert scale rating provided to experts, each variable is evaluated with a numeric (1-5) value. According to the weighted evaluation of experts, the different variables of the determined intensity factors are listed in Table 3. Similarly, the different variables of Weakness, Opportunity, and Threat are shown in Table 4, Table 5, Table 6, and Table 7.

Table 4: Expert Evaluation of Strength Factor

No	Strength Factor
1	Flexible Schedule
2	Lack of Commute
3	Reduced Cost
4	Able to Care for Family
5	Reduced Burnt Out
6	Improved Health Physically And Mentally
7	Freedom to Travel or Relocate
8	Enhanced Work Autonomy
9	Increased Availability
10	Reduced Office Politics

Table 5: Expert Evaluation of Weakness Factor

No	Weakness Factor
1	Distractions
2	Communication Barrier
3	Missing Social Connections
4	Un-Comfortable Environments
5	Lack of IT Support
6	Time Management
7	Work and Personal Lifeline Is Blurred
8	Lack of Monitoring
9	Performance Evaluation Is Injustice
10	Conflict Problem

Table 6: Expert Evaluation of Opportunity Factor

No	Opportunity Factor
1	Improving Productivity
2	Talents Around the World
3	Work-Life Balance
4	Increasing Job Satisfaction

5	More Happy Workers
6	Attracting New Generation Workforce
7	Cost Saving
8	Improving Mobility
9	Accelerating Employee Growth
10	Add Value

Table 7: Expert Evaluation of Threat Factor

No	Threats Factor
1	Cyber Security
2	Company Culture will be Impacted
3	Lack of Innovation
4	Privacy
5	No Clear Work from the Remote Policy
6	Extra Expense When Working from the Remote
7	High Competition in Talent
8	Training Challenge
9	Knowledge Fragments
10	Lack of Attendance

Table 8: SWOT Matrix from Managers' Perspective

		Strength	Weakness
SWOT	1	Flexible schedule	Distractions
	2	Lack of commute	Communication barrier
	3	Cost of savings	Missing social connections
	4	Able to care for family	Un-comfortable environments
	5	Reduced anxiety/burnt out	Lack of IT support
	6	Improved health physically and mentally	Lack of supervision
	7	Freedom to travel or relocate	Work and personal life line is blurred
	8	Enhanced work autonomy	Time management
	9	Increased availability	Performance evaluation is injustice
	10	Reduced office politics	Conflict problem
<b>Opportunity</b>		<b>Maxi-Maxi (S-O) Plan</b>	<b>Mini-Maxi (W-O) Plan</b>
1	Improving productivity	CFR: 1 Technology	CFR: 4 Flexibility
2	Talents around the world	CFR: 4 Flexibility	CFR: 2 Collaboration/Communication
3	Work-life balance	CFR: 2 Collaboration/Communication	CFR: 2 Collaboration/Communication
4	Increasing Job satisfaction	CFR: 2 Collaboration/Communication	CFR: 5 Company culture- workplace
5	More happy workers	CFR: 6 Productivity	CFR: 1 Technology
6	Attracting new generation workforce	CFR: 3 Company culture	CFR: 6 Productivity
7	Cost saving	CFR: 7 Cost benefit	CFR: 7 Cost benefit
8	Improving mobility	CFR: 8 Mobility	CFR: 8 Mobility
9	Accelerating employee growth	CFR: 9 Training	CFR: 9 Training
10	Add value	CFR: 3 Company culture	CFR: 6 Productivity
<b>Threats</b>		<b>Maxi-Mini (S-T) Plan</b>	<b>Mini-Mini (W-T) Plan</b>
1	Cyber security	CFR: 1 Technology	CFR: 1 Technology
2	Company culture will be impacted	CFR: 8 Managing mobility	CFR: 2 Collaboration/Communication
3	Lack of innovation	CFR: 1 Technology	CFR: 1 Technology
4	Privacy	CFR: 1 Technology	CFR: 1 Technology
5	No clear work from the remote policy	CFR: 3 Company culture	CFR: 10 Government support
6	Extra expense when working remotely	CFR: 5 Wellness	CFR: 5 Wellness
7	High competition	CFR: 1 Technology	CFR: 5 Wellness
8	Training challenge	CFR: 9 Training	CFR: 9 Training
9	Knowledge fragments	CFR: 5 Productivity	CFR: 3 Company culture
10	Lack of attendance	CFR: 1 Technology	CFR: 2 Collaboration/Communication

#### 4.1.2 SWOT Matrix

In a SWOT analysis, strength and opportunity are considered positive, while weakness and threats are negative with the external factors paired with internal factors. In the study, through the SWOT matrix, the positive factor is maximized while the negative factor is minimized. The plan is divided into four separate quadrants: Maxi-Maxi (S-O), Mini-Maxi (W-O), Maxi-Mini (S-T), and Mini-Mini (W-T) strategies. In the maxi-maxi (SO) strategy, the favorable strength and opportunity variables are maximized; in the Mini-Maxi (WO) strategy, the unfavorable weakness variables are minimized, and the fascinating opportunity variables are maximized; in Maxi- In the Mini (ST) strategy, the ideal intensity variable



is maximized, and the unwanted threat variable is minimized. In the Mini-Mini (WT) strategy, weaknesses and threats are both unfavorable variables. When a remote work plan is implemented, the threats are addressed, such as employees' physical and mental wellness are not emphasized enough as minimized threats. Here the Remote work business plans categorized by 10 critical success factors for external and internal variables are developed and recorded in Table 8 for managers and Table 9 for employees.

Table 9: SWOT Matrix from Employees' Perspective

		Strength	Weakness
SWOT	1	Flexible schedule	Distractions
	2	Lack of commute	Communication barrier
	3	Cost of savings	Missing social connections
	4	Able to care for family	Un-comfortable environments
	5	Reduced anxiety/burnt out	Lack of IT support
	6	Improved health physically and mentally	Lack of supervision
	7	Freedom to travel or relocate	Work and personal life line is blurred
	8	Enhanced work autonomy	Time management
	9	Increased availability	Performance evaluation is injustice
	10	Reduced office politics	Conflict problem
<b>Opportunity</b>		<b>Maxi-Maxi (S-O) Plan</b>	<b>Mini-Maxi (W-O) Plan</b>
1	Improving productivity	CFR: 4 Technology	CFR: 1 Flexibility
2	Talents around the world	CFR: 1 Flexibility	CFR: 2 Collaboration/Communication
3	Work-life balance	CFR: 2 Collaboration/Communication	CFR: 2 Collaboration/Communication
4	Increasing Job satisfaction	CFR: 2 Collaboration/Communication	CFR: 5 Company culture - workplace
5	More happy workers	CFR: 6 Productivity	CFR: 4 Technology
6	Attracting new generation workforce	CFR: 5 Company culture	CFR: 5 Company culture
7	Cost saving	CFR: 7 Cost benefit	CFR: 7 Cost benefit
8	Improving mobility	CFR: 8 Mobility	CFR: 8 Mobility
9	Accelerating employee growth	CFR: 9 Training	CFR: 9 Training
10	Add value	CFR: 10 Add value	CFR: 6 Productivity
<b>Threats</b>		<b>Maxi-Mini (ST) Plan</b>	<b>Mini-Mini (WT) Plan</b>
1	Cyber security	CFR: 4 Technology	CFR: 4 Technology
2	Company culture will be impacted	CFR: 8 Managing mobility	CFR: 2 Collaboration/Communication
3	Lack of innovation	CFR: 4 Technology	CFR: 4 Technology
4	Privacy	CFR: 4 Technology	CFR: 4 Technology
5	No clear work from the remote policy	CFR: 5 Company culture	CFR: 1 Flexibility
6	Extra expense when working remotely	CFR: 3 Wellness	CFR: 3 Wellness
7	High competition	CFR: 4 Technology	CFR: 3 Wellness
8	Training challenge	CFR: 9 Training	CFR: 9 Training
9	Knowledge fragments	CFR: 2 Collaboration/Communication	CFR: 2 Collaboration/Communication
10	Lack of attendance	CFR: 4 Technology	CFR: 2 Collaboration/Communication

#### 4.1.3 Critical Success Factors

Based on our SWOT analysis, we found that most employees are keen to continue working remotely for most of their careers. Our data indicates that 70% of those we interviewed expressed support for this statement. Additionally, the interviewees said that they would recommend remote work to others after trying it. Consequently, most remote employees wish to continue working remotely for a certain period - but are they satisfied with how often they can work remotely? During in-depth interviews, most interviewees said they are satisfied with the amount of time they currently work remotely; however, it varies from company to company and employee to employee. Working remotely comes with challenges. There are three top challenges associated with remote work: distraction, collaboration/communication, and missing social contact. The top benefit most people reported was "flexibility." In most cases, remote employees prefer to work from home and cite their home as their main place of work. The second-place employees chose to work is the co-working place. Some of them also mixed it up with homes, co-working places, and coffee shops.

Most employers and employees believe that mixed work is feasible and predictable in the future. Employees will list remote/mixed work as an important consideration for their future work. Employees believe that mixed work is feasible and prefer it as their way of working in the future. From the perspective of the benefits, most employers believe that mixed work will increase flexibility in work arrangements helping formulate flexible recruitment plans and reduce company costs. Most employees believe that mixed work is a way to achieve work-life balance, and can promote better time management and save costs.

Both employers and employees recognize that IT technology is the leading skill of the future. However, when it comes to the responsibility to close the skills gap, the two sides are at odds. Although many employees want their employers to safeguard their future, not many employers think so. The majority of employers regard basic IT technology as a "must" requirement for recruitment. Few employers believe that their workforce has the skills to fully adapt to the new normal. Most employers are willing to provide IT-related training to their employees. For employees to cope with the new normal, employees said they need to improve their IT technology, such as artificial intelligence, big data, and cloud technology. More than half of employees expect their employers to arrange relevant training to improve productivity and competitiveness. In addition, the top IT challenges such as data security risks, and lack of proper IT infrastructure are mentioned. Employees said that flexibility is the top factor followed by communication, wellness, and teamwork network connection (Technology). We will delve into these critical factors listed in Table 10 in the next chapter.

Table 10: Critical Success Factors

ID	Success Factors - Manager	ID	Success Factors - Employee	MSF vs ESF ranking
MSF1	Technology	ESF1	Flexibility	Technology (MSF1, ESF4)
MSF2	Collaboration	ESF2	Collaboration	Collaboration (MSF2, ESF2)
MSF3	Culture	ESF3	Wellness	Culture (MSF3, ESF5)
MSF4	Flexibility	ESF4	Technology	Flexibility (MSF4, ESF1)
MSF5	Wellness	ESF5	Culture	Wellness (MSF5, ESF3)
MSF6	Increasing Productivity	ESF6	Increasing Productivity	Productivity (MSF6, ESF6)
MSF7	Cost-benefit	ESF7	Cost-benefit	Cost-benefit (MSF7, ESF7)
MSF8	Managing Mobility	ESF8	Managing Mobility	Mobility (MSF8, ESF8)
MSF9	Training	ESF9	Training	Training (MSF9, ESF9)
MSF10	Government Support	ESF10	Add Value	Government Support (MSF10, ESF11)
MSF11	Add Value	ESF11	Government support	Add Value (MSF11, ESF10)

#### 4.2. Qualitative Data Analysis and Results

During the interview, ten critical factors are extracted. Yet, there are slight differences between the employers' and employees' views in the rankings. The result shows that remote work takes place in highly technical, highly competent, and highly motivated work environments. Employers need to be familiar with distance leadership so that they can effectively communicate with both the remote team as well as the on-site employees.

Also, the results of these interviews are similar to previous research. This study goes beyond the remote work model to examine the hybrid work model that combines technology, communication, and the company's culture as a human-centric workplace. First of all, Technology plays a key role in enabling a smooth and efficient remote working experience for IT equipment deployment and broadband network setup at home or in the office. Second, effective communication or collaboration is crucial for working from home. Working from the remote is phenomenally successful only if there is effective communication, this is a pivotal factor in the success of the practice.

During the interview, the managers stated that hybrid models for remote work would continue to be used for those employees whose job roles require on-site collaboration or socialization. In the workplace, this pandemic causes a shift in cultural and technological aspects. With the pandemic on the decline, more people being vaccinated, and the country's borders reopening, the pros and cons of remote work are becoming clearer. To make it successful in a hybrid work model, managers must consider these four facets: technology, collaboration, flexibility, and culture regarding employee mental and physical health.

##### 4.2.1 Job Role Categorization

After two years of working remotely, most organizations now believe that the physical presence of employees in the office is important in terms of working productivity. It is found that job tasks, proximity to the physical location for human interaction, and use of on-site equipment are the deciding factors to classify employees as remote or office workers. The elements that determine whether an employee is classified as a remote or office worker are job tasks, closeness to the workplace for human connection, and the use of on-site technology. They might be a remote worker or an office worker, depending on the jobs or job duties they have held in the company. The likelihood of remote work depends on the mix of tasks carried out by industry employees as well as their

physical, spatial, and interpersonal relationships. Whether a task is remote or not depends on whether employees must travel to the location to complete it, interact with others, or use specialized equipment on-site.

In remote working scenarios, many job tasks call for the use of hands-on tools that cannot be done online. These activities include administering care, managing machines, using lab equipment, and processing consumer transactions in retail businesses. On the other hand, remote work is possible for activities involving processing, teamwork, consulting, training, and programming. It is more common for workers whose professions involve thinking and problem-solving to work remotely. Hence, the likelihood of managers, developers, and programmers working remotely is higher than the likelihood of employees with jobs requiring on-site testing or the use of operating equipment.

In working settings for the IT business, some positions, such as procurement, may be able to do sourcing operations from home in some circumstances, while other engineers must use the fixture equipment at the laboratory and must operate on-site. In the banking sector, IT support personnel may work online but customer care representatives must be present in person at the bank. The employment responsibilities being carried out in Figure 1 below are the deciding factor, not the industry.

- Bank Clerk (High Physical Interaction, Moderate Remote Potential): Keep in mind that a bank clerk may need to operate from behind a desk to provide client service because there is a high level of physical human interaction. This job role can classify as an office worker or hybrid worker depending on the company's workplace policy.
- Office Administrator (Moderate Physical Interaction, Moderate Remote Potential): Keep in mind that office administrators may need to complete onboard or new hire training and that this job can be classified as either an office worker or a hybrid worker.
- Manager: Take into account that the manager might need to coach staff members and conduct feedback exercises in person while doing problem-solving (Moderately Low Physical Interaction, High Remote Potential). It is proposed that this position be labeled as a remote or hybrid employee.
- Programmer (Low Physical Interaction, High Remote Potential): Based on Low Physical Human Interaction, may work offshore. This position can be labeled a remote worker.
- Taiwan is noted for its high-tech and service industries, both of which offer the ability to work remotely with any of its employees, however, work in professions that can't be remotely supervised, like

construction workers in the retail sector and farmers in the agriculture sector.

Working from home scenarios, are determined not so much by the industry. However, with the new IT through virtual reality and Meta platforms, some job roles will be evolved and the working scenarios will be revised accordingly shortly.

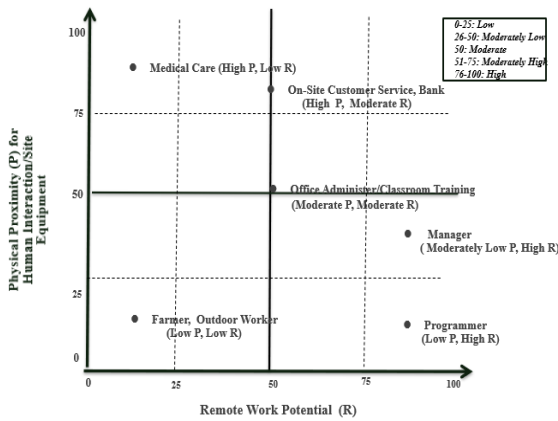


Figure 1: Remote Work by Physical Proximity

#### 4.2.2 Middle Ground is Proposed

Going remotely has advantages and disadvantages. From a productivity perspective, employees do better at home because there is less interference. In addition, the time originally used for commuting can now be used for work. When people are in the same room, there is a cooperation effect for teamwork. Employees usually do the best work through innovation and problem-solving on-site with the team. When working from home, employees may lose the sense of unity and increase burnout. If the company admits the advantages and disadvantages of remote work, the answer is that there is no “right” solution. It only depends on the specific circumstances of the organization and business plan. For example, companies have been remote for years, these companies are in a position for the remote company culture that supports this approach. Companies where employees need to be undisturbed most of their working time in designing for thought processing. In this case, remote work also makes sense.

#### 4.3. Case Study

Globally, COVID-19 has forced almost every organization of employers and employees on how they work. In Taiwan, although many aspects of the human experience and response to the pandemic are the same, there are differences in how employees across geography manage the challenge differently and hold different views toward the future of work. At work, the employees’ optimism about work in the future, feelings about working at home, and the level of work productivity might be varied by market. We asked employees about

their experiences when they re-enter the workplace and manage the working model. We want to understand the impact of time working remotely to see if the change in professional behavior will be permanent or not. Are employees supporting WFH or the office option? The answer is the subtle fusion of the two choices has a far-reaching significant impact on employees and provides insights into future collaboration and productivity.

This case study aims to reduce office working time through verified office solutions to speed up processes and amplify and promote innovation as the early adopter in leading office-to-edge solutions. In this multifaceted environment, the regular 9 to 5 is outdated, and many types of companies are using a variety of workplace solution combinations, including working from home, business lounges, and remote offices, as well as traditional office locations instead of supporting the traditional office solution. This case provides an overview of the office-to-edge opportunity, the motivations, the ecosystems, drivers, benefits, and how the company is evolving to address the effectiveness of the hybrid work.

#### 4.3.1 Reinvent the Office to the Edge

The definition of edge employees: Company employees will primarily conduct work outside of company sites, choosing a location either at home or a coffee shop where they feel most productive. The company office will be used for collaboration, social connections, and other work, leveraging available spaces as needed. The edge employees work on experience elements that embrace flexibility, wellness, and inclusion. The employees will be provided with resources to help maximize productivity and well-being, including a one-time payment for home office equipment. The office will be for collaboration and social connections. It is defined that work should be primarily done outside of company office sites. Edge employees will need to change the schedule of their weeks by proactively grouping meetings, catch-ups, and in-person training for their days in the office.

The definition of office employees: The company office sites will transform to be collaboration hubs, with more open spaces. Office employees will have a workstation and spend most of their time at the office performing their roles. Office employees will be using the office in the same way, but the workstation will be at a free address, meaning that employees working in the workstation, but may not work at the same one every day. This will let the employees organize dynamically every day and the new interaction and allow the seats to be used by the other remote workers when they are not in the



office. Office workers are expected to be more proactive in scheduling meetings, collaboration, and social activities with office workers. According to the remote-oriented office plan, people who can work remotely spent most of their time outside the office only coming into the office when the team required it. Employees on the company's edge employees will receive a one-time payment to optimize the home facility settings.

The definition of the office to the edge: The mixed working model offers employees changeability in working hours and locations. To put it simply, flexible work. There are many forms or ways of mixed work. Companies may provide employees to work in-office and out-of-office for a few days in flexible arrangements, or companies may select a portion of employees as office roles or as remote roles in the hybrid work models. Each company may offer its mixed work arrangements according to its business nature in pursuit of different company cultures. Although remote work has become the new normal around the world, many companies are favoring flexible work planning based on the reason there are still many employees who are passionate about joining the office workforce.

The global pandemic has changed the way people work and live, and businesses are adapting. Many companies are seeing this shift to remote as an opportunity to re-think the future of office work. The next milestone is for which are made or grouped under the remote employees and office employees based upon the job descriptions, location, and other factors that determine how employees need to use the office to perform their jobs. For example, product managers, call center employees with low physical proximity for human interactions, and low site equipment dependency can be classified as remote workers, whereas Hardware engineers working at the research laboratory must use the site equipment and may be required to work on-site for fixture tools can be classified as office employees. Mailing room staff operate as office employees, whereas procurement, finance, accounting, and human resources work as edge employees' potential. The case study is simulated in Figure 2.

- HW Testing Engineers in the research lab(High Physical Interaction, Low Remote Potential): Considering testing engineers may need to utilize the testing tool close to the lab's equipment. This job falls into the category of an office worker who requires a high level of physical interaction but has a little possibility for remote work.
- Delivering Customer Service(High Physical Interaction, Moderate Remote Potential): Based on moderate physical human interaction, may work on-

site or hybrid. This position falls under the category of the office worker.

- Remote Office Supply Chain Team(Moderately High Physical Interaction, Moderately High Remote Potential): Depending on the remote logistics and the local work policy, this team may work on-site or off-site. This employment role may be categorized as either an office worker or an edge worker.
- Human Resource, Financial, and Procurement Team (Moderate Potential for Remote Work, Moderate Potential for Physical Interaction): Depending on the nature of the assignment and the level of physical interaction necessary, working on-site may be an option. This occupational function may be categorized as either an office worker or an edge worker, depending on the locals' workplace policies.
- Manager: This position fits the definition of an edge worker because problem-solving can be done remotely.
- Programmers, Salespeople, and Product Managers fall under the category of edge workers because they have the option of working remotely, require little in the way of direct human contact, and have access to equipment tool usage.

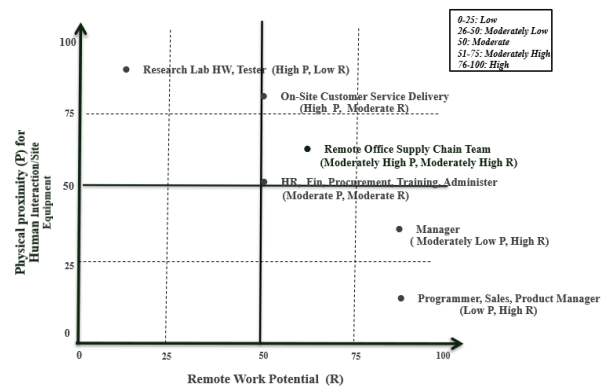


Figure 2: Case Study Remote work by Physical Proximity

#### 4.3.2 Redefined the Office Role

Though now companies are aware many tasks can be performed at home or work remotely. It remains to be seen if remote work can be supported long hours or long-term productivity. Some sectors, such as technology, would be best placed to drive this trend, but the case study shows that the company sees some challenges, as well. The study shows that not all Asian employees feel productive when working from home. Therefore, the office space will remain important, in most cases as the best work environment. However, for those employees who continued to work remotely after the pandemic, it can add the choice of using the office space when needed to add to the flexibility and mobility they enjoy.

In a known remote-centric economy, the future of the organization relies heavily on the company and



innovation on the efforts of its employees; that is, in turn, driven by face-to-face communication, and interaction. Most workers, especially employees in Taiwan, missed the social and human aspects of office life. Therefore, the office will still be an irreplaceable human connection and inspiration, and where the conditions are ripe for innovation. The office provides a cultural place that remote work cannot replicate and serves as a social center for achieving team goals. However, the workspace needs to be re-amended to provide friendly cohort environments for team building between on-site or out-of-site employees.

At the company, how to create a sense of belonging for the work team and communication has become priorities to be solved. The workplace can be employees' homes, coffee shops, or outside the company. The office experience is different for each employee to think of the office as either a collaboration spot, a place for team meetings, or informal chats, and the office space setup with limited workstation, more open seats, and collaborative space for the hybrid work. The priority is to clarify what kind of office the whole industry needs, including the space configuration model in the hope that the space design will bring out employees' full energy in meeting employees' requirements and the organization's cultural integration.

The office physical space has been transformed into a "collaboration center", where employees can safely come together, collaborate, and socialize. Instead of the traditional ways of the go-to office, the near future-fit and responsible companies will seize the opportunity to reinvent the role the office plays in fostering collaboration and productivity, and in creating the work experiences between office and remote to model the way for the company's culture.

#### 4.3.3 People, Process, Technology Transformation

In the event of the COVID-19 pandemic, IT companies are moving most of their office workers to remote work to make it shift from a traditional to a hybrid work model. There are unforeseen obstacles to widespread hybrid work arrangements. Companies are trying out practical steps in helping employees with physical and mental wellness during the crisis. But no matter the steps, the working environment should put employees' human needs first by considering that technology is a tool to balance technology with human nature as technology originated from people. Once a company can define its values and what to prioritize during this period, it can be easier to implement practical methods to cultivate participation and company culture.

The IT company designed a series of programs that leverage the expertise of each functional department that affects the experience of team members: real estate, human resources, communications, and IT. The goal is to deeply embed the corporate culture into the remote or on-site work experience. The company gave three tips to help employees cultivate company culture and connections when working from home. They are 1). Designate a team leader to motivate small group employees as one team. Assign one employee as a team coach to lead the team to challenges, find team volunteer opportunities, and make sure the team has time for social connections. Take time to talk about the team goals and expectations. Challenge, actively debate, and make sure everyone reaches goals and communicates it like this is part of the job. 2). Adopt a new way of working behaviors. Since employees are working in various locations, it is important to establish new norms to ensure a respectful and productive digital work environment. Suggestions have been introduced for a smooth transition to new work arrangements, such as how to organize work areas at home and the establishment of new work routines. Managers also received guidance on how to better participate in teams remotely, including building trust, and empathy behind the scenes, especially for disabled people for inclusiveness. 3). Keep the social connection. To overcome the lack of physical gatherings or face-to-face conversations, employees are encouraged to use the company's common platform to maintain social connections, such as Slack for work and off-work activities.

Hybrid work brought challenges and opportunities. The new normal now is for most companies to shift to a hybrid work model, in which companies re-examine the goal for the on-site work and mix mobile workers for transformation in the organization's productivity and performance. It is the organization's responsibility to provide the technology tools so that the data access from the remote to the office is secure for reliability and serviceability. When considering supporting remote and hybrid environments, technology readiness has a major impact on work productivity. It's imperative to check the scenario cases or user experiences. It is important to start with user experiences to adapt, evaluate internal and external environments, and produce a work plan on how the ecosystems can set up and support employees, employers, and organizations. In addition, as the world recovers and rebuilds, it is to plan by evaluating technical requirements for strategic business, technology coordination, adequacy of operational processes, systems, policy, and culture. The technology evaluation is a critical factor in successful business operation transformation.

Although the changes are not transitory, organizations shall listen to employees' voices and produce a quality mix of work user scenarios to work on-site and out-of-site via a flexible work schedule. On the other hand, the workplace should adapt to the needs of employees and make up for the differences between remote and office employees. We have explained afar the methods the company is adopting in improving productivity, and efficiency while viewing the employees' wellness as a high priority. We used the pandemic crisis as a good user scenario to review the company's workplace, and work model and to develop an innovative value proposition for the intermediate and long-term bold goal. It is to say that the use of hybrid workplace solutions maximizes the potential of employees and organizations from office to remote. Companies have step-by-step work plans and work models to mitigate challenges for change that will emerge from the crisis quickly in a new normal and align with technology as an enabler of the cultural shift.

## 5. Findings and Discussions

This study establishes the framework for objectively assessing remote work experience in the IT industry. During the interview, we developed a model to conduct a comprehensive assessment of CSFs and determine their priority by using the Delphi, Likert scale, and SWOT analysis as effective methods for analyzing problems from the office to the remote. In this study, SWOT is evaluated qualitatively, and the results suggest technology, communication, culture, and flexibility are four pivots in driving full remote work while workplaces require effective communication environments with emphatic leadership in company culture's good forming while with employees' wellness in mind. In the post-pandemic technology industry, hybrid work is more challenging than pure remote work, but it is foreseen that the processes will be streamlined. Amid the management decision-making processes, effective technology paired with communication is the leading factor to start with no matter which working model for the company to adopt. According to the survey findings, employers and employees do not agree on everything. The view from the top is different from the employees on the ground as shown below:

- Technology (MSF1, ESF4): Managers prioritize technology while employees prioritize flexibility as a top crucial factor. The position in three different rankings is that managers expect or intend to soon emerge out of the crisis with a stronger cultural and competition transformation using technology as a

driving force, while employees place a premium on individual autonomy.

- Flexibility (MSF4, ESF1): Employees love the flexibility that comes with working from home, and employers realize this but there is a risk of losing important talent and are trying to strike a balance between employee health, safety, and happiness, as well as cost-effective real estate models and return-to-work schedules. There are no simple solutions.
- Culture (MSF3, ESF5) vs Wellness (MSF5, ESF3): There is two ranking difference view between managers and employees. Employers focus more on culture formation. The work-life balance is the primary factor that contributes to a positive employee experience. Salary is important, but it is not a priority at work. Employees believe that a good work-life balance, being part of a team, and having the tools and equipment suitable for the job are the most important contributors to their positive experience. In practice, there is no precise evidence delving deeply enough into the problem of remote work in industries to distinguish the two factors that matter most to managers and employees. The research shows that there is no one-size-fits-all solution to the problem of the office to the hybrid or the full remote. As companies re-open offices for business, the workplace continues to evolve.
- Government support (MSF10, ESF11) and add value (MSF11, ESF10): Employers rank government support as the tenth factor, while employees rank add value as the tenth. The managers emphasize regulatory compliance in the remote work support while the employees are focused on individual growth.

A company's strategy has an impact on the work model at the workplace. Employees benefit from the hybrid model because they may strike a balance between effective work, stress, and commuting reduction. Employees have more freedom and autonomy in the decision to choose where they want to work while remaining within a work-from-home setting. Employees with more freedom and autonomy are more productive. A range of pilot and experimental methodologies to study the relationship between corporate strategy, organization, and technology are offered as a business considers its potential future types of hybrid work. As a result, these are critical pivots for corporate executives to consider as they embrace this moment of truth to develop a future operating model that is both efficient and resilient. When a company changes its strategy, the work model shifts or changes. Technology, culture, communication, and flexibility are the four pivots to consider while choosing a working paradigm. Managers must evaluate these

elements while selecting a working model. As an organization moves around these four quadrants, four stylized work environments can be explored: standalone offices, hybrid work environments, satellite offices/co-working spaces, or fully remote settings. Managers deal with a variety of stylized work models when it comes to flexibility against rigidity, collaboration versus creativity, and work versus life balance in Figure 3.

Most companies in Taiwan adhere to the global work policy whether it is for remote work or hybrid work. The hybrid work is still in its early stage. Business leaders in Taiwan may use this crisis as an opportunity to reconsider and adopt the prospects and possibilities of flexible work entry into the workplace in the future.

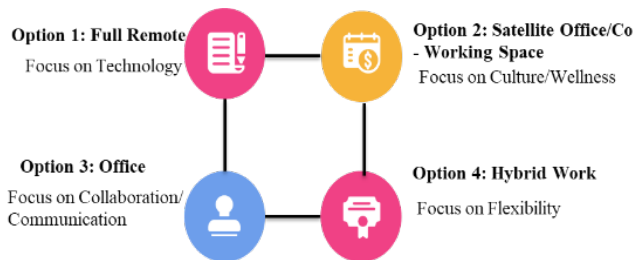


Figure 3: Four Work Models in the Workplace Diagram

### 5.1. Employers' Points of View

In our discussions with managers, we gain an in-depth look at the factors that score high in our interview. Technology, collaboration/communication, culture, and flexibility are the four pillars. The opportunities and challenges of remote work, as well as what the future holds for the management team will be briefly stated in the following session.

#### 5.1.1. Technology

With the new technology, IT companies aim to reinvent the way the office setting and business are performed by using cloud SaaS platforms. Thus, companies are transforming not only their physical offices into flexible offices but are also shifting their business models from hardware to SaaS (Software as a Service). Employees have access to offices that are shared or activities based. The motivations are to encourage teamwork and trust. It can meet employee needs while stimulating organizational growth. As a result, employees communicate and participate more, whether on a virtual or face-to-face basis in their work schedules.

Also, this is not about using high technology at home or work. Instead, the term "technology" is here to refer to skillfulness in the new IT industry. This is not only related to building learning environments for employees to learn it, but also to enable them to become familiar and competent in applying it to their work environment.

Learning to use the technology, effectively using it, and incorporating it in new ways to increase efficiency and effectiveness are equally crucial. Because of this IT adoption, the management team will need to create a highly technological and extensive work environment following this new IT definition. For example, during the pandemic, employees from the supply chain created manuals to increase transparency for long-term data, while engineers use a simple scorecard to track progress on each project. At the close-end of the pandemic, one application was co-created by both team members via Team and Slack communications, with the system up and running with data auto-input.

#### 5.1.2. Collaboration/Communication

In the interview, one company executive said that before the pandemic he used to fly across Asia to meet all his employees. During the pandemic, he used Zoom to meet with all his leadership team in an effective and cost-saving manner. Employees used to communicate via emails, conference calls, or face-to-face meetings in the past. They now have more options following the pandemic. Video conferencing has become more popular and user-friendly with various features such as whiteboards, voting, and brainstorming. People utilize instant messaging and various techniques to share and interact together, and an online message is common. However, it is important to note that face-to-face meetings shall not be overlooked. People need to work out a working model to use these collaborative tools systematically. The physical office may need to be re-design for a better hybrid working model for better collaboration and communication. To take full advantage of these technologies, we need to focus more on the management team communicating expectations and work norms. Employees need informal communication channels to feel being listened to and cared for.

Nowadays, people are becoming technology influencers by ensuring that collaboration tools can be accessed easily and by deploying powerful infrastructure at home and work. Businesses that make employee well-being, work-life balance, and career development the priorities will reap the benefit. Managers need to be role models for their employees, and their corporate social responsibility efforts need to address important social and environmental issues.

Most employees did not want to return to a traditional work environment full-time. This prompted IT companies to launch office-to-remote (outside office) plans in a hybrid work model, the purpose of which is to build



company culture and enhance employee experience, as well as encourage collaboration, innovation, and company values instead of the site-centric stand-alone office. When entering the post-pandemic, offices and physical locations will become hubs from where remote employees can connect, collaborate, and socialize with office employees.

### 5.1.3. Culture

In the wake of the pandemic, companies will plan to adopt the hybrid work model in which some employees will work locally and others remotely, based on the company's strategy. When the organization aligns its working model with its business strategy, it attracts the right talents, increases productivity, reduces costs, improves employee satisfaction, and has respectful leadership. Employee retention is affected by remote leadership during the pandemic. Whether an organization can retain employees is linked to its ability to survive a crisis. Over half of the employees interviewed felt that their opinions of company leaders improved during the pandemic. If there is a career path for them, they are also planning to work for the current company. A company's survival is linked to employees' loyalty.

When homes are converted into offices, the COVID-19 dilemma has a significant impact on how the organization and employers operate overnight. Employees are growing busier and multitasking more frequently. However, something unexpected has happened employees choose to work from home. Employees felt more productive at home and appreciated the freedom of not just where they wanted to work but also the ability to return to the office when necessary. The remote work model is changing, and the flexible work model now provides the opportunity for culture building by increasing employee productivity.

How to maintain company culture and strengthen the value of an organization during the hybrid work model. Productivity is more closely tied to a sense of belonging than to money. A sense of belonging is not rewarded with compensation, but when employees feel that they are part of a team sharing the same values, doing good to the world, and the contributors can be recognized when they take the risks. Create connections in remote areas through virtual meetings, while avoiding fatigue and signing up for a company volunteer event. The purpose of hybrid work aims at maintaining a business culture while strengthening the organization's values.

Taiwanese employees are increasingly working remotely following the global company's policy, proving that people are eager to experience the cultural aspects of the office environment. Although a lot of regional

companies will continue to have offices, greater acceptance of remote work will force them to establish a new work model. Considering mixed work arrangements, employees in the Asia Pacific have high confidence in the company's future, while few are very confident in their career prospects. According to some global surveys, it shows the young generation such as the Millennium has more confidence level to work remotely. The hybrid work model has raised concerns that employees may feel isolated or disconnected. In this case, employees' voices would need to be heard. Committing to EDI (Diversity, Equity, Inclusion) as the company culture is one way to ensure remote workers' voices are heard.

### 5.1.4. Flexibility

Flexibility is one of the key reasons why employees prefer mixed work models. Flexible work arrangements make finding a work/life balance easier. Employees who have more control over their work schedules have more time to attend to personal matters and they can free up time to deal with events in their personal lives. Employees are concerned about their health and safety when back to work. The fewer employees in the office, the lower the chance of employees getting infected with each other. Since employees can choose to work remotely in a mixed work mode, employees infected can stay at home.

In this study, we examine the leading technology companies specializing in services, servers, and networking, and focus on the internet of things, AI solution, and the cloud as a service. These companies have a history of multiple remote work practices for work flexibility before the pandemic. A work-at-home culture has emerged because of the epidemic. It makes employees happier, more productive, and less likely to leave. On the other hand, flexible access to the office posed a new difficulty for businesses. To make working from home a healthy and popular office culture, it takes meticulous preparation by senior leadership management, as well as phased arrangements for trial and error collections. In the hybrid culture flexibility setting, home employees will not let go of their workplace competitiveness or be subjected to undue pressure from office employees.

In addition, remote leadership is important. Leaders who are primarily effective in fieldwork arrangements do not necessarily prove so in hybrid virtual methods. Leaders now need to appear in different ways, when they are face-to-face with some employees and interact with others virtually. Managers need to develop social cohesion and build trust in the hybrid work model with their employees. When managers are working from the remote



several days a week, it conveys the message that employees do not need to work in the office to be successful. In a hybrid workplace, what managers demonstrate can have a significant impact on the behaviors of employees. Sometimes, email and text communication are sufficient, or even better, because it allows employees time to write responses after thinking. However, when building trust or discussing sensitive work-related issues, such as promotion, salary, and performance, face-to-face is the first choice, followed by video conferencing, which can increase participants compared to audio demonstrating the ability to understand non-verbal information.

## 5.2. Employees' Points of View

When speaking with employees, the purpose is to learn how they handle the shift to remote work and what they're doing to make the change successful. From the perspective of employees, we gain in-depth knowledge of the four pillars as well. The four elements are flexibility, collaboration/communication, wellness, and technology.

### 5.2.1. Flexibility

In our interview, the facility of an employee's home-office environment and technical settings have a significant role in their remote productivity. The employee interviewed said they have the fundamental skills required to continue organizational operations and processes, and 50% of employees feel more efficient. Remote work does not entail working anywhere and anytime, but it offers the option. By allowing employees to make decisions regarding what, when, and where they work within defined areas and allowing them to jointly decide which roles and responsibilities can be flexible, employers can increase employee productivity and get better performance out of their employees. Employees who have greater flexibility are more likely to collaborate.

When the pandemic and lockdown pushed everyone to work from home, employees and employers scrambled to do their best under difficult circumstances. Research on employee emotions shows that remote work has a positive impact on the overall employee experience. For years, more flexibility in management has been a trend in human resources, but the pandemic does show that the office does not equate to productivity and the benefits of remote work for overall health and well-being. Companies face the risk of brain drain and employers make remote work.

Does the employee want to continue working from home or back to the office as soon as possible? There is a common notion that remote work reduces the degree of

innovation. Some leaders feel that employees who come into the workplace to have official or casual conversations with coworkers in the corridor or building will generate more creativity than those who stay at home.

Alternatively, mixed work environments enable employees to have access to more resources and provide greater flexibility in how they spend their time and space. With a hybrid work approach, more chances for mindful collaboration can be designed. Work efficiency is not affected by the pandemic. Most employees want employers to rethink the length of workweeks and the number of hours people expect to work. More than half of the employees believe they can work within 40 hours. Hence, both employers and employees should measure work in terms of results, instead of hours worked. Although, company leaders have not yet adapted to the need for results-based rather than time-based methods. Employees believe that managers evaluate their performance based on results instead of hours worked. Rather than working longer, employees want to work smarter. As a result, keeping a flexible schedule is key. To this end, company leaders must establish a culture of trust and replan and collaborate for a new era of flexible work, and shift to providing support, and guidance to help managers transform from evaluating work and workers based on hourly input to output for results.

### 5.2.2. Collaboration/Communication

Although the employees interviewed favor "flexibility of working from home", they believe that the most important aspect of being away from the office is, first and foremost, interpersonal communication. The second is peer social engagement, and the third is a delicate environment in which they can receive whatever need while working collaboratively face-to-face. 60 percent of the interviewees miss the office most. Work-life balance and flexible working hours were also mentioned as advantages of remote work.

According to the official site study, many people desire a human-centered experience at work. Even as offices continue to exist, a growing acceptance of remote work is pushing many regional businesses to adopt a new workplace paradigm. Flexible work arrangements can alter how employees work; for example, nine or five working days could go away, and work hours could be tailored to employees' needs/preferences. As long as the aims and objectives are met, this will mean less reliance on the office setting, and more work can be done anywhere. While remote employees stated they liked working from home because it gave them more flexibility, they missed

the office for personal connection, social interaction, and face-to-face collaboration with coworkers. Employees don't have the resources in their home office to get everything they need to finish their work. During our interview with IT professionals, we learned that they missed their work at work. Employees have also mentioned the advantages of remote employment, including a better work-life balance, more flexible working hours, and shorter commutes. When the necessary technology tools are available to work from home, they believe it is more productive, but they couldn't afford to set up a facility or workspace. They thought that working from home would last forever, but now that the epidemic hasn't ended, the company has a different idea.

Since the epidemic began in 2020, people's lives and their work have been greatly affected. Many employees were working from home and thought they would continue forever, but now that the epidemic is about to end, the new normal is about to come to light with different ideas and communication. For example, Google announced that the company would begin transitioning to a hybrid workweek due to breakthroughs in prevention and treatment, as well as a continuous drop in cases. Google will assist workers who work remotely in transitioning to the new hybrid model. Employees who are unable to return to the office right away may request a work-from-home extension. Some employees may be required to work more than three days per week, depending on the nature of their profession.

### 5.2.3. Wellness

In the interview, three-quarters of interviewees (70%) said that having the correct mental health support is critical to their future success, and they anticipate employers to pay more attention to the issue. On the other hand, employers appear incapable of supporting their employees' well-being. More than half of managers say it is tough to tell when their staff is dealing with mental health issues or stress. Employees claim that their bosses did not pay enough attention to their mental health. This demonstrates that mental health is a universal issue. As a result, this is a key challenge facing employees and employers post-pandemics. The major factor that contributes to the employee experience is work-life balance. Since the past two years have been challenging for all employees, it is even more important to maintain a healthy lifestyle. Many IT companies set up global wellness programs to promote overall health and well-being by providing employees with the programs and resources to boost employees self-esteem and self-ego. That is why some IT companies hold a wellness day every

month on a full-day leave to reset the psychological state of employees.

Several key data have been thoroughly reviewed for decision-makers' consideration for the post-pandemic business strategy and organization success. A post-pandemic approach will require offices and work plans to prioritize employee health and well-being before the business plan and performance. Vaccinated and unvaccinated employees require innovative solutions to protect themselves, as well as to meet the growing expectations of employees for remote working.

During the pandemic, when companies adopted a work-from-home policy, employers around the world prioritized the health and safety of their employees. Today, the number of cases of infection around the globe is turning low along with Omicron's variants being under control, employers are ready to restore the workforce to normal conditions. Some companies are planning a new combination of remote and on-site work as hybrid work arrangements, where some employees work locally, and others work from home. Some companies are planning for the co-working space or going for the full remote. No matter which model is being applied, the new model is expected to acquire talents, increase the productivity of individuals and small teams, reduce costs, increase personal flexibility, and improve the employee experience.

### 5.2.4. Technology

COVID-19 changed the way employees worked. When employees' dining rooms are converted to offices, employees are settled into new routines and schedules. When employees felt more satisfied and productive at home and liked the flexibility of choosing where they work and wanted the option to go into the office as needed. Hybrid work is now becoming the new normal. As a result, the workplace will be redefined on a technology premise: more collaboration and socialization, and fewer dedicated workstations. This will allow for a more holistic approach to the workplace. As an increasingly remote workforce, both works will take place at the workplace and out of it. This means office experiences will be redefined based on technology. This involves considering who needs to be in an office versus who can do their work at home, at a coffee shop, or elsewhere. The bold vision will create a more flexible, and modern work environment.

Amid 5G, digitization, automation, and AI advancements, the past two years of pandemic crisis have taught the companies in the IT industry how to be agile,

and how to take time to connect with their employees. It has shown how geography and physical space are not a barrier to advancing the way people live and work. No matter where employees sit, the work gets done. Agile is a mentality based on the Agile manifesto values and principles. These values and principles guide how to approach change and deal with uncertainty. In essence, the first sentence of the Agile Manifesto says it well: Discovering better IT software development methods by doing and helping others.

Employees believe that the organization can improve in areas such as accessing HR policies and documents, simplifying the submission process for fees and vacation applications, and so on. For example, Slack is a channel-based collaboration platform. Employees can interact more successfully with one another and with external customers. It's simple to gather materials and information to do the best work, and it's all done in a seamless, safe environment. Because of the wide collaborative experience, the technology makes it easier for employees to collaborate in a more connected, flexible manner. It allows employees to form stronger bonds, improves culture, allows employers to make faster decisions, and boosts productivity.

Employees in Taiwan have increasingly moved from the office to the remote workplace, and this shows that many people are now seeking the cultural experience of the office. There is no denying that offices will continue to exist, but the acceptance of remote work is forcing many regional companies to adapt to a new workplace model. When given the opportunity of mixed work arrangements, many employees have high confidence in their company's future.

## 6. Conclusion

This study focuses on how to choose the best-fitting workplace, using the information technology industry as an example, and re-imagine how the workplace will work post-pandemic. As of now, no comprehensive work model has been developed or can be applied to simulate the best scenarios for the best organization operations, including physical premise and job role category, not to mention gender equity and inclusion. The study offers insight into the industry and research on future work plan management, based on a hybrid work approach. As organizations around the world slowly return to the office, a mixed workplace with a human-centered approach is the new standard. To reflect on our experiences, here are the key lessons we learned:

Firstly, leaders must be prepared for changes and adapt. Unpredictability and constant change are nothing

new. Adapting to change is the new normal. Modernizing and simplifying the company's technology and continuously improving employees' skills, with effective communication are key differentiators. In this way, companies are well-positioned to meet the unpredictable crisis ahead. Today, it is the company's flexibility, and leadership to transform it.

Secondly, IT must be innovative and nimble. The experience of the pandemic has shown that both employers and employees must not only be flexible but also agile in technology. The Digital transformation is accelerating the pace of the entire business by requiring IT to be innovative and align with company strategy and organization. The company must be continuing to upskill employees in AI, mobility, and cloud business expertise. The pandemic in 2021 has proved that agile is critical to increasing the flexibility and productivity of the company. To deal with ongoing uncertainty and change shifting the strategy paradigm in the workplace model is the right trend to move effectively. The management team must play a role in assisting all employees. Technology will be a key enabler in reshaping the way business is delivered. Automation and artificial intelligence will be the key tools required, and leadership excellence will be necessary for impact change. The company embracing the opportunity to simply automate and allow employees to focus on high-level processes while leveraging their expertise to stimulate short-term solutions will be a trophy. The company leadership team can turn the tide in communications and collaboration because of the big employee departure tide for flexible work.

Thirdly, make the organization the best place to work for. As the level of burnout increases, so does the level of work tension. With the new opportunities that come with people working remotely, every company is struggling to find the office employees and remote employees they need. Considering this new work model, we need to overhaul the way we work before. Companies need to make the organizations the best places to work to give employees reasons to stay which means the company using technology to streamline operations, remove unnecessary tasks, increase productivity, and provide a better experience for the entire workforce - all to help the overburdened employees can do their jobs well and stay on the job in finding more satisfaction and fulfillment.

Fourthly, the hybrid work will be with us for a long time. The pandemic forces organizations to implement remote office options and they will be continuing to offer this option in response to employees' demands. We must recognize that talent is readily available, it is a competitive necessity. Hence, providing flexibility to employees around the world is imperative. The focus is on ensuring the hybrid work arrangement has the tools and best practices to work together.



Lastly, the company's strategy has an impact on the work paradigm at the workplace. There are a variety of styled work arrangements based upon the company's post-pandemic approach; we mention four options: Fully remote, with an emphasis on the new technology and virtual office; Office, with a focus on collaboration and innovation; Hybrid work, with a focus on flexibility; Satellite office/Co-working space, with a focus on wellness. There is no such thing as a one-size-fits-all solution. It all depends on the organization's long-term plan and short-term priorities. In the post-pandemic era, the work, the workplace, and the workforce will be put to the test and re-adjusted. Considering Taiwan has from time to time entered and lifted the lockdown in the last two years, this arrangement combining remote work and office work is taken into consideration locally to be in line with employees' needs, as well as their ability to collaborate and work efficiently in a shared physical space design. The future of work is striking a balance between the two, and Taiwan will be no exception.

### 6.1. Conclusion and Suggestions

There is a possibility that a new event could hit, and if that happens, businesses must be prepared. A new variant could usher in another chapter in the crisis event, and if that happens, a business must be ready to deal with it. But for now, the pandemic phase is coming to an end. Given this conclusion, this study has focused on how to support the post-pandemic workforce through technology, communication, and human-centric office space. It is no longer possible to go to work the way we used to.

During the COVID-19 pandemic, the function of traditional physical offices is outdated and interrupted. The company leaders now have an opportunity to crash the location-centered workplace and re-design it into a human-centered workplace. In this human-centered workplace, company employers and employees can protect talents in this digital age and deliver business results. The people-oriented work model is recognized by flexibility and empathy, makes employees feel more incent, and increases their productivity and engagement. It also enables the organization to better respond to customers' demands, be more able to withstand interruptions, and increase productivity. It can also reduce a range of costs from real estate to employee turnover.

### 6.2. Future Research

Moving forward, a people-oriented approach is effective from employers' and employees' perspectives, but it requires the leadership team to commit to leveraging a hybrid workplace strategy. The first step is to get rid of old thoughts about the meaning and function of the

traditional work model. Due to time constraints, no full-fledged details are being fully sought out and only technology leaders and experts were consulted, so this study may not be comprehensive enough to explore the effectiveness of using vast data. Future studies are expected to extend the research scope and enhance the depth and width of the people-centered work model and approach.

### Conflict of Interest

The authors declare no conflict of interest.

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