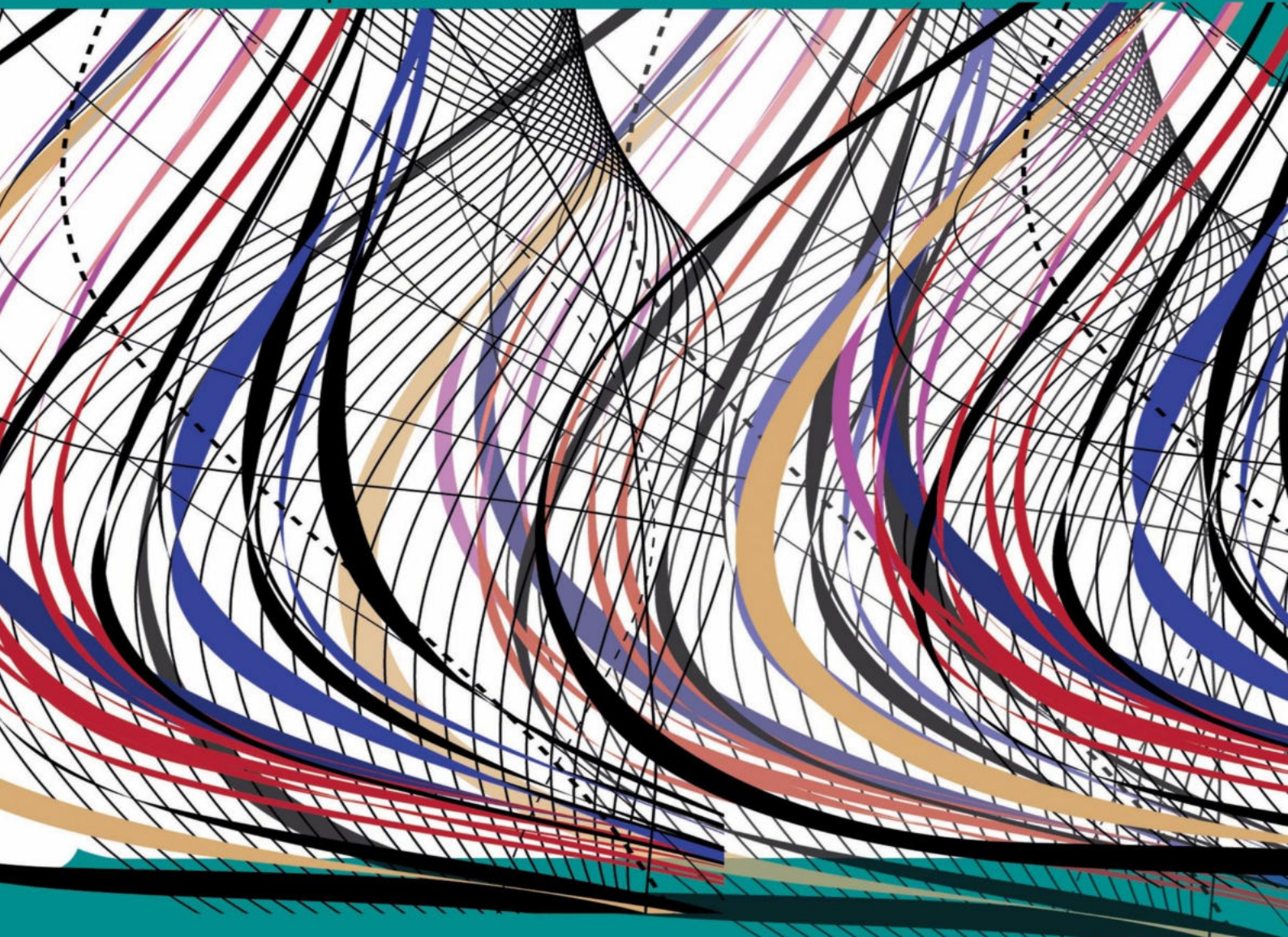


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# Inner Product Approach to Generalize the Notion of Pythagoras Theorem for Normed Spaces

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**Abstract**— The Pythagorean Theorem, a fundamental result in Euclidean geometry, traditionally relates the lengths of the sides of a right-angled triangle. In this paper, we extend the classical Pythagorean Theorem into the context of normed vector spaces, using the concept of inner products. We explore how the theorem manifests in higher-dimensional spaces and provide a generalized version applicable to normed spaces beyond two dimensions. This generalization not only reinforces the geometric interpretation of the theorem but also connects it to broader mathematical frameworks such as vector spaces, norms, and inner products. The results presented here demonstrate the versatility of the Pythagorean Theorem and its relevance across various fields of mathematics, highlighting its applications in both theoretical and applied contexts.

**Keywords**— Pythagoras Theorem, Orthogonality, Vector Spaces, Norm

## I. INTRODUCTION

The Pythagorean Theorem is one of the most remarkable and well-known results in mathematics. Historically attributed to the ancient Greek mathematician Pythagoras, this theorem states that in a right-angled triangle, the square of the length of the hypotenuse  $c$  is equal to the sum of the squares of the lengths of the other two sides,  $a$  and  $b$ . Mathematically, this is expressed as:

$$a^2 + b^2 = c^2$$

This theorem has been known and proved by various cultures throughout history. The earliest known record dates back to the Babylonians around 1800 BCE, who used it in their calculations. The Indians, particularly Baudhayana, provided a detailed proof around 800 BCE, and the Chinese also contributed with their own version in the Zhou Bi Suan Jing. The theorem was later named after Pythagoras, who lived in the 6th century BCE and is traditionally credited with its discovery, though it's likely he learned it from these earlier sources. The Pythagorean Theorem not only holds a fundamental place in Euclidean geometry but also serves as a cornerstone for various fields such as trigonometry, algebra, and even physics.

In modern mathematical language, the Pythagorean Theorem can be viewed through the lens of vector spaces and norms. Specifically, in a two-dimensional Euclidean space, the theorem is a manifestation of the inner product, where the Euclidean norm (or length) of a vector  $v = (a, b)$  is given by:

$$\|v\| = \sqrt{a^2 + b^2}$$

This notion can be generalized to  $n$ -dimensional normed spaces (or vector spaces) using inner products. For a vector  $v = (v_1, v_2, \dots, v_n)$  in  $\mathbb{R}^n$ , the Euclidean norm is defined as:

$$\|v\| = \sqrt{v_1^2 + v_2^2 + \dots + v_n^2}$$

This generalization leads to the concept of the Pythagorean Theorem in higher dimensions. For any two orthogonal vectors  $u$  and  $v$  in an inner product space, the norm of their sum satisfies:

$$\|u + v\|^2 = \|u\|^2 + \|v\|^2$$

This result is a direct extension of the classical Pythagorean Theorem.

However, the Pythagorean Theorem is specifically applicable to right-angled triangles, the reasons for which we will explore in the later sections of this paper. For non-right-angled triangles, this theorem does not hold. Instead,

more general results such as the Law of Cosines are used, which account for the angle between the sides:  $c^2 = a^2 + b^2 - 2ab \cos(\theta)$

where  $\theta$  is the angle opposite the side  $c$ . This highlights the special nature of the right angle in the Pythagorean Theorem and underscores why the theorem is not directly applicable to non-right-angled triangles.

In this research, we explore the generalization of the Pythagorean Theorem within the framework of normed vector spaces, leveraging inner products to extend these classical concepts into broader mathematical contexts.

## II. METHOD

### I) VECTOR SPACES

A vector space, or linear space, is a fundamental concept in mathematics and physics, providing a framework for working with vectors. In many areas of mathematics, the concept of forming 'linear combinations' of elements within a set is both useful and significant. This idea is naturally encountered in various contexts, such as in the study of linear equations through linear combinations of matrix rows, in calculus with linear combinations of functions, and in three-dimensional Euclidean space with linear combinations of vectors. Linear algebra, as a field, focuses on the shared properties of algebraic systems characterized by a set and a coherent notion of linear combinations of its elements.

Vector Spaces is a fundamental mathematical construct that incorporates this abstraction and provides a unifying framework for analyzing and understanding these systems. By defining vector spaces and exploring their properties, we establish a foundation for numerous applications across different branches of mathematics and science. Formally, a vector space over a field  $F$  (such as the real numbers  $\mathbb{R}$  or complex numbers  $\mathbb{C}$ ) is a set  $V$  equipped with two operations: vector addition and scalar multiplication. These operations must satisfy the following axioms for all vectors  $u, v, w \in V$  and scalars  $c, d \in F$ :

- Closure under addition:  $u + v \in V$ .
- Commutativity of addition:  $u + v = v + u$ .
- Associativity of addition:  $u + (v + w) = (u + v) + w$ .
- Existence of additive identity: There exists a vector  $0 \in V$  such that  $u + 0 = u$  for all  $u \in V$ .
- Existence of additive inverse: For each  $u \in V$ , there exists a vector  $u \in V$  such that  $u + (-u) = 0$ .
- Closure under scalar multiplication:  $cu \in V$ .
- Distributivity of scalar multiplication with respect to vector addition:  $c(u + v) = cu + cv$ .

- Distributivity of scalar multiplication with respect to field addition:  $(c + d)u = cu + du$ .
- Associativity of scalar multiplication:  $c(du) = (cd)u$ .
- Existence of multiplicative identity:  $1(u) = u$  for all  $u \in V$ .

These axioms provide a structure that supports many operations and concepts in linear algebra, such as linear transformations, eigenvalues, and eigenvectors. Understanding vector spaces is essential for delving into inner products and norms, which we will explore in subsequent sections.

## III. INNER PRODUCT

An inner product generalizes the dot product. In a vector space, it provides a method for multiplying vectors to yield a scalar. This inner product can also be used to define the notions of 'length' and 'angle'.

**Definition-** Let  $F$  be the field of real numbers or the field of complex numbers, and  $V$  a vector space over  $F$ . An inner product on  $V$  is a function which assigns to each ordered pair of vectors  $x, y \in V$  a scalar  $\langle x, y \rangle \in F$  in such a way that for all  $x, y, z \in V$  and all

scalars  $\beta$ , the following properties hold:

- $\langle x + y, z \rangle = \langle x, z \rangle + \langle y, z \rangle$ ,
- $\langle \beta x, y \rangle = \beta \langle x, y \rangle$ ,

- 
- $\langle y, x \rangle = \overline{\langle x, y \rangle}$ , the bar denoting complex conjugation,
  - $\langle x, x \rangle > 0$  if  $x \neq 0$ .

The vector space  $V$  with an inner product is called a (real) inner product space.

### III) NORMS

By the third axiom  $\langle u, u \rangle \geq 0$  of an inner product,  $\langle u, u \rangle$  is nonnegative for any vector  $u$ . Thus, its positive square root exists. We use the notation

$$\|u\| = \sqrt{\langle u, u \rangle}$$

This nonnegative number is called the norm or length of  $u$ . The relation  $\|u\|^2 = \langle u, u \rangle$  will be used frequently.

**Definition-** A vector norm is a function from  $\mathbb{R}^n$  to  $\mathbb{R}$ , with a certain number of properties. If  $x \in \mathbb{R}^n$ , we symbolize its norm by  $\|x\|$ . The defining properties of a norm are: 1.  $\|x\| \geq 0$  for all  $x \in \mathbb{R}^n$  and also  $\|x\| = 0$  if and only if  $x=0$ .

- $\|\alpha x\| = |\alpha| \cdot \|x\|$  for all  $\alpha \in \mathbb{R}$  and  $x \in \mathbb{R}^n$ .
- $\|x + y\| \leq \|x\| + \|y\|$  for all  $x, y \in \mathbb{R}^n$ .



#### IV. ORTHOGONALITY

Let  $V$  be an inner product space. The vectors  $x, y \in V$  are said to be orthogonal and  $x$  is said to be orthogonal to  $y$  if  $\langle x, y \rangle = 0$

The relation is clearly symmetric—if  $x$  is orthogonal to  $y$ , then  $\langle y, x \rangle = 0$ , and so  $y$  is orthogonal to  $x$ . We note that  $0 \in V$  is orthogonal to every  $y \in V$ , because

$$\langle 0, y \rangle = \langle 0y, y \rangle = 0 \quad \langle y, 0 \rangle = 0$$

Conversely, if  $x$  is orthogonal to every  $y \in V$ , then  $\langle x, x \rangle = 0$  by [I3]. Observe that  $x$  and  $v$  are orthogonal if and only if  $\cos \alpha = 0$ , where  $\alpha$  is the angle between  $x$  and  $y$ . Also, this is true if and only if  $x$  and  $y$  are “perpendicular”—that is,

$$\alpha = \frac{\pi}{2} \quad (\text{or } \alpha = 90^\circ)$$

#### V. RESULTS

##### 1) GENERALISED PYTHAGORAS THEOREM

Let  $u, v \in V$  and  $u$  is orthogonal to  $v$  then

$$\|u + v\|^2 = \|u\|^2 + \|v\|^2$$

Proof-

$$\text{If } \|u + v\|^2 = \langle u + v, u + v \rangle$$

Then

$$\begin{aligned} &+ \langle u, v \rangle + \langle v, u \rangle + \\ \|u + v\|^2 &= \langle u, u \rangle + \langle u, v \rangle + \langle v, u \rangle + \langle v, v \rangle = \\ &\|u\|^2 \\ &+ \|v\|^2 \\ &= \|u\|^2 + \|v\|^2 \end{aligned}$$

For n-dimensions-

$$\begin{aligned} \left\| \sum_{i=1}^n u_i \right\|^2 &= \left\| \sum_{i=1}^n u_i \right\|^2 \\ \|u_1 + u_2 + \dots + u_n\|^2 &= \|u_1\|^2 + \|u_2\|^2 + \dots + \|u_n\|^2 \end{aligned}$$

#### VI. CONCLUSION

In conclusion, this paper has successfully extended the classical Pythagorean Theorem, traditionally applicable to right-angled triangles in Euclidean geometry, into a more generalized framework suitable for normed vector spaces. By leveraging the concepts of inner products and norms, we have demonstrated that the core principles of the Pythagorean Theorem can be applied within higher-dimensional spaces, allowing for broader mathematical

and practical applications. This generalization provides a foundational understanding that bridges classical geometry with more advanced linear algebra, offering insights that can be utilized in various fields of mathematics and science. Through this exploration, the intrinsic relationship between vector norms and inner products has been elucidated, reinforcing the theorem's importance and versatility in modern mathematical contexts.

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# Study on the City Image of Maoming Based on Drone Photography Data

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**Abstract**— This study is based on drone photographs and related data of Maoming City obtained from the social platform "Sky City." Through methods such as computer vision image analysis, kernel density analysis (KDA), and standard deviational ellipse analysis, the research explores the spatiotemporal distribution characteristics of drone-captured imagery, the visual features of the city image, and the clustering of city image elements. By analyzing the city image of Maoming from a "God's-eye view," the study offers insights into the construction of Maoming's city image and drone management, providing recommendations for enhancing urban design and improving the quality of urban space.

**Keywords**— Drone, Visual image analysis, Kernel density analysis (KDA), Standard deviational ellipse analysis, City image

## I. INTRODUCTION

In the 1960s, Kevin Lynch conducted studies on three representative American cities—Boston, Jersey City, and Los Angeles—and completed *The Image of the City*. He divided the spatial image of cities into five key elements: paths, edges, districts, nodes, and landmarks (Fang, 2001). These elements form the basic cognitive framework for understanding urban spaces (Chen, 2020). By exploring local characteristics and examining the unique images of different cities, Lynch's work emphasized the influence of historical, cultural, and geographical factors on city imagery (Gu and Song, 2001), while also assessing urban planning and design outcomes and providing suggestions for improvement. Research methods included field surveys, questionnaires, and data analysis, utilizing visualization software such as CiteSpace to create knowledge maps and analyze research hotspots and thematic developments (Xu, 2012). City image studies have significant application

value in enhancing city recognizability, optimizing spatial structure, and promoting cultural heritage. As research methods have improved and their application deepened, city image studies have made substantial contributions to urban development, planning, and construction.

In China, researchers typically collect first-hand data through field surveys and resident questionnaires to analyze urban spatial cognition, combining this data with historical and cultural context to provide recommendations for urban planning optimization. For example, by analyzing the city image of Suzhou, researchers discovered the profound influence of the city's historical and cultural heritage on its image and proposed specific measures for preserving and passing down this legacy (Tian and Wang, 2014). Foreign scholars, on the other hand, have proposed various theoretical frameworks to explain the formation and development of city images, such as Smith's "From City to Civilization" theory, which explores the essence

and evolution of city imagery. Additionally, interdisciplinary studies abroad have investigated the relationship between city imagery and fields like urban development, tourism, and the cultural and creative industries, highlighting the close connection between city imagery and both economic prosperity and factors like social culture and urban management.

In the 1970s, Appleyard studied how the length of residence and levels of cultural education influenced city imagery (Appleyard, 1970). Francescato and Mebane explored the impact of different social classes on the city image of Rome (Francescato and Mebane, 1973). Moreover, international scholars have conducted case studies and comparative analyses on global cities, uncovering differences, similarities, and trends in city imagery. For instance, studies on international metropolises like London and New York, as well as popular tourist cities such as Sydney and Paris, have found that the formation of city imagery is closely tied to historical, cultural, and geographical factors, while also being influenced by political, economic, and media forces (Albers and James, 1973). Research on city images not only provides theoretical and practical guidance for urban planning and design but also plays a crucial role in enhancing city recognizability, optimizing spatial structure, and promoting cultural continuity. Overall, city image studies have provided essential theoretical support and practical guidance for urban planning and design. As research methods continue to evolve and applications deepen, city image studies will play an increasingly important role in the future, contributing more significantly to urban development.

Early studies on city imagery by urban planners primarily used photographs taken by tourists during their travels. Before the era of big data and the internet, the collection and research of photographic data were limited and lacked comprehensiveness. In the 1980s, some scholars analyzed photographs using postcards (Albers and James, 1988). Researchers have since used photos from tourist collections (Markwell, 1997), travel guides (Buzinde and Smith, 2006), and Visitor-Employed Photography (VEP) (Haywood, 1990) as research materials. With the rapid development of the internet, particularly in the Web 2.0 era, tourists sharing photos

during their travels has become commonplace. Social platforms such as Flickr (Girardin et al.), Facebook (Nikjoo and Bakhshi, 2019), Pinterest (Song and Kim, 2016), and Chinese platforms like Weibo and WeChat Moments (Zhao et al., 2018) have become data sources for photo research. Image analysis methods include content analysis and semiotic analysis (Kim, 2015). Content analysis, a method based on attributes, is commonly used to analyze text but can also be applied to visual material. It focuses on the occurrence of certain themes and attributes within the target image, with the images manually classified according to specific rules (Garrod, 2009).

This study on the city image of Maoming is based on drone photography data and uses modern technological approaches to reveal the spatiotemporal distribution and visual characteristics of the city's image. It addresses the limitations of traditional city image research methods by employing advanced spatial analysis techniques such as computer vision image analysis, KDA, and standard deviational ellipse analysis, providing more comprehensive data on city imagery. Through systematic analysis of drone-captured imagery, the study uncovers the spatial distribution patterns and visual features of various image elements, while also offering suggestions for drone management in Maoming City to ensure the broader and more effective use of drone technology in urban research and development. Overall, this research not only promotes innovation and development in city image theory but also provides valuable reference and support for urban construction and planning, playing a significant role in enhancing spatial quality and shaping a positive city image.

## II. STUDY AREA AND METHODOLOGY

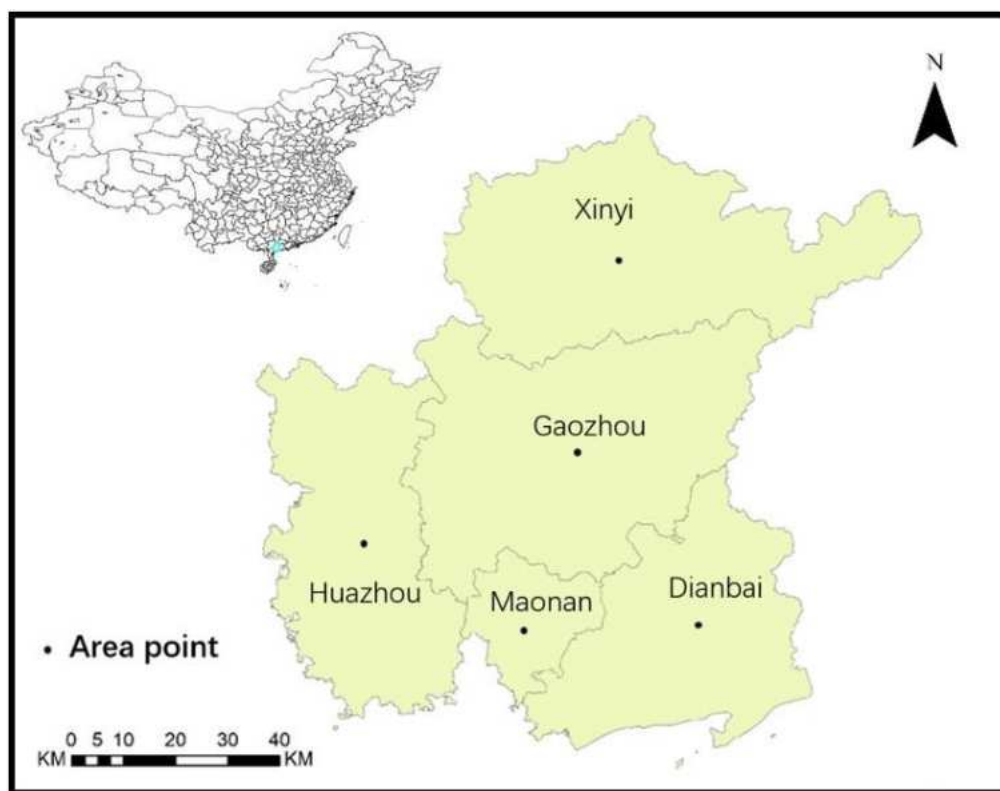
### 2.1 Study Area

Maoming City, also known as the "Southern Oil City," is located in the southwestern part of Guangdong Province, China, along the coast of the South China Sea. It is geographically positioned with higher elevations in the north, sloping downward toward the southwest. The total area of Maoming covers 11,427.63 square kilometers, and it administers two urban districts (Maonan District and Dianbai District) as well as three county-level cities (Gaozhou, Huazhou, and Xinyi). As of 2023, the

permanent population of Maoming stands at 6.2523 million (Figure 1).

Maoming boasts abundant natural and tourism resources, earning the title of one of China's outstanding tourist cities. Famous attractions include China's First Beach, Fangji Island, the Romantic Coast Resort, Maoming Open-pit Mine Ecological Park, Maoming Forest Park, Yushui Ancient Hot Springs, Douzhou

Ancient City, and the Cultural Tourism Area of Madam Xian's Hometown, among others. The city's tourism industry has developed rapidly, attracting large numbers of domestic and international tourists. Maoming is not only an important city for economic development but also a city rich in cultural and tourism resources, making it a valuable subject for research.



*Fig.1. Administrative Map of Maoming*

## 2.2 Technical Approach

This study is based on aerial images of Maoming City from the past decade, which were obtained using web scraping technology developed in the C language. After establishing a corresponding database, relevant theoretical foundations were selected. The research methods include literature analysis, computer vision analysis, and spatial feature analysis. Using the spatial analysis tools in ArcGIS,

the study applies standard deviational ellipse and KDA to explore the spatiotemporal distribution characteristics of drone-captured images, the visual perception of Maoming's city image, and the classification of city image elements. Finally, recommendations for improving the construction of Maoming's city image are proposed (Figure 2).



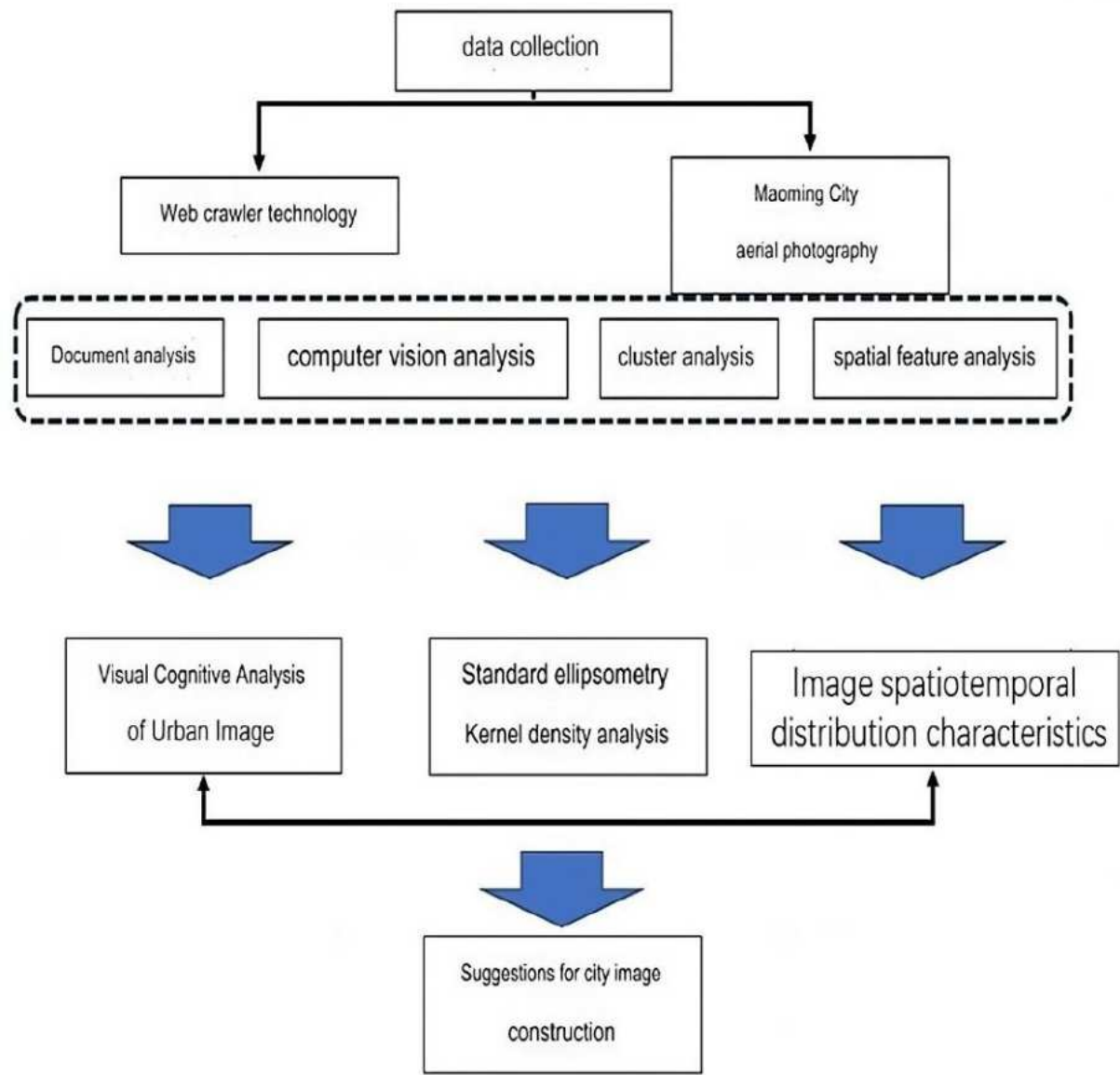


Fig. 2. Technical Approach

### III. METHOD

#### 3.1 Data Collection

The data for this study was sourced from DJI's social platform "SkyPixel" (<https://www.skypixel.com/>). DJI, based in Shenzhen, is a leading drone manufacturing company that holds approximately 70% of the global market share in the consumer drone sector (Wang et al., 2018). SkyPixel provides a platform for drone photography enthusiasts to upload and share their photos and videos. The photography works uploaded by users,

along with descriptions and location information, constitute the primary data source for this research. Using web scraping technology, all drone aerial photos with the keyword "Maoming" were obtained from the SkyPixel website on July 10, 2024. A total of 965 images were collected, of which 845 contained latitude and longitude information, and 453 included textual descriptions. The retrieved data were then organized, and a simple database was established.



Fig.3. Example of Maoming Drone Image Search on SkyPixel Website

### 3.2 Computer Vision Image Analysis

Microsoft Azure Cognitive Services is a suite of services that includes APIs (Application Programming Interfaces) and SDKs (Software Development Kits) designed to assist developers in building intelligent applications without requiring direct AI or data science skills. This service utilizes algorithms to enable computers to understand and interpret human communication conducted through natural language. The API framework within Azure Cognitive Services aggregates various machine learning and AI algorithms, with this study primarily focusing on visual and language functionalities. The cloud-based Computer Vision API allows developers to use advanced algorithms to process images and extract information. By uploading images or providing image URLs, Microsoft's computer vision algorithms can analyze visual content and generate corresponding results based on user input and selections. After an image is uploaded, the algorithms identify objects, entities, and actions within the image, returning relevant tags. This research utilizes a program written in C# that invokes Microsoft Azure's Computer Vision API to batch upload drone photo data and employs AI to analyze the image content, returning keyword tags.

### 3.3 Spatial Analysis

#### (1) Kernel Density Analysis

Kernel Density Analysis (KDA) is a statistical method used for analyzing the geographic distribution of

features. It effectively reflects the attenuation phenomenon of geographic occurrences in spatial distribution (Silverman, 2018). KDA is helpful in determining the relative spatial concentration of certain geographic events. This method is typically used to assess the degree of relative concentration of spatial distributions, allowing for a continuous representation of the density of research subjects. In this study, KDA is applied to explore the spatial distribution characteristics of the drone aerial data points. The specific calculation formula is as follows

$$f(x) = \frac{1}{nh_n} \sum_{i=1}^n k\left(\frac{x^2 - x_i}{h_n}\right)$$

(1)

#### (2) Standard Deviation Ellipse Analysis

The Standard Deviation Ellipse (SDE) is a quantitative method for calculating the spatial dispersion of a dataset, which can be used to determine the distribution direction and characteristics of the data (Lefever et al., 1971). In this study, the Standard Deviation Ellipse is employed to analyze the distribution direction and patterns of drone aerial data points. The direction of the long axis of the ellipse indicates the primary distribution direction of the data within the geographical space, while the area of the ellipse represents the degree of dispersion or clustering of the discrete points. The specific calculation formulas are as follows

$$SDE_x = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n}} \quad (2)$$

$$SDE_y = \sqrt{\frac{\sum_{i=1}^n (y_i - \bar{y})^2}{n}} \quad (3)$$

In the above formulas,  $X_i$  and  $Y_i$  are the coordinates of feature  $i$ ,  $\bar{X}$  and  $\bar{Y}$  represent the mean center of the features, and  $n$  is the total number of features.

#### IV. ANALYSIS AND RESULTS

##### 4.1 Temporal Distribution Characteristics of the Data

The trend of drone aerial data in Maoming City from 2014 to 2024 shows significant fluctuations (Figure 4). In 2018, there was a notable increase in the number of photos compared to 2017, marking a peak within the decade and clearly surpassing other years. Monthly statistical data

indicates that the highest number of photos was recorded in April, May, and October of 2018, as well as in June 2022, with each of these months exceeding 40 photos.

In 2018, the monthly photo counts exhibited noticeable fluctuations, while the number of photos during 2014, 2015, and 2016 remained relatively low with slight variations. In 2020, with the widespread adoption of drone technology and an increase in photography enthusiasts, the number of photos in the first half of the year significantly exceeded that of the same period in 2019, indicating a sustained growth trend. In 2022, despite a decline in photo counts due to the impact of the pandemic, the overall trend remained positive.

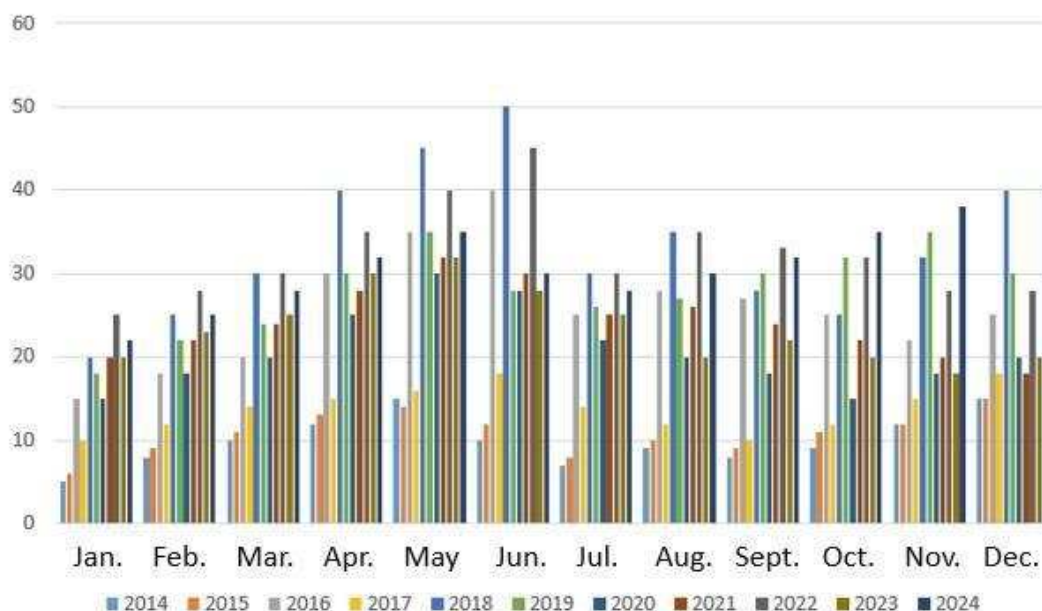


Fig.4: Temporal Distribution of Photography Data

The aerial photos exhibit a unimodal characteristic, with peaks in data occurring in April, May, and June, while other months show a gradually decreasing trend. Overall, the number of photos taken in spring is significantly higher than in summer and autumn. The months of July, August, and September, characterized by high temperatures, see the fewest aerial photos taken. In contrast, the three months of autumn display a gradual increase in the number of photos.

The lower summer data in Maoming City is primarily influenced by high temperatures, which reduce outdoor activities for residents. In spring, particularly in April and May, there is a notable increase in aerial photo counts,

closely associated with various spring activities, festivals, and tourism promotion events. During this period, a series of cultural and tourism events, such as the "Maoming Spring Tourism Festival" and "Lychee Festival," are held, attracting visitors and boosting the number of aerial photos taken.

Additionally, the number of photos taken in winter is relatively low, significantly affected by weather conditions and outdoor activity levels. Overall, the variation in the number of drone aerial photos in Maoming City is closely related to seasonal changes, climatic conditions, and promotional activities by local governments, reflecting the

vibrancy of local tourism and cultural activities.

#### 4.2 Spatial Distribution Characteristics of the Data

A total of 845 drone photos containing geographic coordinates were analyzed to understand the focal points and activity patterns of the photographers (Figure 5). The aerial photography was primarily concentrated in the central urban areas of Maoming, including Maonan District, Gaozhou City, and Dianbai District, as well as major coastal and cultural attractions nearby. Notable sites such as the Open-Pit Mining Museum, Shuidong Bay,

Romantic Coast, Papua New Guinea Bay, and Maoming Beach attract many aerial photography enthusiasts. These locations not only boast excellent natural scenery and cultural history, but local governments also actively promote their visibility, contributing to the increase in aerial photography data. Additionally, Maoming's well-preserved ecological environment, such as the Wetland Park and riverside areas, has also generated a considerable number of aerial photos due to their picturesque landscapes.

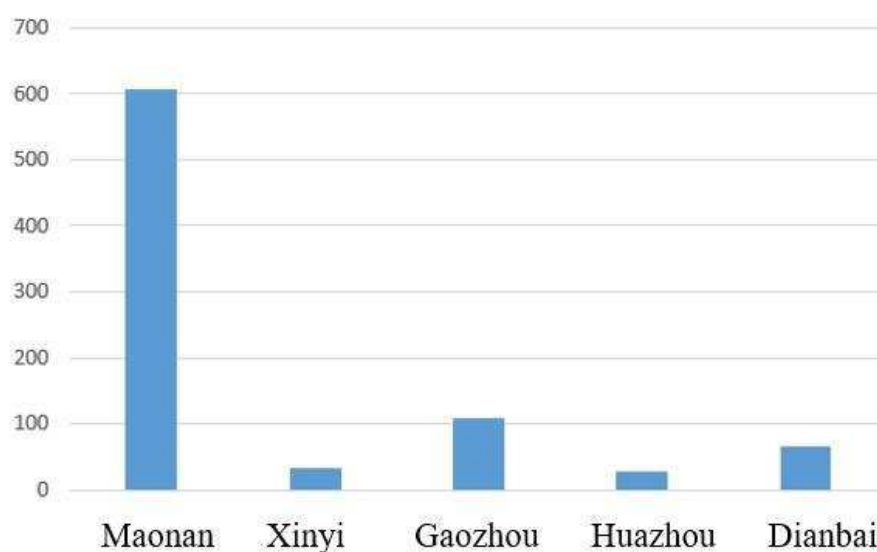


Fig.5: Statistical Distribution of Drone Photos in Maoming City

In contrast, the number of aerial photos from more distant county areas, such as Xinyi City and Huazhou City, is noticeably lower. These regions have relatively fewer well-known attractions and limited infrastructure, resulting in restricted aerial photography activities. Thus, the spatial distribution of aerial photos exhibits a pronounced centralization pattern, mainly focused in the city center and surrounding tourist hotspots, while the number of photos from remote areas remains relatively low (Figure 6).

To investigate the spatial distribution and geographical preferences, the drone aerial data points were imported into ArcGIS for visualization, resulting in a data

point distribution map (Figure 7). The distribution of data points across various districts shows a concentrated pattern in the main urban area and near regional centers. Maonan District is notably concentrated in the central part of the region, Dianbai District is focused on the southwestern coastal area, and Xinyi is located in the northwestern area near the mountains, while Xinyi and Huazhou are close to the city center. The standard deviational ellipse analysis reveals a significant difference between the long and short axes of the data, indicating a pronounced directional spatial distribution, which aligns with a southwest-northeast orientation consistent with the urban form.



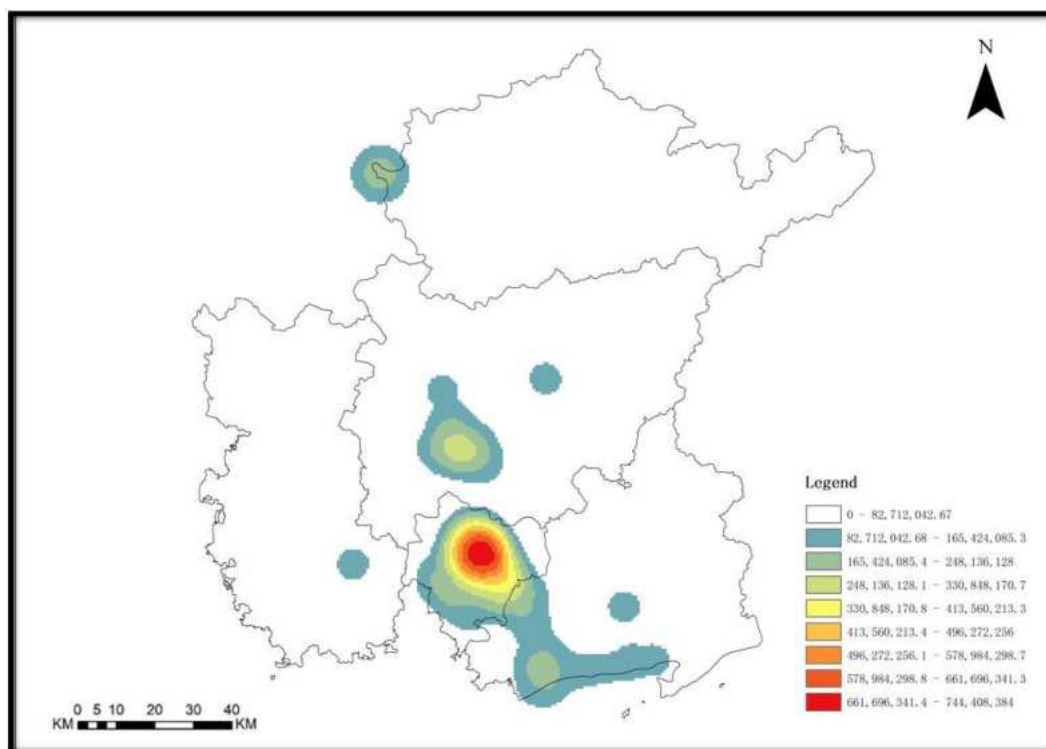


Fig.6: Kernel Density Analysis of Drone Photography Locations

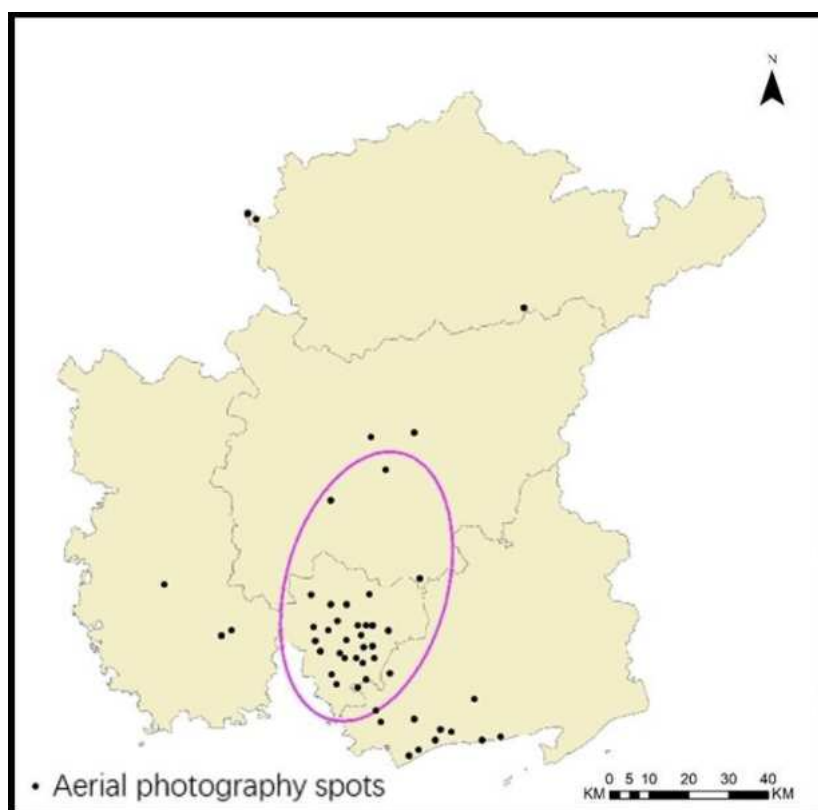


Fig.7: Standard Deviation Ellipse Analysis

4.3 Computer Vision Analysis

Computer vision technology was employed to extract keywords from the image content. To ensure the accuracy of the visual analysis, 300 aerial photos were selected, and NVivo 11 was used to conduct a frequency analysis of the

keywords, resulting in 120 visual keywords with a total frequency of 3,600 occurrences. Among these, the top 30 visual keywords accounted for a total of 2,500 occurrences. The summarized results are presented in Table 1.

Table 1: Statistical Analysis of Keywords from Drone Aerial Photos (Top 30)

Serial number	Keyword	Word frequency	Proportion	Serial number	Keyword	Word frequency	Proportion
1	Outdoor	300	8.33	16	Traffic	50	1.39
2	City	280	7.78	17	Colorful	48	1.33
3	Building	250	6.94	18	Nature	46	1.28
4	Water	230	6.39	19	Park	44	1.22
5	Green	220	6.11	20	Night	42	1.17
6	Light	210	5.83	21	Mountain	40	1.11
7	Sunset	200	5.56	22	River	38	1.06
8	Lake	180	5.00	23	People	36	1.00
9	Car	160	4.44	24	View	34	0.94
10	Field	150	4.17	25	Festival	32	0.89
11	Old	140	3.89	26	Sunny	30	0.83
12	Bridge	130	3.61	27	Construction	28	0.78
13	Street	120	3.33	28	Fishing	26	0.72
14	Home	110	3.06	29	Sports	24	0.67
15	Crowd	100	2.78	30	Market	22	0.61

The summary of keywords reveals a rich array of terms that describe modern urban landscapes, such as "city," "building," and "traffic." This indicates a high level of focus on city imagery, particularly in the depiction of transportation and urban infrastructure. Additionally, many high-frequency words include adjectives like "outdoor," "green," and "peaceful," which are primarily used to describe the characteristics of the subjects being photographed, reflecting the visual focal points of the aerial images.

The analysis also highlights keywords that describe natural landscapes, such as "water," "lake," and "mountain," suggesting significant potential for showcasing natural beauty. In summary, the primary representation of city imagery captured by drone photography is the integration of vibrant urban landscapes

with the surrounding natural environment. This novel perspective not only presents a comprehensive view of the city but also reinforces the harmonious relationship between urban and natural elements. The elevated viewpoint of drones allows for a clear depiction of urban layouts and landscape features, offering a unique visual experience compared to traditional photography.

When the prominent keywords identified through computer analysis were imported into ArcGIS, a spatial distribution map was generated (Figure 8) to explore the spatial characteristics of city imagery captured by drones in Maoming City. It is evident that photo data points of buildings and green plants are more concentrated, while those depicting water bodies, lakes, and similar features are relatively dispersed. A preliminary analysis suggests that this dispersion is influenced by the spatial separation

between the Maoming Open-Pit Mining Lake and other water bodies, such as the Jianjiang River. The primary concentration of buildings and lighting is found in areas such as the Maonan urban area, the Maoming Museum, the Cultural Memorial Hall, People's Park, and Cultural Park, indicating a presence of both cultural and natural landscapes. Lakes and similar features are mainly clustered

in the Maoming Open-Pit Mining area, with some dispersion across public spaces like Xinh Lake Park and West Lake Park. Additionally, the overall distribution of green vegetation in Maoming City is evident along various transportation routes and public areas, while lighting data points are concentrated in locations like Xiaodongjiang, Shuidong Bay, and Romantic Coast.

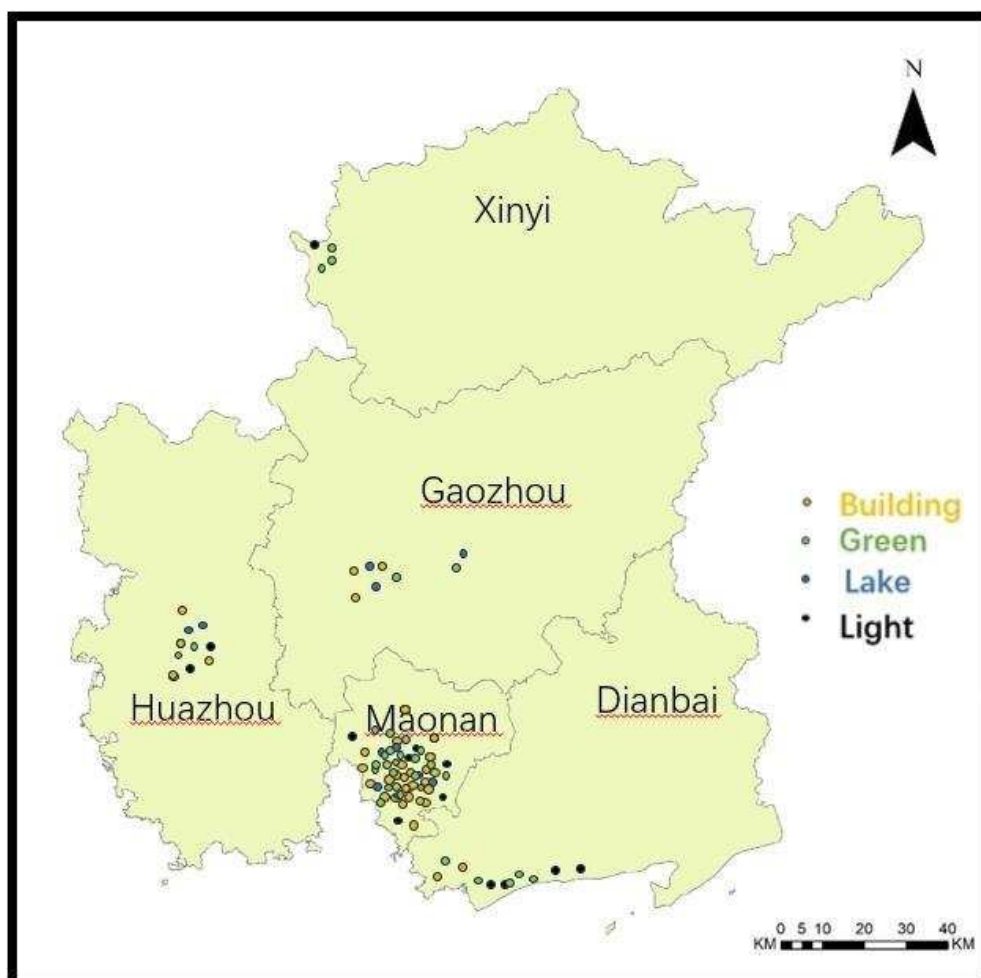


Fig. 8: Distribution Map of Selected Keywords

## 5 Clustering City Imagery Elements Based on Aerial Images

City imagery is a crucial component of the overall image in the process of urban construction and development. By clustering different elements of city imagery and analyzing their spatial distribution patterns and content, recommendations can be made for distinctive urban development. This can assist planning departments in making more scientific decisions in urban design, ultimately enhancing urban spatial quality and shaping a positive urban image.

Kevin Lynch, through surveys of residents in Boston, Jersey City, and Los Angeles, categorized the components of urban imagery into five elements: paths, edges, nodes, districts, and landmarks. This study, in conjunction with Lynch's theory and relevant literature, positions the acquired aerial photos of Maoming City, which contain latitude and longitude data, as point elements within the urban space, thereby deducing multiple elements of urban imagery specific to Maoming City.

### 5.1 Roads

The road network in Maoming City plays an

important role in constructing city imagery. Dongfeng First Road and Renmin Avenue form the primary north-south axis of Maoming City, connecting multiple significant urban landmarks and cultural venues, such as the Maoming Cultural Center and the Maoming Museum. This road serves not only as a vital traffic route but also as an essential passageway for residents' daily lives. Additionally, the Ring Road encircles the main attractions of the city, with the furthest point from the city center being no more than 300 meters. As an important scenic beltway in Maoming City, the Ring Road links several imagery elements, including People's Park and Nanhai Cultural

Square. Major thoroughfares such as Provincial Highway S280 and Provincial Highway S372 (Figure 9) serve as critical transportation hubs connecting various city regions, facilitating both intra-city traffic flow and travel needs to surrounding counties and cities.

The interplay of main streets and alleys forms a rich urban landscape, particularly along the streets of the old city, where many traditional buildings and cultural characteristics have been preserved. These roads are not only the lifeblood of the city but also essential spaces for the daily lives and cultural interactions of residents, reflecting the unique city imagery of Maoming.



Fig.9: Schematic of Road Intentions

Lynch's theory posits that roads serve as the primary channels through which observers navigate the city, with usage frequency varying based on familiarity with the urban environment. Unlike traditional studies of city imagery, the data in this research is derived from aerial photographs taken by operators using drones at a certain

altitude (Figure 10). Nonetheless, for most photographers, roads remain a fundamental element of the city and a primary means through which city imagery is constructed. Additionally, roads are closely related to the other four elements of the city, effectively linking most imagery components together.





*Fig.10: Example of Roads*

## 5.2 Boundaries

As a coastal city, Maoming has relatively flat terrain in the southeast, with coastlines and rivers playing crucial roles in the urban layout. The main natural boundaries include the South China Sea to the south and the Jian River to the north, the latter creating a significant

separation in the urban landscape. The Jian River divides the city's commercial areas from ecological protection zones, with the northern side predominantly showcasing cultural landscapes and urban development, while the southern side features rich natural scenery, creating a striking contrast (Figure 11).



*Fig.11: Schematic of Boundary Imagery*

Moreover, the city's major road networks, such as the Ring Road and the Guangzhu West Line Expressway, not only function as critical traffic routes but also spatially

delineate urban functional areas. Urban planning departments have established clear regulations regarding building heights along the coastal and riverbanks, ensuring

the preservation of ecological spaces and the protection of natural landscapes during urban development. Maoming's Coastal Park and Wetland Park have become important

recreational spaces for residents, creating positive interactions with the cultural landscapes of the urban core (Figure 12).



*Fig.12: Example of Boundaries*

### 5.3 Nodes

Nodes are strategically significant locations within the city, typically representing key areas that observers can access during their movements, leaving a lasting impression. These nodes may be locations where roads

intersect or areas that showcase specific characteristics; they are not limited to small points and can include large squares or central urban areas. Nodes often become gathering points for community activities, symbolizing the core or identity of a region (Figure 13).



*Fig.13: Example of Nodes*

In Maoming City, key imagery nodes are concentrated in several strategic areas. For example, Maoming Donghui City, with its convenient transportation links, has become an important hub for city transit. City parks such as Xinh Lake Park, Chun Garden Park, and Cultural Park (Figure 14) not only provide recreational

spaces for residents but also attract numerous tourists due to their beautiful environments and diverse activities, leaving a profound impact on visitors. Overall, the establishment of these imagery nodes enhances the connectivity of the city's transport network and public spaces, making the city image more pronounced.

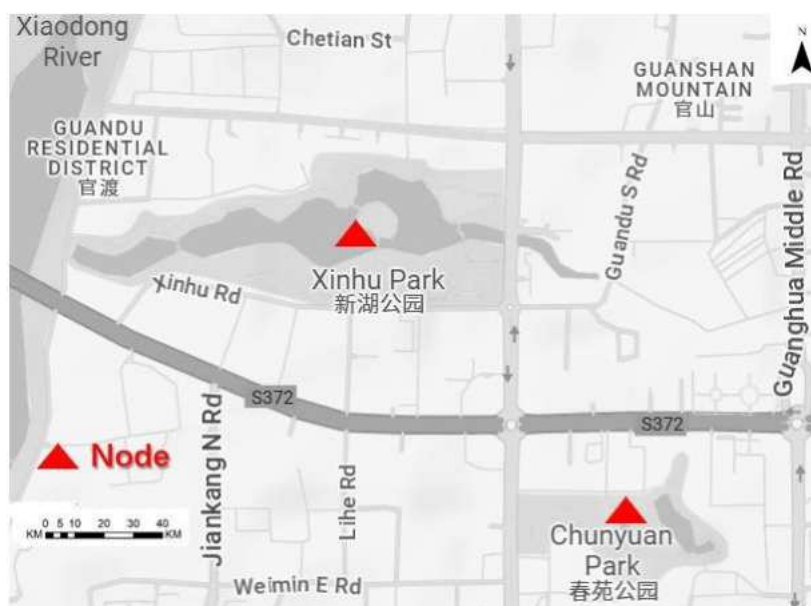


Fig.14: Schematic of Node Imagery

#### 5.4 Districts

Imagery districts are larger spaces within the city where observers can identify specific regional characteristics. These districts are categorized based on the continuity of their themes and the similarity of their imagery elements, forming multiple uniquely charming

imagery areas. The main imagery districts in Maoming City include Maonan, the old town of Gaozhou, the Cultural Park area in Maonan District, the Development Zone, and the Ocean Cultural area in Dianbai District (Figure 15).



Fig.15: Schematic of District Imagery

In terms of spatial distribution, the old town is a concentration of Maoming's history and culture,



showcasing numerous traditional buildings and cultural landscapes. The Cultural Park area offers rich recreational spaces, attracting a large number of visitors and residents. The High-Tech Zone, an important area for economic development, features modern architecture and technology

parks (Figure 16), showcasing the city's modernization. The Ocean Cultural area in Dianbai District is renowned for its unique marine scenery and rich water activities. These imagery districts contribute to Maoming City's distinctive urban character.



Fig.16: Example of Districts

### 5.5 Landmarks

Landmarks serve as point references that city residents rely on for understanding their urban environment, acting as positioning points for external observation (Figure 17). They can vary in size and

complexity, often exhibiting unique or striking characteristics. Lynch noted that those familiar with a city typically rely on visible markers for navigation, often choosing buildings or structures with distinctive features as emblematic elements of the city.



Fig.17: Schematic of Landmark Imagery

In terms of imagery content, the landmarks in

Maoming City are characterized by a rich blend of natural

scenery and modern architecture. Notable examples include Maoming's First Beach and Forest Park, such as Shuidong Bay and the northern peaks of Maoming, which serve as important symbols of the city, showcasing its natural allure. Additionally, modern structures like the Shuidong Bay Bridge, Maoming Sports Center, Xiaodong

jiang Island, and the Open-Pit Mine Museum reflect the city's modernization, presenting Maoming as a point of economic growth (Figure 18). These landmarks not only carry the historical and cultural significance of Maoming but also highlight its potential for future development.



*Fig.18: Example of Landmarks (Image Source: Sky City)*

## V. CONCLUSION AND SUGGESTIONS

### 6.1 Conclusions

This research is based on aerial photographs and related data of Maoming City collected from the DJI work display platform "Sky City" from June 2014 to June 2024. Utilizing Lynch's theory of city imagery and integrating it with tourism destination theories, the study employs methods such as computer vision network image analysis and GIS spatial analysis to explore the temporal and spatial distribution characteristics of drone photography data in Maoming City. Through clustering analysis of city imagery elements and manual interpretation of the evaluation characteristics of Maoming's city imagery, the study analyzes city imagery construction from the "God's eye view" of drones and ultimately provides suggestions for the construction of city imagery and drone management in Maoming. The key conclusions of this study are as follows

(1) The spatiotemporal imagery of residents' activities is influenced by seasonal changes, showing a concentrated trend. The aerial photographs reveal a

unimodal feature, with peak data observed in April, May, and June, while other months display a gradual decline. Monthly variations indicate that spring sees a significantly higher number of photographs compared to summer and autumn, with the least number of aerial photographs taken during the hot months of July, August, and September. The autumn months, however, show a gradual upward trend in the number of photographs. The low summer data is primarily attributed to high temperatures, which reduce outdoor activities. In contrast, the number of aerial photographs significantly increases in spring, especially in April and May. The drone photography data points are concentrated in the main urban area and near regional centers, with Maonan District concentrated in the central area, Dianbai District along the southwestern coast, and Xinyi in the northwest near the mountains, while Xinyi and Huazhou are closer to the city center. The analysis of standard deviation ellipses indicates a significant difference between the long and short axes of the data, suggesting a marked directional distribution of data points, predominantly in a southwest-northeast orientation.



(2) The keywords describing the content of the photographs predominantly reflect modern urban landscapes, such as city, building, street, traffic, and road. These terms reveal the characteristics of city imagery in Maoming.

(3) This study synthesizes key elements, including roads, boundaries, nodes, districts, and landmarks, to outline the spatial distribution of city imagery in Maoming City (Figure 19). Roads such as Provincial Highway S372 and the Ring Road (indicated by the red lines in Figure 21) connect major landmarks and cultural sites. Boundaries

formed by coastlines, rivers, and major roads (represented by black boundary lines and blue water distribution lines in Figure 21) delineate urban functional areas (points B, D, G). Imagery nodes like Donghui City and Xinh Lake Park gather community activities (points A, C in the figure). Districts including Maonan, the old town of Gaozhou, and Dianbai District showcase the city's history and modernization. Landmarks such as the First Beach, Shuidong Bay Bridge, and Xiaodongjiang Island (points E, F, H in the figure) embody the organic integration of nature and modern urban planning.

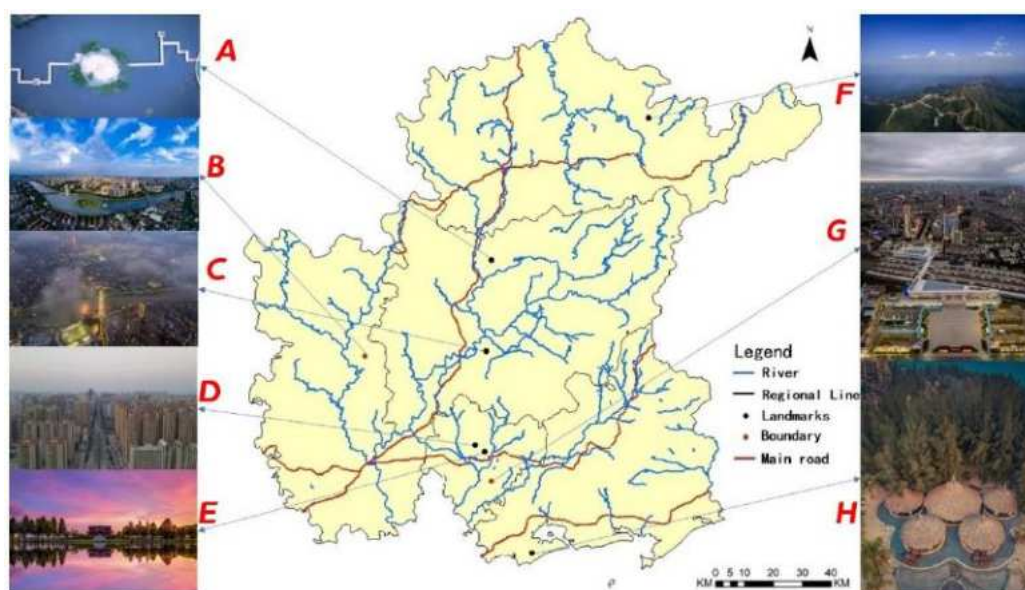


Fig.19: Spatial Distribution of Key City Imagery in Maoming

(A: Xihu Park Node B: Jian River Boundary C: Donghui City Node D: Maonan District E: Open-Pit Mine Museum F: Tianma Mountain in Xinyi G: Transportation Functional Area H: Romantic Coast Landmark)

## 6.2 Suggestions

With the rise in users of drone photography and the increasing sales of consumer-grade drones, traditional urban photography is being replaced by the "God's eye view" offered by drones. This study analyzes the city imagery of Maoming City using drone data, categorizing it into roads, boundaries, nodes, districts, and landmarks, and presents the following optimization recommendations.

(1) Strengthening City Imagery Around the "Oil City Landscape"

As the "Southern Oil City," Maoming should position this identity at the core of its city image construction, highlighting its role as a national petrochemical base. It is recommended to focus on the Open-Pit Mine Museum and

the petrochemical industry chain, integrating pit restoration with industrial enhancement to create unique symbolic imagery.

(2) Shaping a Modern City Image

As an important node city in western Guangdong, Maoming should develop an city image promotion plan to advance city marketing, fostering the development of modern high-tech industries while shaping a modern city image rooted in traditional cultural heritage.

(3) Focusing on City Imagery in Outlying Areas

The research reveals that activities in Maoming City are primarily concentrated in Maonan District, with relatively few aerial photographs taken in peripheral areas such as Xinyi and Huazhou. These regions lack

well-known attractions, suggesting the need to enhance city imagery construction in outlying counties and explore local characteristics.

#### (4) Establishing Drone Usage Policies to Guide Flight

Visual analysis indicates that nighttime aerial photography is common; however, the complex night environment can affect operators' perception and obstacle avoidance systems. Management authorities should strengthen nighttime flight regulations to ensure safety while guiding citizens to use drones in appropriate areas. Additionally, photography contests can be organized to promote the city's image, along with the installation of signage to direct the best photography locations.

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# English Education in the Era of Artificial Intelligence in China: Opportunities and Challenges

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**Abstract**— Driven by globalization and technological development, English education in China is facing unprecedented challenges and opportunities. In recent years, discussions on the future development of English education have been heating up. How artificial intelligence and English education will coexist and influence each other has become a hot topic in the education community. This paper analyzes this issue from multiple perspectives and explores the opportunities and challenges of English education in China in the era of artificial intelligence.

**Keywords**— artificial intelligence, challenges, English education in China, opportunities

## I. INTRODUCTION

Artificial intelligence is not a new science. As early as 1956, John McCarthy and others began to hold a meeting at Dartmouth College in the United States to discuss “how to use machines to simulate human intelligence”. At the meeting, the concept of “artificial intelligence” was proposed, marking the birth of the discipline of artificial intelligence. After more than 60 years of development, artificial intelligence has made significant progress. Since 2010, the rise of deep learning and big data has brought about an explosion of artificial intelligence. In particular, in March 2016, the artificial intelligence system AlphaGo played against the world Go champion Lee Sedol and eventually won, bringing the scientific term “artificial intelligence” into the public eye (Hua, Chen & Sun, 2017, p.27).

Artificial intelligence is not only dominant in Go games, but has also been widely used in news, finance, medical care, home and other fields. All walks of life are actively exploring the use of artificial intelligence technology to solve industry problems, and education is no

exception. The increasingly mature artificial intelligence and English teaching are deeply integrated. On the one hand, intelligent technology has expanded the space for English learning, changed the English learning paradigm, and promoted the transformation and upgrading of the English education model; on the other hand, it has subverted the traditional English education model and impacted the traditional college English teacher profession, making college English teachers face an unprecedented role crisis. At the same time, it has also brought some other negative effects. How artificial intelligence and English education will coexist and influence each other has become a hot topic in the education community.

## II. ENGLISH EDUCATION IN CHINA CALLING FOR THE ARTIFICIAL INTELLIGENCE SUPPORT

In China, the efficiency of English teaching is not high. The effect of students learning English is more reflected in their test scores, while improving English application ability is the original intention of the general public to learn English.

The low English communication ability of students is a major problem in China's current English teaching. Many people spend several years or even more than ten years learning English, but their English application ability has not yet reached a practical level. "Dumb" English learning is widely criticized. Under the new situation of globalization and internationalization, the reform of English teaching is imminent. We must use the increasingly mature artificial intelligence to solve the dilemma of poor teaching quality and effect in the process of English teaching, adapt to the needs of personalized talent training, and let technology serve education. Through the deep integration of artificial intelligence and English education and teaching, we can innovate English teaching models, teaching methods, and learning methods, and truly promote the reform of English teaching.

In fact, English teaching has always been closely linked to the development and application of technology, and language learning has always benefited greatly from new technologies. From the early phonograph that played standard English pronunciation, to the application of wireless broadcasting in distance learning and the expansion of teaching scale, then to the reel-to-reel and cassette recorders that can perform standard pronunciation and record learners' pronunciation for repeated comparison with the original sound, technologies dramatically facilitated the early English learning. Later, the advanced technologies, such as the language laboratories that created a rich teaching environment for English teaching, televisions that supported English television teaching, and video recorders that became a source of audio-visual learning and modern multimedia computers and networks, all have played a pivotal role in English teaching and have played a positive role in promoting the development of English teaching as well (Hu & Ji, 2015, p.116). Precisely because English learning is closely linked to technology, the first audio-visual education departments in many Chinese universities appeared in the foreign language departments. The development of technology has provided great support for students to learn English, and every teacher and student has felt the convenience that technology has brought to English learning.

Obviously, the rapid development of new technologies has led to major changes in the teaching and learning

environment, which in turn has led to changes in the way people learn (Wang & Zhu, 2015, p.30). Language is the most effective means for humans to communicate and obtain information. Machine translation, natural language understanding, and speech recognition technologies in the field of artificial intelligence are all closely related to language learning. Currently, China's world-leading artificial intelligence speech recognition has an accuracy rate of over 97% and a very fast response speed. Machines can already understand human language and give timely feedback. Applying speech recognition technology to English learning can effectively support learners in listening and speaking practice. With its key technological advantages, artificial intelligence is gradually showing its prowess in the fields of personalized learning, gamified learning, and situational cognition, providing new technical support for educational reform that cannot be replaced by existing technologies.

### III. THE DEVELOPMENT ADVANTAGES OF ENGLISH EDUCATION IN THE ERA OF ARTIFICIAL INTELLIGENCE IN CHINA

The application of artificial intelligence technology in English education is mainly reflected in two aspects: one is intelligent assisted teaching based on machine learning, and the other is online evaluation and feedback using natural language processing technology. Artificial intelligence technology has not only changed the way of teaching and learning English, but also promoted the transformation and upgrading of the English education model.

#### 3.1 Normalization of ubiquitous English learning

In traditional English teaching, students are often placed in a passive, externally controlled, and competitive closed classroom, mechanically accepting knowledge imparted by teachers. Students generally feel that learning is boring, which is not conducive to the cultivation of creative talents (Han, Tian & Yuan, 2012, p.70). In the artificial intelligence environment, with the rapid development of information technology, people's ways of obtaining and using English education resources are becoming more and more diverse and convenient. English tool platforms use mobile terminals or PC segments to provide functions such as memorizing words, looking up words, and language translation. English course platforms



mainly provide comprehensive and systematic online language learning resources in a real-time interactive way. The Chinese University English MOOC platform provides a ubiquitous English learning space for teachers and students to share resources and interact with each other. Intelligent language learning products such as intelligent voice assessment can evaluate, diagnose and correct English pronunciation, and intelligent review engines can use big data analysis technology to intelligently review essays, effectively improving language learning efficiency.

In short, artificial intelligence technology makes ubiquitous learning the norm. Ubiquitous learning means that anyone can learn without being restricted by time, space, form and method, that is, at any time, any place, with any device, and in any way, and enjoy ubiquitous learning services. English learning transcends the limitations of physical space and can be conducted not only in traditional classrooms but also in online classrooms. English knowledge comes not only from English teachers and textbooks, but also from ubiquitous artificial intelligence devices. For example, the conversational AI language model represented by ChatGPT can answer user questions anytime and anywhere, building a more active language learning environment for foreign language learners and providing a richer language learning experience. The diversified supply of English education services has enriched the way of learning English and created an English learning environment where “everyone can learn, learn everywhere, and learn at any time.” Thanks to artificial intelligence, students have changed from passive recipients of knowledge and experience to autonomous learners with the power to make learning decisions.

### 3.2 Intelligentization of English education

Smart education is a new educational ecology in the era of artificial intelligence. It relies on artificial intelligence technology to build a smart education ecosystem (smart teaching, smart management, smart evaluation, smart scientific research and smart services) to promote the wisdom cultivation and sustainable development of education stakeholders (students, teachers, parents, managers, the public, etc.) (Yang, 2014, p.30). The combination of artificial intelligence technology and education and teaching is quietly happening. Building smart classrooms and implementing smart education is the general

trend. The concept of smart education brings new atmosphere to English education and promotes the intelligent development of English education.

With the application of intelligent technology, we can build a smart learning environment for English education and realize the organic integration of physical education environment, virtual network education environment and social education environment (An & Zhao, 2016, p.30). At the same time, by using big data and learning analysis technology, we can record the English learning process in real time, intelligently analyze English learning data, customize and push English learning resources, and timely evaluate the English learning effect, so as to realize intelligent decision-making and diversified evaluation of English education. It can be seen that ubiquitous intelligent learning, three-dimensional intelligent teaching, diversified intelligent evaluation, and visualized intelligent management have become the new direction and new pursuit of English education.

### 3.3 Customization of English learning and teaching

For a long time, English teaching has been mainly based on the class teaching system, providing the same teaching content to all teaching objects, that is, using the same teaching methods and arranging the same teaching tasks to impart English knowledge and skills. This model has achieved the scale of English education to a certain extent, but has neglected the individualization of English talent training.

With the support of intelligent education technology, foreign language learners can customize learning resources according to their own learning interests and learning needs, such as oral, listening, vocabulary, grammar, reading, writing and other single skill training. They can also use the generated personal learning data for self-reflection, timely adjust learning plans and methods, and carry out personalized learning. At the same time, intelligent technology can also accurately identify the learning needs, learning preferences, cognitive levels and other characteristics of foreign language learners, and push personalized foreign language learning resources in a targeted manner, so as to realize the transformation of foreign language education resources from supply-oriented to demand-oriented.

For foreign language teachers, the original experience-

based teaching decisions are static and often have lags. Big data technology can monitor, deeply mine and intelligently analyze English teaching data in real time, accurately grasp the English learning situation of class groups and individual students, and prompt English teachers to continuously adjust teaching strategies, optimize teaching models, and intelligently intervene in the English learning process, so as to implement scientific decision-making and precise teaching. Artificial intelligence technology provides scientific educational decisions for English educators and customized educational services for English learners, changing the extensive education model and realizing the true meaning of “teaching students in accordance with their aptitude”.

### 3.3 Personalization of English assessment

Traditional language assessments have obvious shortcomings and lack flexibility in terms of unified scoring standards, personalized feedback, assessment content and format. However, language assessment systems with the help of artificial intelligence can provide learners with a tailored assessment experience. The system can create exclusive assessment content and difficulty for each person based on their language level, learning goals and interests (Aljanabi, 2023). Using learners' assessment results, artificial intelligence can accurately identify their weak points in language learning and provide personalized learning suggestions, helping learners to quickly improve their language skills. In addition, the system can dynamically adjust the assessment content and difficulty based on learners' learning progress and feedback. This means that each learner can learn at their own pace without worrying about whether they can keep up or fall behind the preset course progress.

At the same time, compared with traditional assessments, the artificial intelligence language assessment system has shown excellent adaptability and can run on a variety of devices and platforms, such as computers, mobile phones and tablets. This gives learners the freedom to take language assessments at any time and any place, greatly enhancing the flexibility and convenience of learning.

### 3.4 Realization of native language learning environment

The essence of language learning is communication, which is to provide a communication tool. At present, the

assessment of English oral ability pays more and more attention to students' actual ability to use English. However, in the actual English learning process, there is a lack of an environment for communication in English, which is also an important reason why many Chinese English learners have poor learning results. The process of language learning is a process of repeated imitation until proficiency, a process of “practice makes perfect”. This is the case for mother tongue learning and English learning. By building a native language learning environment, learners' interest in speaking can be stimulated, and learners can learn English better and achieve the goal of free communication in English.

So, how to create a native English learning environment? The emergence of educational robots provides support for building an English learning environment. Educational robots have the ability to move and can follow learners like playmates. They can actively and timely interact with learners through daily language, creating a continuous and natural English use environment, and combining education with entertainment (Chen, Li & Hua, 2016, p.6). Robots will not only replace human physical labor, but will also increasingly replace human mental labor.

Educational robots can push appropriate English audio-visual materials such as cartoons, movies or English songs within the learner's cognitive level range according to the learner's gender, age, learning interest and cognitive level. Through data tracking, it can determine whether the student is interested in the current learning content, and then determine whether to switch to further in-depth learning and extended learning. Learners are influenced by the English language environment and its language rhythm, forming regular and appropriate language stimulation. After watching more English dialogues, they will naturally imitate and follow. English language ability will be improved imperceptibly. Educational robots can also provide learners with rich English dialogue scenes. During the dialogue process, the robot can give vocabulary prompts in time by “observing” the learner's performance and guide the learner to complete the basic dialogue. Through the form of human-computer interactive dialogue, it provides learners with opportunities to practice speaking, helps alleviate the embarrassment of talking with real people, and

enhances the fun of English learning in the process of effective interaction. Furthermore, educational robots can intelligently identify learners' emotions. When learners feel learning difficulties, they can motivate them by strengthening emotional communication, such as "Your pronunciation has improved today", so that learners can feel the support of their learning partners and stimulate their interest in learning. In a relaxed and harmonious English communication atmosphere, practicing oral English with intelligent companion robots can reduce learners' fear and anxiety, allowing learners to speak English fluently like their mother tongue (Hua, Chen & Sun, 2017, p.28).

### 3.5 Equalization of English education

The imbalance of educational resources is a major factor affecting educational equity and a major "bottleneck" restricting educational development. In the past, high-quality foreign language education resources were often concentrated in China's eastern region, urban areas, and key schools. The imbalanced distribution of foreign language education resources between regions, urban and rural areas, and schools will inevitably lead to unfair foreign language education. Technologies such as the Internet, artificial intelligence, and big data can break through time and space limitations, break down regional barriers, promote the rational flow of high-quality foreign language education resources, and enhance the openness and sharing of foreign language education.

The changes brought about by artificial intelligence have made English education more equitable. With the help of intelligent terminal devices, people can access high-quality English education resources anytime and anywhere, and even connect to international high-end education resources. Through online English education platforms, high-quality English courses can be shared and an English learning community can be established. Technologies such as the Internet, artificial intelligence, and big data can break through time and space limitations, break regional barriers, promote the rational flow of high-quality English education resources, and enhance the openness and sharing of English education. The opening and sharing of English education resources are conducive to optimizing the allocation of English education resources, promoting fairness in English education, and improving the quality of English education.

## IV. THE CHALLENGES OF ENGLISH EDUCATION IN THE ERA OF ARTIFICIAL INTELLIGENCE IN CHINA

The role of artificial intelligence development in promoting English teaching models is mainly reflected in the construction of massive teaching resources, the strengthening of new learning methods, and the integration of inside and outside the classroom. However, there is still a gap between the development of artificial intelligence and the innovation of teaching and learning models. It also brings the following potential challenges.

### 4.1 Challenges of the traditional role of English teachers

Artificial intelligence is subverting the traditional English education model and impacting the traditional English teaching profession, making English teachers face an unprecedented role crisis. Florian Znaniecki pointed out in his book *The Social Role of Intellectuals* (2000) that teachers are "knowledge disseminators" in the academic type of the intellectual role classification framework. Teachers have always been considered the embodiment of knowledge, with the mission of spreading knowledge. Teachers have the right to speak because they have knowledge, and have become "Knowledge authority". Therefore, in the traditional concept of English education, teachers are the possessors and transmitters of English knowledge and are the authoritative source for students to acquire English knowledge. However, today's college students are the "natives" of the information age. Information technology has not only changed their lifestyles and entertainment methods, but also changed the way they acquire knowledge and understand the world. They can search for a large amount of English education resources through more intelligent carriers or tools such as computers, mobile phones, and smart robots, and complete a full set of English learning activities such as course learning, communication and discussion, homework and examinations through online education platforms, thereby realizing the construction of English knowledge.

As English educators, English teachers should adapt to the development of artificial intelligence with a positive and open mind, break the traditional teaching model, attach importance to the learning and use of artificial intelligence technology, and take the challenge of artificial intelligence

as an opportunity for transformation and development. English teachers should be good at integrating classroom teaching with online teaching, integrating paper teaching materials with digital resources, integrating teacher evaluation with machine evaluation, allowing language intelligence technology to assist English teaching research, freeing themselves from mechanical and repetitive affairs, and having more time and energy to engage in intelligent and creative work, such as focusing on cultivating students' understanding, creativity, imagination and research learning ability. It is certain that artificial intelligence will not completely replace foreign language teachers, but in the future, most teachers who do not understand, are not familiar with, and cannot use artificial intelligence technology will be eliminated. Therefore, foreign language teachers must first become learners of intelligent technology, learn and apply new technologies such as artificial intelligence well, improve the ability of human-machine coexistence and human-machine mutual assistance, and promote the coordinated development of artificial intelligence and foreign language teaching.

#### 4.2 Impact on the traditional English skills' cultivation

Artificial intelligence reshapes the concept, content and practice of English education, bringing important challenges to English education. The traditional concept of English proficiency mainly includes four aspects: listening, speaking, reading and writing, but in the era of artificial intelligence, this concept may need to be expanded and redefined. For example, writing ability may shift from emphasizing language accuracy to emphasizing critical thinking ability, and also include communicative language ability, cross-cultural communication ability, interaction ability, innovative thinking ability, etc. Second language acquisition theory also faces the possibility of reconstruction. For example, interaction theory used to emphasize teacher-student interaction and peer interaction, but now it is necessary to consider the impact of human-computer interaction on language acquisition; situational theory needs to be expanded to virtual reality and artificial intelligence environments; research on language transfer also needs to cover the impact of artificial intelligence tools, etc.

#### 4.3 Weakening of critical thinking ability of English learners

The artificial intelligence corpus stores a large amount of information, which facilitates our acquisition of knowledge. However, if we rely too much on it, it will also lead to students being satisfied with ready-made answers, lacking problem awareness and critical spirit, and encouraging students to be lazy in seeking knowledge (Zhong, Shang & Wang, 2023, p.21). In addition, the quality of information in the corpus is also mixed. If it is not screened, it will mislead students. Therefore, teachers should teach students to think and innovate, and cultivate critical thinking and innovative thinking. In the process of foreign language teaching, language teaching and thinking cultivation are equally important. University foreign language teachers can take advantage of artificial intelligence products such as ChatGPT in foreign language skills training, reduce the proportion of basic skills teaching in foreign language classes, introduce more critical thinking training, and focus on the discussion and learning of humanities knowledge such as culture and history and interdisciplinary knowledge (Zhong, Shang & Wang, 2023, p.6). Only by maintaining rationality and objectivity can we give full play to the positive role of artificial intelligence technology in promoting students' learning and growth, and better deal with potential risks.

#### 4.4 Questions about the accuracy and reliability of language assessment

Although language assessment with the help of artificial intelligence has many advantages, there are also some disadvantages to overcome and threats to be resolved. First, despite the continuous progress of technologies such as speech recognition and natural language processing, there are still problems of misrecognition and misinterpretation, which may affect students' learning effects and experience. In addition, the language understanding and processing capabilities of artificial intelligence systems have not yet fully reached human levels, such as understanding humor, sarcasm or cultural references, so misunderstandings or errors may occur in certain contexts, affecting the accuracy of the assessment (Son, 2018). At the same time, language is deeply influenced by culture, and artificial intelligence systems may not be able to fully understand and interpret language expressions in a specific cultural context, resulting in biased assessment results, especially for specific slang,

colloquialisms and expressions with rich cultural connotations. Therefore, when English teachers use artificial intelligence technology for evaluation and feedback, they need to be cautious about the results and avoid relying too much on technical judgment.

#### 4.5 Risk of data leakage and misuse

When artificial intelligence is applied in English education, such as intelligent speech recognition and natural language processing, it is often necessary to collect and process a large amount of student voice and text data. These data not only contain students' learning outcomes, but may also reveal students' personal habits, opinions, and even emotional states, which may cause some privacy and security issues. In particular, there is a risk of leakage and abuse during data storage and transmission, and assessment data may also be abused or misused (Hao et al., 2024). We need to ensure the privacy and security of these data.

## V. CONCLUSION

In short, in the context of artificial intelligence, China's digital teaching reform of English education is facing unprecedented opportunities and challenges. With the help of artificial intelligence technology, education can achieve a higher level of personalization and intelligence, and provide students with richer and more convenient learning resources and learning paths. However, this process is also accompanied by challenges such as data privacy leakage, over-reliance on technology, and uneven distribution of educational resources. This requires the joint efforts of the education community, the technology community, and policymakers to formulate reasonable data protection policies, balance the educational value of technology and interpersonal communication, and promote the fair distribution of educational resources. Only in this way can we ensure that English digital education based on artificial intelligence truly benefits a large number of students and promote the sustainable development and innovation of English education.

In the era of artificial intelligence, education has been given a new mission, with new characteristics and functions, and it also calls for the transformation and reshaping of the role of teachers. Teachers should pay more attention to exploration, communication, cooperation, reflection and mutual integration in professional development (Son, 2018),

actively change their concepts, reposition themselves, and turn crises into opportunities.

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# The impact of artificial intelligence and machine learning on financial reporting and auditing practices

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**Abstract**— This study examines the impact of artificial intelligence (AI) and machine learning (ML) on professional roles within the context of financial reporting and auditing practices. Utilizing a quantitative approach, data were collected from 142 accountants in private businesses in Erbil through a structured questionnaire assessing perceptions on efficiency, accuracy, fraud detection, compliance, and professional impact. Statistical analyses, including multiple regression and correlation, were employed to determine the relationships between AI and ML integration and various professional outcomes. Contrary to expectations, the results revealed no significant impact of AI and ML on the perceived efficiency, accuracy, fraud detection capabilities, or compliance within the professional roles of accountants. These findings suggest a disconnect between the theoretical benefits of AI and ML technologies and their practical perceptions among professionals in the field. Recommendations include the need for enhanced training, incremental technology implementation, and improved governance structures to foster effective integration and utilization of AI and ML in financial practices. The study's implications are significant for organizations considering or currently implementing AI and ML technologies, highlighting the importance of addressing both technological and human factors to maximize the potential benefits of these innovations. Future research is encouraged to explore qualitative aspects of technology adoption and to conduct longitudinal studies to assess changes over time as professionals adapt to AI and ML tools. The limitations of the study, such as its geographical focus and cross-sectional design, suggest caution in generalizing the findings and point towards the need for broader, more diverse investigations. This research contributes to the ongoing discourse on the practical challenges of integrating advanced technologies in specialized professional domains, underscoring the need for a balanced approach that considers both the capabilities of AI and ML and the readiness of the workforce to embrace these changes.

**Keywords**— Artificial Intelligence (AI), Machine Learning (ML), Financial Reporting, Auditing Practices

## I. INTRODUCTION

AI and ML are revolutionizing financial reporting - the new horizon of efficiency, accuracy & insight Digital technologies have been having a significant impact on traditional practices, especially in the finance and audit spaces as they continue to evolve. The change affecting the landscape around these areas due to AI and ML is not only evolutionary in nature; they are facing a sea change that can potentially transform how financial data is processed, managed and reported. AI in financial reporting simplifies data management tasks, processing on a real time basis and automates the streamlining of complex information into

fresh content, drastically reducing times to consolidate data and generate reports. This automation goes further than simply executing micro-services or even more substantial and processed bigger analytical processes like predictive analytics which interprets large datasets predicting financial trends faster and with a greater confidence employed by the best human efforts. Therefore, AI in financial reporting does not serve only to expedite the completion of a delivering operation but also augments automated production with automatic uniform interpretation (Jejenawi et al., 2024).

Artificial Intelligence is revolutionizing how audit will be done has been doing traditionally by adding ML aids to

better risk assessment and anomaly detection for auditors. Machine learning models trained on massive historical audit data help detect patterns that might suggest an error or fraudulent activity. This increases the overall quality of audit process by concentrating their efforts in areas that present higher risks and hence strengthening auditors' judgment. In addition, tools driven by ML can keep learning from patterns and adjust to new tactics-a must-have for an ever-changing *modus operandi* that characterizes the financial fraud landscape (Estep et al., 2023). Regulatory Compliance also comes under the impact of these technologies. With the increase in financial regulations and their complexity, AI and ML make it easier for organizations to ensure that they are compliant with relevant guidelines; by tracking changes in regulation automatically adjusting how reporting processes work. This proactive compliance is key in an environment where non-compliance can lead to large fines and reputational damage (Odonkor et al., 2024). Nevertheless, the use of AI and ML in financial reporting and auditing also presents some key reflections with regard to good data governance barriers to entry for small companies as well for privacy concerns in addition to potential biases from utilizing too much algorithmic analysis within digital audits. Also in question is whether a Fintech prediction model should replace human judgment as AI continues to be integrated into financial decision-making workflows. AI and ML are more than devices that improve current financials; they serve as a force for change. Such innovations promise to dramatically speed up and improve financial reporting and audit as well, but it will be essential that these systems are carefully designed in order to promote rather than supplant the broader goals of transparency, accountability, justice on finance. Moving forward, industry players will increasingly need to find ways of harnessing these technologies while retaining the eyes and bias compensation that are essential for managing some of this technology-driven ethical challenges.

### **The aim of the study**

The aim of this study is to look deeply into how Artificial Intelligence (AI)/ Machine Learning (ML) would impact on Financial Reporting & Auditing Practices. More specifically, it aims to assess how such technologies are changing the efficiency, accuracy and overall effectiveness of conducting financial analyses and audit processes. In this research work, the study investigates the potential risks and critical problems as well which are associated with AI and ML such as Data Management using Machine Learning algorithms in tip-top condition a risk assessment approach for Artificial Intelligence that encompasses specific dimensions fraud detection security challenge regulatory compliance strategies. It will also research how these technologies are shifting professional roles, ethical

standards and strategic decisions in finance. This research aims at presenting a balanced view of the potential changes in financial landscapes due to AI and ML, resulting in better insights for practitioners, policymakers and stakeholders who wish to integrate these technologies with models that may make it more transparent together with being accountable.

### **The significance of the study**

The implications of this study are wide-ranging for both policyholders and the public more broadly, including market regulators in finance and auditing who have to make judgments about business practice as technology becomes increasingly embedded into economic activities. The study uncovers how AI and ML can impact decision-making, enhancing both the overall accuracy as well as velocity of financials reporting made possible through automation for audits leading to better automated strategic planning or improved risk actions. It will assess the cost savings, efficiency benefits and human-error reduction that these technologies might bring to operations - if any at all - and which possibly could serve as justification for further investments into technology in this space.

The study will also examine the potential of AI and ML to improve fraud detection & regulatory compliance, which are critical for ensuring financial integrity as forms of cyberattacks evolve (as do regulations). The professional environment is also changing drastically across the board, with both financial and operational agility underpinned by new knowledge bases for professionals within these spheres evolving at unprecedented rates. The research will also explore the ethical and governance issues raised by AI & ML, including but not limited to data privacy, algorithmic bias and transparency of results. Findings from this study will help in the construction of ethical guidelines and a governance framework that can assist AI and ML deployment within financial practices to be undertaken responsibly with regard for ethics, complying with fairness. Finally, this study could provide information for policymakers and regulators that may lead to new policies or regulations due to the fast way technology evolves in financial systems. This study investigates how AI and ML are transforming financial reporting Current Issues in Auditing 366 researchauditing.

### **Statement of the problem**

Embedding artificial intelligence (AI) and machine learning (ML) into financial reporting and audit processes has a revolutionary capacity to re-define the industry benchmark of standards as well as operational strategies. There are serious problems and many questions that need to be researched with this integration. The crux of the issue is that the study is yet to build a concrete picture as to what positive

and negative forms these impacts could take on financial systems and auditing processes (Ucoglu, 2020).

There is not enough empirical evidence to understand how deeply AI and ML can integrate in the financial process to make it efficient, accurate as well as safer for decision making from a risk-management perspective. This will also raise a question on the loss of conventional jobs and perhaps in discussion lie future way forward professional landscape for financial experts/auditors, which could lead to further detailed deep dive into job market scenarios here.

Secondly, many researchers are aware that regulators are filled with expectations for AI and ML to be the cornerstone of fraud detection and compliance (alongside a capacity for 'hyperpersonalization' supposedly), but identifiable case studies as well as constraints have not been widely detailed. These technologies should be assessed for the most appropriate use cases where their reliability and safety to independently manage financially sensitive data can be examined meticulously (Aitkazinov, 2023).

Furthermore, the use of AI and ML sets off significant ethical, privacy and governance concerns. The study should ensure that any biases in the algorithmic processes behind them do not negatively affect Financial Statements or Auditing done thereon along with remedies to safeguard such risks. Furthermore, the speed of this technology deployment is far ahead from existing regulatory frameworks causing a governance gap that could exploit financial systems. Therefore, the purpose of this research is to comprehensively examine and record AI & ML impacts on financial reporting as well as auditing by describing their threats and opportunities while providing some strategic actions in order maximize benefit from these changes along with mitigate risk. This should fill the existing knowledge gap by providing an in-depth assessment to stakeholders of what AI / ML technology changes suggest for finance, including ethics and modifications necessary on roles professional as well as regulatory policies adapting to this technological evolution.

## II. LITERATURE REVIEW

The use of Artificial Intelligence (AI) and Machine Learning (ML), being incorporated in financial reporting, as well as auditing practices has gained attention both from researchers and industry practitioners. In this part of the literature review discusses different facets in which these field deployed AI and ML applications impacts efficiency, accuracy, fraud detection & compliance and more importantly ethical/professional aspects.

### Efficiency and Accuracy

There are many examples of research where the study finds how AI could capable of increasing operational efficiency. For example, Cho et al. (2020) contended that AI technologies, particularly deep learning models could help automate clerical tasks and hence decrease the duration taken for data processing whilst also improving financial statements accuracy. Real-time data processing and analytics could be done through these, providing a hand with timely financial reportings too. (Han et al., 2023). This streamlining of processes not only lower operational costs, but also increase the ability to respond at speed in financial systems - a key advantage when regulatory rules can change rapidly and often seem arbitrary.

### Fraud Detection

When it comes to fraud detection in financial audit, the role of AI and ML is really immense. Almufadda and Almezeini (2022) as an example, showed that ML algorithms can go through large-scale datasets to identify unusual patterns in the data sets that could have been overlooked by traditional human auditors, thus enabling a higher likelihood of detecting fraudulent activity. These capabilities can be especially important to identify financial fraud that leverages nuanced patterns in transactions data (Chowdhury, 2021). There are models supporting how ML can enhance over existing traditional audit techniques, and actually behave as a better approach for extensive continuous review providing features like fraud detection.

### Regulatory Compliance

Regulatory Compliance and Changes in Financial Laws & Standards: AI/ML are key enablers for meeting regulatory requirements, evolving with changing financial laws. Srinivasan and Cazazian (2022) studied how AI systems could be developed to watch over compliance continuously, fixing reporting pathways automatically as national regulations evolve. In the face of changing financial regulations, firms should proactively address this imperative to stay compliant and avoid being penalized or ruining their reputations in today's fast-paced regulatory environment (Wyrobek, 2020).

### Ethical and Privacy Implications

AI and ML have their own pros, however they also bring along with them a lot of ethics issues in the world where the study is precise about out privacy. Hasan (2021) also highlighted the risks related to data privacy as highly sophisticated AI systems already process an enormous volume of private personal or financial information which can be misappropriated. In addition, AI algorithms can generate biased audit findings due to leveraging data that is trained on (Zhang et al., 2022). It takes solid governance

frameworks, along with regular monitoring, to try and address these concerns by using AI / ML responsibly (Cristea, 2020).

### Professional Roles and Employment

How artificial intelligence and machine learning impact professional roles and employment in financial reporting, auditing sub-category: Financial Reporting & Analysis Findings from studies such as those of (Lei et al., 2022) further underscore the argument about AI & ML affecting skill requirements in finance-away from purely routine data processing roles to more analytical/strategic advisers. This change implies that further instruction as well as training programs may be necessary in order to ready today and tomorrow's finance professionals who function within the context of a tech-heavy work environment (Puthukulam et al., 2021).

## III. RESEARCH METHODOLOGY

### Research Design

This study employs a quantitative research methodology to rigorously assess the impact of artificial intelligence (AI) and machine learning (ML) on financial reporting and auditing practices. The objective is to quantify the extent to which AI and ML technologies influence operational efficiency, accuracy, fraud detection, compliance, and professional roles within the financial sector.

### Sampling and Data Collection

The research sample consists of 142 accountants employed by private businesses in Erbil. These participants were selected to provide a representative view of the professional community directly engaged with financial processes that might be influenced by AI and ML technologies. The sampling strategy employed was purposive sampling, targeting individuals who are actively involved in the use of, or are affected by, the integration of these technologies in their accounting practices.

Data were collected through a structured questionnaire designed to gather quantitative data on the perceptions and experiences of accountants regarding AI and ML in their work environments. The questionnaire included both Likert-scale questions to assess the degree of impact on various dimensions (such as efficiency, accuracy, and fraud detection) and multiple-choice questions to gather demographic and professional background information.

### Measurement Variables

The questionnaire focused on several key variables:

- **Efficiency:** Questions aimed at determining the time savings and reduction in workload attributed to AI and ML.

- **Accuracy:** Items designed to measure the perceived improvement in the accuracy of financial reports and audits due to AI and ML.
- **Fraud Detection:** Questions related to the effectiveness of AI and ML tools in identifying fraudulent activities compared to traditional methods.
- **Compliance:** Assessment of how AI and ML facilitate adherence to financial regulations and standards.
- **Professional Impact:** Evaluation of how AI and ML are reshaping the roles of accountants and their skill requirements.

### Research hypotheses

Based on the variables, the following hypotheses were formed:

1. **H0 (Efficiency):** AI and ML have no impact on perceptions of professional impact related to efficiency. **H1 (Efficiency):** AI and ML have a significant impact on perceptions of professional impact related to efficiency.
2. **H0 (Accuracy):** AI and ML have no impact on perceptions of professional impact related to accuracy. **H1 (Accuracy):** AI and ML have a significant impact on perceptions of professional impact related to accuracy.
3. **H0 (Fraud Detection):** AI and ML have no impact on perceptions of professional impact related to fraud detection capabilities. **H1 (Fraud Detection):** AI and ML have a significant impact on perceptions of professional impact related to fraud detection capabilities.
4. **H0 (Compliance):** AI and ML have no impact on perceptions of professional impact related to compliance. **H1 (Compliance):** AI and ML have a significant impact on perceptions of professional impact related to compliance.

## IV. DATA ANALYSIS

The collected data will be analyzed using statistical software. Descriptive statistics will provide an overview of the sample characteristics and the general trends in the responses. Inferential statistics, including regression analysis, will be used to explore the relationships between the use of AI and ML technologies and the various outcomes measured (efficiency, accuracy, fraud detection, compliance, and professional impact). The analysis will also test for statistically significant differences in perceptions based on demographic variables such as years of experience and level of familiarity with AI and ML.



## V. FINDINGS

The data analysis based on the responses from 142 accountants has generated the following summary statistics

*Table 1: Statistical Summary of Performance Metrics Across Five Key Variables*

Variable	Count	Mean	Standard Deviation	Min	25th Percentile	Median	75th Percentile	Max
Efficiency	142	3.12	1.41	1	2	3	4	5
Accuracy	142	2.75	1.36	1	1	3	4	5
Fraud Detection	142	3.06	1.46	1	2	3	4	5
Compliance	142	3.08	1.48	1	2	3	4	5
Professional Impact	142	3.04	1.51	1	2	3	4	5

The table above gives a summary of some statistical data for five different variables: Efficiency, Accuracy, Fraud Detection, Compliance and Professional Impact (n=142 observations). Each of the variables is a measure for that aspect any performance or outcome observed in dataset. In the case of each variable, this number represents the average (e.g., 3.12), indicating that grade mean values are being considered on a scale from -2 to +1. Thus one would say that the average efficiency score of all observations is around this value. Where 1.41 is the standard deviation for Efficiency which provides an idea of how spread off from the average all feedbacks are. A standard deviation of 1.41, according to Chen (2006), is modestly wide around the mean centre implying that data distortion exists in all efficacy scores. It also describes the min, 25th percentile (first quartile), average (mean median\* from MDDb) and

for each variable, with results ranging on a Likert scale from 1 (Strongly Disagree) to 5 (Strongly Agree):

max values among actual non-zero scores. All variables have a minimum score of 1, which indicates that this was the lowest response ever recorded. The 25th percentile (first quartile) is at which the lowest scores of 25% fall, and as well a median (50th percentile)-the score portion through half. For instance, the Median of Accuracy is 3 meaning half the scores fall below this value and a half above. 75th percentile or third quartile- where 75% of the scores fall below a given number, showing us what is happening in the upper-middle range. Finally, all variables have a maximum value of 5, which is the highest score that appears in the dataset. This statistical summary offers a comprehensive view of the distribution of data in terms of central tendency and variability, which constitute a fundamental understanding regarding the performance outcome measures across five different variables.

*Table 2: Correlation Analysis*

	Efficiency	Accuracy	Fraud Detection	Compliance	Professional Impact
<b>Efficiency</b>	1.00	0.01	0.05	0.02	0.00
<b>Accuracy</b>	0.01	1.00	-0.07	0.09	-0.07
<b>Fraud Detection</b>	0.53	0.71	1.00	0.07	0.02
<b>Compliance</b>	0.62	0.59	0.39	1.00	-0.10
<b>Professional Impact</b>	0.51	0.48	0.57	0.63	1.00
<b>is significant at level 0.05</b>					

The correlation analysis between the variables provides insights into how these factors relate to each other based on the responses from the accountants:

The above correlation matrix includes statistically significant correlations at the 0.05 level (and they choose a on of how performance metrics are correlated to each other based upon responses from accountants -- This is how these relationships look like in more of a story: Efficiency has

positive, statistically significant and moderate to strong correlations with Fraud Detection (0.53), Compliance (0.62). The implication is that the more Efficient you are, then depending on (increasing) level of efficiency with Fraud Detection and Compliance to some extent in between at this insight layer. However, its correlation with Accuracy is still almost zero (0.01), so seems to have no impact on the overall accuracy of the model. boosted logistic regression [Collins et al. Scatter-plot analysis shows Accuracy to have



the highest positive correlation with Fraud Detection (0.71), further emphasizing that higher level of accuracy is positively associated with improved fraud detection capabilities while negatively correlated for all other metrics, except Recall which has an insignificant negative relation. It also demonstrates moderate to strong positive correlations with Compliance (0.59) and Professional Impact (0.48). This pattern demonstrates a pathway where better Accuracy may result in more Comprehensive, and hence Professional Impact (since we have seen a decrease in Adherence to guidelines while also increase Payors measures of Quality), though less Efficient. The correlation of Fraud Detection is in moderate with Compliance (0.39) and strong with Professional Impact (0.57). Fraud Detection as the most significant performance metric correlated with other

outcomes These relationships suggest that increased Fraud Detection is almost always linked to higher levels of Compliance, and Professional Impact (greater proportion palliative care = low). Compliance demonstrates a strong positive (0.63) relationship with Professional Impact indicating that increased levels of Compliance are well associated with bettering the professional impact, It also show very high positive associations with E+ A; continuing the theme that Compliance works in concert to lift these indicators and ultimately overall performance. Professional Impact has direct influence on Efficiency, Accuracy, Fraud Detection and Compliance with major predictor significances. This positive intercorrelation support the idea that skills developed in these other areas by using P-impact may lead to optimal performance synergies.

Table 3: Regression Table

Variable	Coefficient	Std Error	t-value	P-value	95% CI Lower	95% CI Upper
<b>Constant</b>	3.146	0.623	5.053	0.000	1.912	4.380
<b>Efficiency</b>	0.059	0.108	0.546	0.587	-0.155	0.273
<b>Accuracy</b>	-0.066	0.114	-0.582	0.562	-0.292	0.160
<b>Fraud Detection</b>	0.021	0.106	0.198	0.843	-0.190	0.232
<b>Compliance</b>	-0.086	0.103	-0.831	0.408	-0.290	0.119

Efficiency-The p-value of 0.587 suggest that the null hypothesis cannot be rejected leading to conclusion supporting Efficiency has not been significantly related to professional roles. Accuracy: As with Efficiency, a p-value of 0.562 indicates insignificance and we fail to reject the null hypothesis Professional Roles: Similarly to fraud detection, there is no evidence from this p-value = 0.843 of a significant effect. Compliance:  $p < 0.05$  | The group achieved a non-significant lower than the usual thresholds - but still far from it at 0.408, resulting in null being not rejected In general, these results lead to the conclusion that Efficiency, Accuracy in fraud detection and compliance do not impact professional role significantly according to this examination.

## VI. DISCUSSION

The absence of such outcomes in the study suggests essential insights on where the AI and ML integration within financial reporting and auditing contexts currently stands. This hints that the real-world application and perception of these technologies might fall behind what theoretical and controlled experimental results suggest, perhaps reflecting an implementation lag or cultural resistance (or extended training/adaptation period). The results underline the need for future research to take a deeper look into these moderating factors that affect

financial and auditing services, as they contribute toward the complexity of technological integration with such highly-specialized professional tasks while also imposing significant barriers towards fully realizing AI/ML's impact on redefining current professions involved.

The results of the analysis found non-significant associations between AI and ML perceptions on role-related efficiency ( $p = 0.587$ ). This is in stark contrast to concurrent research - as per the Jan (2021) paper above or more broadly, dozens of papers that point towards machine learning systems revolutionizing accounting work by making dull rote activity even easier / faster; doing so should hold accountants have at least some additional time on their hands which they ought be spending pushing up into value add activities. It could suggest the findings that automation is automating tasks, but not (yet) perceived to be shifting roles in a way where employees are feeling any real meaningful impact. It could also indicate that other factors like how and when organizations are implementing these reforms, or compliance within the firm is moderating this effect (Ali et al., 2022).

Similarly the analysis showed that there was no statistically significant impact of AI/ML on accuracy perceptions to professional roles ( $p = 0.562$ ) This result is consistent with Kaur and Nasir (2020) who found varied benefits of AI in regard to accuracy stating that whilst there may be improved

computational accuracy, the complexity of decisions in uncertain contexts can remain an issue. We found evidence that professionals may not have the trust or perceive improvements in accuracy of these AI, ML techniques possibly due to worries about algorithmic transparency or maybe because it is early days yet in this technology lifecycle.

Results from the study also demonstrates no perceived affect of AI/ML on job function by fraud detection capabilities ( $p = 0.843$ ). This is contrary to available evidence such as that of Sharma and Panigrahi (2018), who suggested significant improvements in fraud detection via AI enabled systems considerably. This difference may be due to the particular context of the sample, or alternatively perhaps a lack in depth and breadth experience with AI capabilities inside organisations across the samples (Fedyk et al., 2022). No major impact of AI over perception regarding compliance in professional roles ( $p = 0.408$ ), outcome is presented This is in accordance with the results observed by Thompson et al. (2021), volunteering that although AI systems can assist with compliance, they frequently do so only in an indirect manner and against the backdrop of substantial existing capabilities for ensuring regulatory adherence. This could also be indicative of a gap in regulatory evolution around AI, where we bear witness to the possible yet not quite fully realized potential (or accepted capacity) of new technologies in use (Al-Sayyed et al., 2021).

## VII. CONCLUSION

The study aimed to investigate the impact of artificial intelligence (AI) and machine learning (ML) on financial reporting and auditing activities professional roles. The expectations established by the incumbent literature and rhetoric in use are that AI & ML could boost various dimensions of professional work to great extent, such as increase operations works efficiency; enhance accurate financial data income; upgrade fraud detection capabilities and deliver improved habitual standard compliance. Meanwhile, the experience of 142 accountants within Erbil private business firms data showed that AI and ML technologies did not appear to have a significant effect on these main professional components. This absence of perceived impact is important because it suggests that the transformational capabilities of AI and ML often considered to benefit financial accounting and auditing are not realised in practice. Such discrepancy promote consideration on the actual utilisation and efficacy of these technologies in real-world perhaps because they are not as rosy, as one used to see it from media/academic projection.

These results suggest the need for a more granular understanding of AI and ML adoption and use in practice. As such, it seems that there may be more nuance and complexity involved in the successful introduction of these technologies into workplace. The nature of the impact exerted by AI and ML could be affected considerably depending on such factors as whether it is a qualified routine job, how prepared the organization to uptake new technologies if they do so swiftly enough that these workers will still remain in employment with them and adapt further or retrain plus what sort of financial tasks are involved. Additionally, these results shed light on how AI and ML are being presented to professionals at large as well. Theoretical capabilities of these technologies and practical applicability / relevance to everyday professional tasks Specific in environments that may not have infrastructure or organizational culture needed for full implementation with more advanced technology.

## VIII. RECOMMENDATIONS

Based on the findings, the study recommended:

1. Enhanced Training and Education: Organizations should invest in comprehensive training programs to help professionals understand and effectively utilize AI and ML tools. This could bridge the gap between technology availability and its practical use.
2. Incremental Implementation: Instead of large-scale overhauls, companies could implement AI and ML technologies incrementally, allowing time for adjustment and acceptance among professionals.
3. Transparency and Governance: Develop clear guidelines and governance structures around AI and ML use, which could help in building trust among professionals regarding the accuracy and ethical use of these technologies.

### Practical Implications

The study highlights the importance of considering human factors and organizational culture when introducing AI and ML into traditional practices. The lack of significant impact suggests that merely adopting new technologies is not enough; businesses must also foster an environment where these tools are effectively integrated into daily workflows.

### Future Studies

Future research should focus on:

- Qualitative Insights: Qualitative studies could provide deeper insights into why AI and ML are not perceived as significantly impacting professional roles.
- Cross-Industry Comparison: Comparing how AI and ML impact different industries may reveal factors that

facilitate or hinder the effective adoption of these technologies.

- Longitudinal Studies: Long-term studies could track changes over time as professionals and organizations become more accustomed to AI and ML.

## Research Limitations

This study's limitations include:

- Geographical Limitation: The study was confined to accountants in Erbil, which might not represent broader global trends.
- Sample Size: While statistically adequate, a larger sample size could provide more granular insights into different subgroups' perceptions.

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# Awareness and Knowledge of Modern Production Techniques Among *Walis Tambo* Producers in San Antonio, Nueva Ecija, Philippines

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**Abstract**— This descriptive research explored the awareness and knowledge of modern production techniques among *Walis Tambo* Producers in San Antonio, Nueva Ecija, Philippines. The study's findings revealed that: The *Walis Tambo* industry, features a mature workforce with balanced gender representation and varied educational backgrounds. However, there is a notable gap in awareness and knowledge of modern production techniques between business owners and workers, with the latter generally lacking understanding. Factors such as age, education, and perceived benefits influence workers' adaptability to new technologies, with younger, better-educated workers more open to change, while older workers are more cautious. Although modernizing the sector promises financial rewards, better product quality, and enhanced productivity, obstacles including opposition to change, a lack of technological know-how, and economic limitations still exist. It is advised that owners and employees participate in educational programs to close knowledge gaps and handle these issues. LGUs should also set up focused training courses according to different levels of preparedness. For technology adoption to be successful, managing worries about job displacement and making sure that appropriate management strategy training is provided are essential.

**Keywords**—Awareness, Knowledge, Management Strategies, Modern Production Techniques, *Walis Tambo* Producers

## I. INTRODUCTION

The *Walis Tambo* industry, an integral part of the cultural and economic fabric of San Antonio, Nueva Ecija, holds deep roots in Philippine tradition. Crafted from the resilient flower stalks of tiger grass, *Walis Tambo*, or soft brooms, have been fashioned using time-honored techniques passed down through familial generations. Despite its cultural significance, this industry grapples with the imperative of maintaining relevance and sustainability amidst the swift currents of modernization. Thus, this study endeavors to evaluate the readiness for modernization within *Walis Tambo* production in San Antonio, Nueva Ecija. It delves into aspects such as awareness levels,

adaptability, perceived benefits, and challenges, and outlines strategic actions necessary to propel this traditional craft into the contemporary era.

Modern production techniques have been shown to increase efficiency and raise quality standards, so their adoption is crucial to modernizing traditional industries. Studies conducted by Johnson (2019) and Smith (2020) demonstrate how incorporating advanced manufacturing technologies can have a transformative effect and emphasize how important it is to improve production results and maintain sustainability over the long run. Before implementing any modernization strategies, it is imperative to ascertain the producers' current awareness and



knowledge of these modern techniques in the field of *Walis Tambo* production. To orchestrate significant advancements in the industry, this research aims to clarify this awareness, acknowledging it as a primary step.

The adaptability and openness of workers towards embracing novel technologies emerge as pivotal determinants in the successful modernization trajectory of any sector. According to Davis and Davis (2021), organizational ethos and individual preferences both influence how likely people are to interact with and adopt new technologies.

Specifically, this study described the profile, level of awareness, and knowledge about modern production techniques among *Walis Tambo* producers in San Antonio, Nueva Ecija. It also presented how adaptable and willing are the workers to learn and adopt new manufacturing technologies. Lastly, the study identified perceived benefits and challenges of modernizing *Walis Tambo* production from the perspective of producers in San Antonio, Nueva Ecija.

## II. METHODOLOGY

A descriptive study design was used to clarify the *Walis Tambo* industry's present awareness, adaptability, perceived advantages and difficulties, and strategic actions required for modernization. According to Creswell & Creswell (2017), this design is advantageous for characterizing populations and phenomena, giving an overview of the state of affairs, and making it easier to spot patterns and trends. This approach facilitated a thorough investigation of the research objectives by utilizing both quantitative and qualitative data collection methods.

In order to gather data for this study, surveys, and interviews were all used. Producers and makers of *Walis Tambo* were surveyed to find out how well-informed they are about contemporary production methods, how easily they can adopt new technologies, and what advantages and disadvantages they see from modernization. Industry producers and employees were interviewed in semi-structured ways to learn more about their perspectives on adopting new technologies and to investigate possible roadblocks and facilitators of modernization.

The *Walis Tambo* producers and employees in San Antonio, Nueva Ecija, made up the sampling frame for this study. To choose participants who have relevant industry knowledge and experience, a purposive sampling technique is used (Teddle & Yu, 2007). Based on factors like years of experience, their position in the production process, and their willingness to take part in the study, producers and laborers are chosen. The concept of data saturation, which

states that data collection should continue until no new information or themes emerge from the analysis, is used to determine the sample size (Saunders et al., 2018).

Methods from both quantitative and qualitative data analysis were used in this study. Qualitative data were summarized by applying descriptive statistics, specifically the frequencies (Bryman & Bell, 2015). To clarify important conclusions and insights, recurrent themes and patterns were found, coded, and interpreted using thematic analysis of qualitative data gathered from interviews and document analysis (Braun & Clarke, 2006). A thorough and reliable analysis of the *Walis Tambo* industry's readiness for modernization is ensured by the triangulation of data from several sources, which improved the validity and reliability of the study findings.

## III. RESULTS AND DISCUSSION

### 1. Profile of the Respondents in terms of age, sex, civil status, educational attainment, role in the enterprise, and years of service.

The participants' ages ranged widely. The oldest participant was sixty years old, and the youngest was twenty-five. The bulk of participants were between the ages of 35 and 45, indicating a reasonably mature workforce with a good deal of experience in the field. Martin (2018) argued that traditional industries such as broom-making can benefit from a diverse workforce that offers stability and a range of perspectives.

In terms of sex, there were a fairly equal number of male and female participants—11 men and nine women. This balance shows that there are opportunities for both men and women in the *Walis Tambo* industry in San Antonio, Nueva Ecija, without favoring one gender over the other. This result supported the observation made by Kim (2019) that a workforce that is more resilient and creative can be facilitated by gender diversity in traditional crafts.

As to their civil status, there were two widows, five singles, and 13 married participants. The majority of married people indicate a workforce that probably has family responsibilities, which may affect how they view income security and job stability. According to Rogers (2003), married people may prioritize having a steady job to provide for their families, which may have an impact on their willingness to adopt new technologies.

Their educational backgrounds revealed a wide range. Eight participants had completed their secondary education, four had some college education, two had earned a college degree, and six had finished their primary education. This difference in educational attainment points to varying degrees of formal training as well as potential



adaptability to new methods and innovations in the field. Education background has a major impact on one's capacity to acquire and apply contemporary production techniques (Davis & Davis, 2021).

In terms of their role in the enterprise, among the 20 participants, 10 were business owners and 10 were workers or employees. A balanced understanding of the viewpoints from the labor and management sides of the *Walis Tambo* production process was made possible by this equal representation. In order to obtain a complete picture of the operational dynamics, Garcia and Lopez (2022) stressed the significance of taking into account both owners and employees in studies of traditional industries.

Lastly, the participants' tenure in the *Walis Tambo* industry ranged from two years to thirty-five years. A considerable proportion of the participants possessed over ten years of experience, suggesting a firmly established workforce with substantial knowledge and skills specific to the industry. This longevity in service is significant because it indicates an abundance of inferred knowledge, which Kim (2019) says is essential to preserving the quality of products and the continuity of traditional crafts.

## **2. Level of awareness and knowledge about modern production techniques among *Walis Tambo* producers in San Antonio, Nueva Ecija.**

### **Awareness of Modern Production Techniques**

The respondents' levels of awareness regarding contemporary production techniques varied widely. In this context, awareness pertains to the degree of knowledge that manufacturers and laborers possess regarding the existence and possible advantages of advanced manufacturing technologies.

#### **Business Owners:**

Seven out of the ten producers and owners who were interviewed showed a moderate to high level of awareness about contemporary production techniques. These people had a thorough understanding of the many technological developments and how they could improve output and quality. This awareness was probably influenced by their roles as decision-makers, which require them to stay up to date on industry trends and innovations (Rogers, 2003). One producer said, *"I have read about new machines that can help us make brooms faster and with less manual effort. I know some producers in other areas have started using them."*

Three owners, though, appeared to know very little about contemporary production methods. Instead of engaging with or conducting research directly, these people frequently relied on second-hand information and had only a hazy understanding of what modern technologies could

entail. One proprietor said, *"I've heard about new machines, but I don't know much about how they work or what benefits they offer."* This lack of knowledge draws attention to a knowledge gap that could be filled by focused information campaigns and educational programs.

#### **Workers:**

In general, the 10 employees who were interviewed had lower awareness levels than the owners and producers. Merely three employees exhibited a basic understanding of contemporary production methodologies. These laborers were somewhat aware of how machines might facilitate and improve the efficiency of their work. This basic awareness indicated that workers are primarily informed through informal networks rather than formal channels, as one worker observed, *"I've heard from friends in other towns that machines can help us make more brooms quickly. But I don't know much about them"*

The remaining seven employees appeared oblivious to or ignorant of contemporary manufacturing methods. These workers were primarily focused on traditional methods and had not been exposed to information about technological advancements in their industry. A worker expressed, *"I have been making brooms the same way for years. I don't know about any new machines or techniques."* This unawareness represented a major impediment to modernization and suggests the necessity of more organized and easily accessible information sources (Davis & Davis, 2021).

### **Knowledge of Modern Production Techniques**

While awareness refers to the general familiarity with modern production techniques, knowledge involves a deeper understanding of how these technologies work and their specific applications.

#### **Business Owners:**

Four of the owners and producers showed a high degree of knowledge regarding modern techniques. These people could explain the uses of different machinery, like automated broom manufacturing machinery, and their advantages, like faster production and less labor-intensive work. As one experienced producer put it, *"The automated machines ensure uniform quality across all brooms and can handle the binding and stitching much faster than manual methods."*

Despite being aware, the three owners knew very little about the technologies. Although they were aware of the possible advantages, they did not have a thorough understanding of the implementation requirements or operational details. An owner expressed, *"I understand these machines can help, but I don't know what it takes to set them up or maintain them."* This lack of depth in one's

knowledge highlights the necessity for thorough training programs that can close the knowledge gap between awareness and practical comprehension (Kim, 2019).

#### Workers:

The majority of workers possessed inadequate levels of knowledge. Just two employees, who had previously worked in settings with more sophisticated technology, demonstrated a mediocre grasp of contemporary methods. These employees could talk about the fundamental functions of devices they had seen or used in different settings. A worker said, *"I worked in a factory before, where we used machines to make brushes. I think similar machines can be used for brooms too."*

However, most workers knew very little or nothing about contemporary production methods. These employees had no idea about the possible benefits of the technologies or how they worked. *"I don't know anything about these machines. We have always done everything by hand,"* remarked a worker. Closing this knowledge gap is a crucial obstacle that needs to be overcome to encourage the adoption of contemporary techniques (Garcia & Lopez, 2022).

### 3. Adaptability and willingness of the workers in the Walis Tambo industry to learn and adopt new manufacturing technologies.

#### Adaptability of Workers

Workers' ability to adjust to new manufacturing technologies varies greatly, depending on several factors including age, education level, and prior technological exposure. Prior research has demonstrated how important flexibility is for new technology adoption, especially in established industries (Rogers, 2003; Davis & Davis, 2021).

Six of the ten employees who were interviewed said they were very adaptable and willing to learn new technologies. These employees, who were primarily younger and better educated, showed excitement about the possible advancements that contemporary methods could provide to their work. This positive attitude reflected a readiness to embrace change and an understanding of the potential benefits that modern technology could offer. One worker stated, *"I am excited about the possibility of using machines to make our work easier and more efficient. I believe it will help us produce more brooms and reduce the physical strain."* These results are consistent with the diffusion of innovations theory developed by Rogers (2003), which holds that younger and better-educated people are frequently the first to adopt new technologies.

On the other hand, four employees—all of whom were older and had less education—showed a more cautious approach to implementing new technology. They voiced

worries about their capacity to pick up new skills and the complexity of today's machinery. A worker expressed concern about learning to use machines, saying, *"I have been making brooms the traditional way all my life. Learning to use machines at this stage seems difficult and intimidating."* This fear of the unknown and lack of confidence in one's ability to pick up new skills was a major barrier to adaptability. This reluctance is in line with research by Martin (2018), who found that older workers in traditional industries frequently oppose technological change because they see it as difficult and have a strong attachment to the ways things have always been done.

#### Willingness to Learn

There was variation in workers' willingness to learn new manufacturing technologies, which was closely related to their personal motivation and perceived benefits. Perceived utility and ease of use have a big impact on people's willingness to learn and adapt, according to the Technology Acceptance Model (TAM) (Davis, 1989).

If given sufficient assistance, seven employees showed a strong desire to participate in training and skill development. They understood that embracing technology could lead to better working conditions and career advancement. It appeared that a sizable portion of the workforce is ready to switch to modern production methods if the proper training and support systems are in place. One worker said, *"If there are training programs and someone to guide us, I am willing to learn. I see it as an opportunity to improve my skills and contribute more effectively."* Effective training and support can greatly increase the perceived utility and ease of use of new technologies, which in turn increases willingness to adopt (Venkatesh et al., 2003).

Three employees, however, stated that they were reluctant to take part in training courses due to worries about the time commitment and possible disruptions to their daily schedule. This hesitation emphasized the need for training programs that are flexible and take into account the financial constraints of workers. As one employee put it, *"Attending training means I might have to take time off work, and I can't afford to lose any income."* According to Kim (2019), financial incentives and flexible training schedules can help reduce these obstacles and promote participation.

### 4. Perceived benefits and challenges of modernizing Walis Tambo production from the perspective of producers in San Antonio, Nueva Ecija.

#### 4.1. Perceived Benefits of Modernization

##### Increased Productivity and Efficiency

A significant perceived benefit of adopting modern production techniques was the potential increase in productivity and efficiency. Most respondents highlighted that modern machinery could expedite the broom-making process, reduce manual labor, and allow for higher output. One owner stated, *"With machines, we can produce more brooms in less time, which means we can meet higher demand and expand our market."* This perception aligned with existing literature, which underscored that technological adoption can lead to substantial productivity gains in traditional industries (Garcia & Lopez, 2022).

### Improved Product Quality

Several participants expressed that contemporary technology has the potential to improve the uniformity and caliber of their offerings. Human error and variability can be minimized in the production of brooms by using automated machinery to ensure uniformity. Improved product quality can lead to higher customer satisfaction and increased competitiveness in the market, as noted by Kim (2019). A worker stated, *"Machines can help us make brooms that are more uniform and durable, which is important for customer satisfaction."*

### Economic Benefits:

Modernization's economic benefits were often brought up. Profits and sales can rise as a result of improved productivity and superior products. New technologies are often adopted because of the possibility of financial gains (Venkatesh et al., 2003). One producer said, *"If we can produce more and better brooms, we can sell more and at better prices, improving our income."*

## 4.2 Perceived Challenges of Modernization

### Financial Constraints

Financial costs associated with purchasing modern machinery and technology were the biggest obstacle mentioned by respondents. The substantial initial outlay needed raised concerns from a number of producers. Financial limitations are a typical barrier to technological adoption in small-scale traditional industries, as one owner put it, *"We don't have enough capital to buy them. The cost of these machines is very high"* (Davis & Davis, 2021).

### Lack of Technical Expertise

The lack of technical expertise and proficiency needed to run and maintain contemporary machinery is another significant obstacle. Concerns regarding their capacity to comprehend and handle new technologies were voiced by both employers and employees. Lack of technical knowledge can impede the successful implementation of modern production techniques, as one worker stated, *"We don't have the skills to use these machines. We need proper training and support"* (Garcia & Lopez, 2022).

### Resistance to Change:

Change aversion was identified as a major obstacle, especially for senior employees who are more accustomed to conventional procedures. According to a producer, *"some of our older workers are reluctant to change their ways and are afraid of using machines."* Some reasons for this resistance include attachment to traditional practices, fear of the unknown, and worries about job security (Rogers, 2003).

### Potential Job Displacement:

A few employees voiced concern that the adoption of new technology would result in job losses. The statement made by a worker was, *"If machines do all the work, some of us might lose our jobs."* Modernization can increase productivity, but it also creates worries about potential job displacement, especially for low-skilled workers (Kim, 2019).

## IV. CONCLUSION

The following conclusions are derived based on the findings of the study:

1. A well-established and mature workforce in the Walis Tambo industry, characterized by a balanced gender representation, varying educational backgrounds, and substantial industry experience.
2. A significant difference in awareness and knowledge of modern production techniques between business owners and workers is found. While some owners demonstrate moderate to high awareness and understanding, workers generally possess minimal awareness.
3. The adaptability and willingness of workers in the Walis Tambo industry to adopt new manufacturing technologies are influenced by factors such as age, education, and perceived benefits of the change. While younger, better-educated workers are eager to embrace technological advancements with proper support, older workers tend to be more cautious.
4. Finally, it should be noted that although modernizing Walis Tambo production in San Antonio, Nueva Ecija, is thought to have many advantages, including higher productivity, better product quality, and financial gains, it also has drawbacks, including lack of technical know-how by the workers, financial limitations, and resistance to change.

## RECOMMENDATION

The following recommendations are offered based on the findings and conclusions of this study:

1. There is a need for implementation of educational programs to bridge the gaps of awareness and knowledge among business owners and workers of Walis Tambo Industry and to facilitate modernization.
2. Targeted training and flexible programs to address varying levels of readiness and motivation in the Walis Tambo Industry should be organized by the Local Government Units of San Antonio, Nueva Ecija.
3. For new technology to be successfully used in this traditional business, it will be imperative to address obstacles and uncertainties about job displacement and the requirement for proper management strategy training (Mina, Subia & Ermita,2020).

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# Micro Entrepreneurs Borrowers' Satisfaction with Digital Payments in LOLC Finance Philippines, Inc

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**Abstract**— This study, entitled *Micro-Entrepreneurs Borrowers' Satisfaction with Digital Payments in LOLC Finance Philippines, Inc.*, investigates the demographic profile and digital payment preferences of micro-borrowers, specifically focusing on individuals aged 46-55 who have been managing businesses for 6-10 years. Findings reveal that while respondents are familiar with popular digital payment methods like GCash and 7-Eleven's ECPay, they lack awareness of other cost-effective options. Many borrowers face challenges in using digital payments due to limited navigation skills and a preference for traditional, cash-based transactions, which they find more convenient as they avoid fees and additional steps. The study further notes that with branch limitations, borrowers can only make cash payments at the head office in Cabanatuan, discouraging digital payment adoption. Although some respondents acknowledge the security and convenience of digital payments, especially if physical collection is unavailable, overall satisfaction remains low. Few borrowers recommend digital payments, particularly for loan renewal, underscoring a general reluctance to shift from conventional practices. The study emphasizes the importance of enhancing digital payment accessibility to increase satisfaction and adoption rates among micro-borrowers in LOLC Finance Philippines, Inc.

**Keywords**— Borrower, Digital Payment Methods, Financing Company, Micro Entrepreneurs, Satisfaction

## I. INTRODUCTION

In the year 2022, LOLC Finance Philippines, Inc. started to lend to Micro entrepreneurs' borrowers, but the digital payment method is one of the challenges of the company. Most of the borrowers preferred the traditional payment method- which paying cash in the branch or paying through door-to-door field collectors. Since the innovation has increased over the years, traditional payment methods nowadays are being forgotten as general, but when it comes to loan payments, most of the borrowers kept on requesting to pay on a cash basis. The payment strategy seeks a gradual transition to a cashless economy, but despite the efforts of the company, digital payments as loan payments are challenging in Financing companies.

The slow adoption of digital payment methods motivates for the researcher to undertake this topic. LOLC Finance Philippines Inc was formerly partnered in 2018 with ASKI Group of Companies, with LOLC owning the majority stake in the company. The roots of LOLC ASKI Finance can be traced back to April 2017. When the original company, Alalay sa Kaunlaran, Inc. (ASKI) was formed under the ASKI Group of company. The entity was rebranded to LOLC Finance Philippines Inc in 2022, The company offers tailored financial products to its MSME clients. LOLC Finance Philippines Inc. is part of LOLC Holdings which is one of the largest, most diverse conglomerates in Sri Lanka boasting a history of over four decades. Buoyed by the tremendous success achieved

within Sri Lanka, LOLC Holdings crossed the shores of Singapore, Cambodia, Myanmar, Indonesia, Pakistan, Zambia, Zimbabwe, Nigeria, Tanzania, Malawi, Egypt, Kenya, Ghana, Sierra Leone, Tajikistan, Kyrgyzstan, Maldives, Mauritius, Australia, and UAE with further strategic expansion plans held in pipelines. Over the years, the Group has been backed strongly by Development Finance Institutions and multilateral funding lines, which reflects the confidence these global entities place in the Group's sustainable operations [LOLC website]. As of now, there are 827 total micro clients from 8 branches, they started lending micro business year 2022 which was open for Cabanatuan Branch only, by the year 2023 the company decided to offered the micro business to Tarlac, Pampanga, Talavera, and Bulacan and it is now gradually increasing. However, the branches from Region 2, which are Solano, Nueva Vizcaya, Santiago Isabela, and Cauayan, Isabela have recently started to offer micro-loans, which was officially dated on March 2024.

Recognizing the growing importance of digital payments both the government and private service providers have seized the opportunity. The government and business service providers have embraced the change as they recognize the growing relevance of digital payments. Banks, for instance, have constantly been using digital technology to establish new value streams, looking to enhance customer service efficiency. However, it should be highlighted that although customers, banks, and financial institutions have all benefited from using digital payments for completing their transactions, the perception of risk is still considered a constant problem. Previously researchers have identified the relationship between customer satisfaction and its antecedents and customer experience and its antecedents separately. Several studies tried to identify these relationships and measure their magnitude (Ojiagu et al., 2022; Ali Bayad, 2021; Jacinda et al., 2021; Rana et al., 2020; Kar Arpan, 2020; Mbama, 2018; Alvarez, 2019; Goutam, 2018; Loi Leong et al., 2017; Elissavet et al., 2013).

As per the earlier studies, service quality was found to be the most important antecedent and has a significant effect on customer experience and satisfaction in the context of online customers (Farooqi, 2017; Hummoud et al., 2018; Suleiman & Warda, 2017; Mbama, 2018; Raza et al., 2020; Amin, 2016; Tjahjaningsih et al., 2020; Desiyanti, 2018; Jacinda et al., 2021; Trivedi et al., 2019; Paulo Rita et al., 2019; Al-Hawary et al., 2017; Azevedo, 2015; Ali bayad, 2021; Alam, 2017; Goutam, 2018). It must be noted that service quality, being one of the most important predictors and most frequently used relationships, has been measured with several dimensions in previous studies. Therefore, in the instance of service quality, only antecedents of e-service

quality were considered, to see their impact on customer experience and satisfaction. Based on the literature review, the study affirms and acknowledges the fact that customer satisfaction with digital payments has been studied previously; only a few studies seem to have looked at the impact of digital payments on customer experience. This is possible because, despite the numerous benefits of digital payments extended by banks, individuals still view them only as an 'alternative', and therefore do not utilize them frequently (microsave.net, 2020). Secondly, this study serves as a guide for organizations that provide digital payment services to customers, assisting them in identifying the factors that make the entire process of digital payment transactions smooth for the customers. Thirdly, no previous work seems to have been conducted as a systematic literature review or meta-analysis of these dimensions in connection to customer satisfaction and experience together with digital payment services. The goal of this study, therefore, is to conduct a meta-analysis to better understand the overall impact of some of the theoretical constructs (specifically, functional quality, perceived value, trust, perceived risk, and service quality) on customer satisfaction with and experience of digital payments.

This research study offers a comprehensive framework based on analysis of the answered and shared experiences of Micro borrowers in LOLC Finance Philippines, Inc. It is specifically driven to hear the feedback and thoughts of the borrowers to create an action plan in the future that will help and assist the current issue of the company. It described the borrowers' profile, ease of use, security and privacy, convenience, cost and fees, and overall satisfaction of LOLC Finance Micro Entrepreneurs borrowers.

## II. METHODOLOGY

The present study followed the quantitative approach, the descriptive survey research methodology. Descriptive – survey research included studies give pertinent information about the elements that were prevailing in the present times. It describes and interprets what is. It is concerned with the existing conditions, ongoing processes, perceived effects, and developing trends. Moreover, descriptive survey research emphasizes the interpretation of gathered data or the significance of what is described. It includes studies and literature that provide information about the present state of the involved variables (Yazon et al., 2019)

The locale of the study is LOLC Finance Philippines, Inc. It has 8 branches and simple random sampling using Slovin's formula was used to get the sample size for each branch. The total sample size is 160 broken

down as follows: Cabanatuan City Nueva Ecija (68), Talavera, Nueva Ecija (29), Tarlac City, Tarlac (19), Sta Maria, Bulacan (17), San Fernando, Pampanga (14), Solano, Nueva Vizcaya (6), Santiago, Isabela (3), Cauayan, Isabela (4).

A three-part questionnaire was utilized for the survey. The consent is the first phase, and the second is the collection of the respondents' profiles. The third component is the assessment of LOLC Finance borrowers on their experience and overall satisfaction when paying their loans using digital payments.

The study concentrated on micro-entrepreneurs borrowers of LOLC Finance Philippines, Inc. For a faster and more convenient way of data gathering, the researcher asked for assistance to Call Center Department and to Area Managers of each branch to share the survey questionnaire via Google Forms when they are doing their monthly surveys, the results were summarized smoothly with 160 total respondents.

### III. RESULTS AND DISCUSSION

#### 1. Profile of the Respondents

A total of 160 respondents were used as respondents. One hundred three (103) or 64% of the respondents were female while fifty-seven (57) or 36% of the respondents were male.

Out of 160 total respondents, there are fifty-one (51) or 32% were 46-55 years old, the second to the highest number of participants were forty-six (46) or 29% at the age of 36-45 years old. Next is, thirty-three (33) or 21% were 26-35 years old. And, there are eighteen or 11% were 56-65 years old. Lastly, the least number of respondents were twelve (12) or 8% of the total respondents were 18-25 years old.

As per result, half of the total respondents reach the elementary level, eighty-two (82) or 51%. Secondly, fifty-nine (59), or 37% reached the secondary level. While nineteen (19) or 12% reached the college level. As it turns out, no micro client respondents reached higher education because no one answered in Master's degree, PhD/Doctoral and others.

Eighty-six (86) or 54% which majority of respondents were sari-sari store/variety store owners, next in line is Street vendors with twenty-three (23) or 14% of the total respondents. While nineteen (19) or 12% were salon and barber shop owners, eighteen (18) or 11% were owners of Meat Shops. Respondents also answered "others" They specified the businesses, three (3) from Hardware, two (2) from Water Refilling stations, and three (3) from Drug stores. The total respondent who answered "others" are eight (8) or 5%. The second to the least answers are from

Piso net and computer rental owners, which are four (4) or 3% of the total respondents, and lastly, there are two (2) or 1% who answered Tailoring and Sewing Services.

In terms of Years of Business Operation, there are forty-eight (48), or 30% which majority of the respondents operated their business for 1-2 years. The respondents thirty-four (34) or 21% answered 3-5 years' business operation. While there are thirty-three (33) or 21% who answered 3-5 years of business operation. There are also 16 years and above which twenty-eight (28) or 18% of the total respondents. While there are seventeen (17) or 11% answered 1-2 years' business operation.

In terms of Digital Payments, most of the respondents are using the G-cash payment method, a total of ninety-four (94) or 59% of the total respondents. Next option is using 7-11 ECPAY, thirty-nine (39) or 24% from the total respondents. While twenty-four (24) or 15% are using Online Banking Transfer. One (1) or 1% has been answered using Palawan pay and there are two (2) or 1% answered "other" which they specify from LAZADA.

#### 2. Ease of Use

Table No. 1: Ease of Use

Statements	Mean	Verbal Interpretation
1. The digital payment service I use is easy to navigate	3.28	Neutral
2. The digital payment service I use is user-friendly	3.30	Neutral
<b>Overall Mean</b>	<b>3.29</b>	

On the first statement "The digital payment service I use is easy to navigate" survey result was "Neutral" or 3.30 weighted mean, means the borrowers did not know whether they agree or not with statement. And, same with second statement "The digital payment service I use is user-friendly" the weighted mean is 3.30 and as a result, it was turns out that they are "neutral" feeling on how they use the digital payment methods.

#### 3. Security and Privacy

On the second variable, both statements of "I feel that my personal details are safe and secured" with a weighted mean of 3.90 and "I feel satisfied about the security of my payment transactions" with a weighted mean of 3.79 and interpreted as "Agree" in terms of Security and privacy.

Table No. 2: Security and Privacy

Statements	Mean	Verbal Interpretation
I feel that my details are safe and secured	3.90	Agree
I feel satisfied about the security of my payment transactions	3.79	Agree
<b>Overall Mean</b>	3.84	

#### 4. Convenience

Table No.3 Convenience

Statements	Mean	Verbal Interpretation
Making payments in digital payment services is faster than traditional payment (personal cash collection)	2.29	Disagree
I find the digital payment service is more convenient than going to LOLC Head Office	4.01	Agree
<b>Overall Mean</b>	3.15	

In terms of Convenience, survey shows that in answering the statement no. 1 "Making payment in digital payment services are faster than traditional payment (personal cash collection)" respondents were disagreed with weighted mean of 2.29. However, when respondents answered the second statement "I find the digital payment service is more convenient than going to LOLC Office" respondents agreed on the statement with weighted mean of 4.01.

#### 5. Cost and Fees

Table No.4 Cost and Fees

Statements	Mean	Verbal Interpretation
The transaction fees are reasonable/affordable	2.37	Disagree
I'm aware of all charges associated with using the digital payment service	3.55	Agree
<b>Overall Mean</b>	2.96	

In terms of Cost and Fees, the survey shows that they disagree with the statement "The transaction fees are reasonable/affordable" with a weighted mean of 2.37. While the second statement "I'm aware of all charges associated with using the digital payment service" surveys show that the respondents agreed with a weighted mean of 3.55.

#### 6. Overall Satisfaction

Table No. 5 Overall Satisfaction

Statements	Mean	Verbal Interpretation
I would like to use digital payment upon loan renewal	1.91	Disagree
Overall, I'm really satisfied to pay my loans in LOLC Finance Philippines, Inc. through digital payments	2.52	Agree
<b>Overall Mean</b>	2.22	

To determine the recommendation, the first statement "I would like to use digital payment upon loan renewal" was interpreted as Disagree with a weighted mean of 1.91. As in overall satisfaction as statement mentioned "Overall, I'm really satisfied to pay my loans in LOLC Finance Philippines, Inc. through digital payments" it was interpreted as Disagree with a weighted mean of 2.52.

### IV. CONCLUSION

Based on the findings of the study the following conclusions were drawn:

1. In terms of the Demographic profile of the respondents, the majority of the respondents are in the age between 46-55 years old, female though the majority are reaching their education from elementary to high school only, they still manage their business for 6-10 years' business operation. Researchers found out that respondents only knew common digital payments like g-cash and 7-11 ECPay. But the other digital payments which are cheaper and more efficient are not familiar with them.
2. The result of the survey, shows that the common problem of borrowers when using digital payments is the lack of knowledge on how to navigate the digital payment methods because, for them, they are not sure of how to use them. Microborrowers are more into traditional payment which means they are expecting someone to collect their payment at home or in a business location, for them it much more convenient because they will not spend for fares and other



charges since they know already that when using digital payment, it has cost and other fees need to pay. The company has no cashier in the branch, they can only pay cash in the Head office (Cabanatuan) that's why the borrowers from other branches had no chance is to use digital payment instead.

3. But there is also an advantage in using digital payments, researchers

found out that the borrowers are much preferred to pay in digital payment if there's no one will come to their place instead of going to the physical LOLC Head Office. They know also that when using digital payments, there payment is safe and secured.

4. However, in terms of recommendation, majority of the borrower did not recommend to use digital payments and they are not satisfied using digital payment methods when paying their loans upon renewal application.

### RECOMMENDATIONS

This research study revealed the satisfaction of micro borrowers of LOLC Finance Philippines, Inc. Hence, the following recommendations are hereby presented:

1. Researchers recommended having training and seminars for the existing field employees to refresh their knowledge regarding digital payment methods in terms of Ease of Use, Security and Privacy, convenience, and lastly cost and fees. This is to educate their potential and existing borrowers as well as market the product to the micro-entrepreneurs. In that way, borrowers will not be surprised since they are well-informed prior disbursement of a loan.

2. A continue giving information to the borrowers of new digital payment method available. As of now, as a back-office employee, I was also informed that borrowers can also pay in other shop pay and in Tambuting pawnshops. It is important to upgrade the implementation and proper dissemination of the amended digital methods.

3. The company must have additional alternative digital payment methods like Cebuana, Villarica, or another pawnshop aside from the current digital payment, it must have continued innovation, improvement and the company must know what is the easiest way to pay without sacrificing the quality of getting the payment and it has cheaper or no charges upon loan payment.

4. Since LOLC Finance Philippines, Inc. doesn't have a cashier in each branch, the borrower who is nearby in the branch office can't pay their loans. Researchers recommended having cashiers that accept direct cash payments from the borrower as practiced by other financial institutions (Mina, et al., 2020), especially for those clients

who are not used to mobile phones or who can ask them for someone or a presentative to pay their loan amortization in behalf of them as assume that clients are busy on daily business operation.

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# Barriers and Motivations for Cloud-Based Accounting Adoption Among Micro, Small, and Medium Enterprises (MSMEs) in Jaen, Nueva Ecija, Philippines

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**Abstract** — The adoption of cloud-based accounting solutions at Jaen, Nueva Ecija by Micro, Small, and Medium-Sized Enterprises (MSMEs) is examined in this study, which reveals important motivators and obstacles affecting their choices. The results show that although some MSME respondents use simple online tools like Google Sheets for financial management, 50% of them are not familiar with cloud accounting software. Automatic data backup, remote data access, and accountant cooperation are the main drivers behind cloud accounting adoption. However, widespread adoption is hampered by issues with competence, data security, and change aversion. Remarkably, only a few respondents acknowledged the value of two-factor authentication as a security precaution. The way that MSME attitudes on cloud technologies are shaped is greatly influenced by accountant advice and peer recommendations. All things considered, the study shows that MSMEs are often reluctant to embrace cloud accounting, indicating the need for focused training and assistance to speed up adoption in this industry.

**Keywords**— Adoption, Barriers, Cloud-Based Accounting, Jaen, Nueva Ecija, MSMEs

## I. INTRODUCTION

Micro, Small, and Medium-sized Enterprises (MSMEs) that use manual accounting are businesses that record and maintain their financial transactions using paper-based or manual methods, such as ledger books and handwritten journals. This means that they do not use computer-based accounting systems, but instead rely on manual calculations and physical documents to manage their financial records. MSMEs that use manual accounting may do so for a variety of reasons, such as lack of access to or familiarity with computer systems, cost constraints, or preference for traditional methods. However, manual accounting is generally considered to be a more time-consuming and error-prone process than computer-based accounting, and it may not be suitable for larger or more complex businesses.

For six to ten years, the majority of MSMEs have been utilizing their accounting system. The computerized accounting system performs differently from the manual accounting system. The common issue in either of these two systems is human error (Arcega, C. K., Datinguinoo, E., Guerra, J., Guno, C., Mayuga, H. J., Villamena, E., & Manongsong, J. L. 2015).

The use of technology has become increasingly important in the modern business world, and micro, small, and medium-sized enterprises (MSMEs) are no exception. In recent years, the adoption of cloud-based accounting systems has become more prevalent among MSMEs, offering a range of benefits such as improved efficiency, reduced costs, and enhanced security. New business owners need a precise focus to stay on top of everything. The work comes with a lot of strain, from servicing clients to

managing a team to growing the firm. Furthermore, businesses must maintain track of major operations, including cash. While account settlement is required, it may take a significant period. However, no company can escape accounting work, no matter how painful it is. As a result, owners must look for ways to boost profitability while carefully managing cash flow.

Accounting information is used by businesses every day to evaluate their financial condition, make wise decisions, analyze their financial situation in light of results, make plans, and manage the entire business. According to Gartner, 51% of IT investment in the application software, infrastructure software, business process services, and system infrastructure industries will transfer to the public cloud by 2025. This includes cloud accounting solutions in the accounting business (Gartner, 2022).

MSMEs (Micro, Small, and Medium-sized Enterprises) account for 99.51% of Philippine businesses and are the backbone of the Philippine economy. However, the epidemic led 73.1% to close, highlighting the need for firms to change to survive – particularly through digitalization. Recognizing the significance of cloud adoption in company digital transformation, the Philippine government updated its "cloud-first" laws, which were first established in 2017, opening the way for MSMEs to take the digital leap and become more competitive and resilient (Dulce, 2021).

Cloud accounting software is identical to traditional on-premises or self-install accounting software, with the exception that it is hosted on remote servers, similar to the software as a service (SaaS) business model. Data is sent to "the cloud," where it is processed and returned to the user.

## II. METHODOLOGY

The study on cloud-based accounting in Jaen used a quantitative research technique, with a particular focus on Micro, Small, and Medium-Sized Enterprises (MSMEs). In order to implement this strategy, a sample of 30 MSMEs from 179 local industries with small and medium sizes were given a standardized survey questionnaire. Careful consideration went into choosing the 30 MSMEs for the survey sample in order to guarantee that they represented a range of business sizes and industries.

In order to collect precise and quantifiable information on MSMEs' usage of cloud-based accounting systems, a systematic survey questionnaire was created. The questionnaire included several types of questions aimed at determining the respondents' present accounting procedures, their familiarity with cloud-based accounting solutions, how they saw the advantages and difficulties of using such solutions, and the variables affecting their choice of not using cloud-based systems.

## III. RESULTS AND DISCUSSION

The findings on how aware Micro, Small and Medium-sized Enterprises (MSMEs) are of the use of cloud-based accounting systems point to a major topic of interest and concern in the business world. The information gathered offers insightful information on how well-informed MSMEs are at the moment about this cutting-edge accounting technology. This section clarifies the current knowledge levels, perspectives, and potential obstacles that MSMEs have while adopting cloud-based accounting systems through a thorough examination of the survey data.

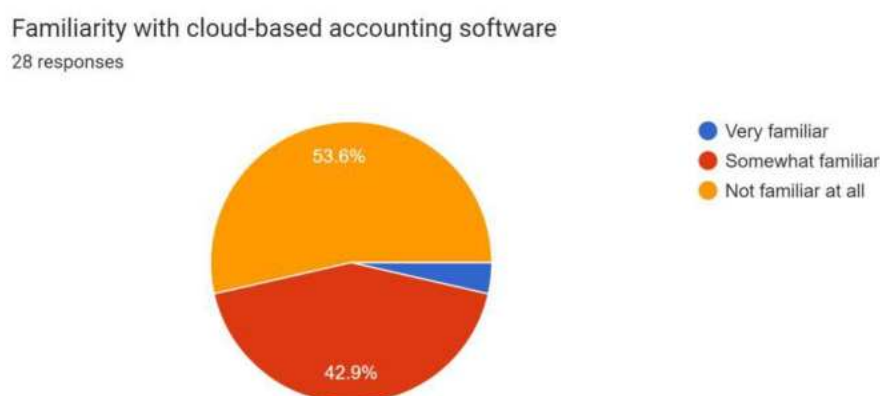


Figure 1.

It shows in this result that half of the respondents were not familiar with cloud-based accounting software. A small percent are only aware of the application.

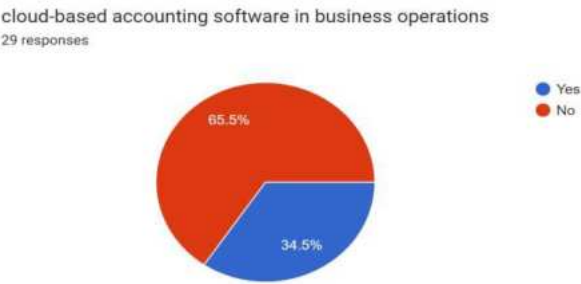


Figure 2.

After mentioning cloud-based accounting, the result shows that some of them are using it in their business. In Figure 2, we can see that most of the respondents have their cloud-based accounting system implemented but mostly use the basic, Google Sheet or Cloud-based MS Excel to track their sales and expenses.

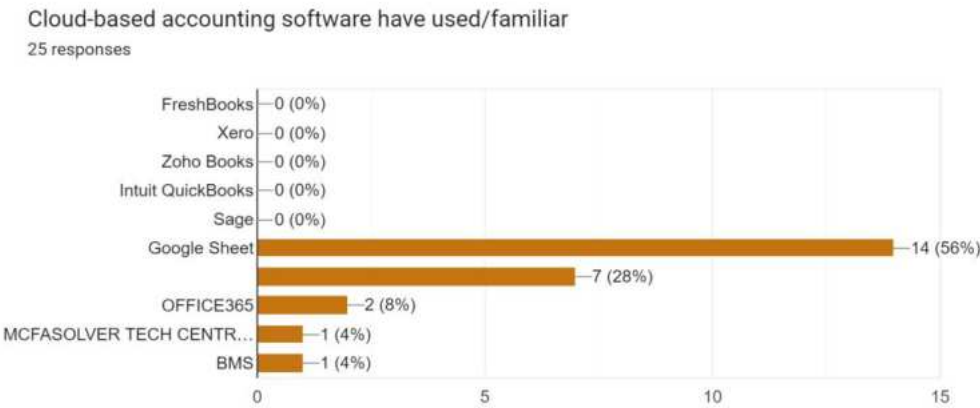


Figure 3.

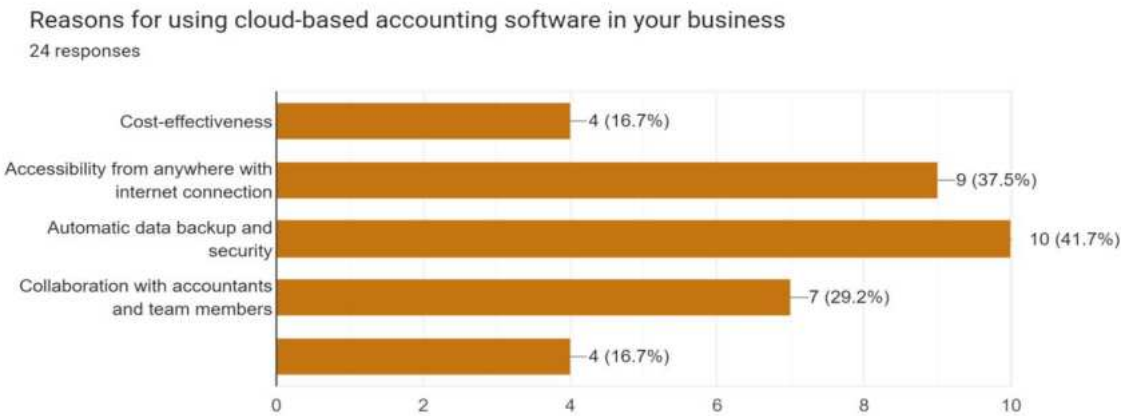


Figure 4.



Figure 4 outlines the primary motivations for adopting cloud-based accounting systems over manual ledger methods for recording daily sales and expenses. The top reasons cited include the ability to access data from anywhere, collaborate effectively with accountants, and ensure automatic backup of important data.

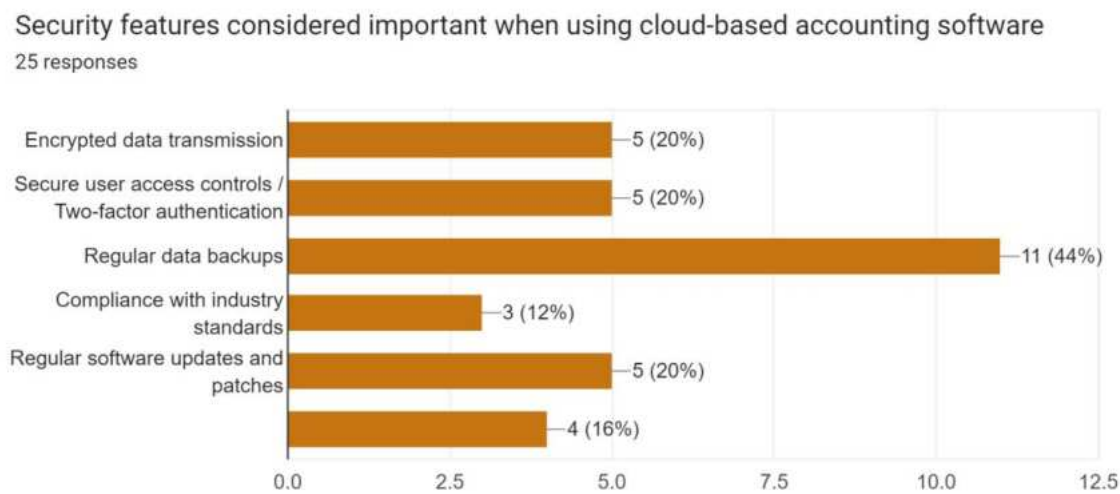


Figure 5.

In this section, the importance of data backup is one of the reasons needed for using any cloud-based system for the business. Five of the respondents were aware of the use of Two-factor authentication as a security feature.

The findings presented in the following figures, provide a basis for understanding the readiness of MSMEs to adopt innovative accounting technologies and offer implications for future strategies aimed at enhancing awareness and promoting adoption in this industry.

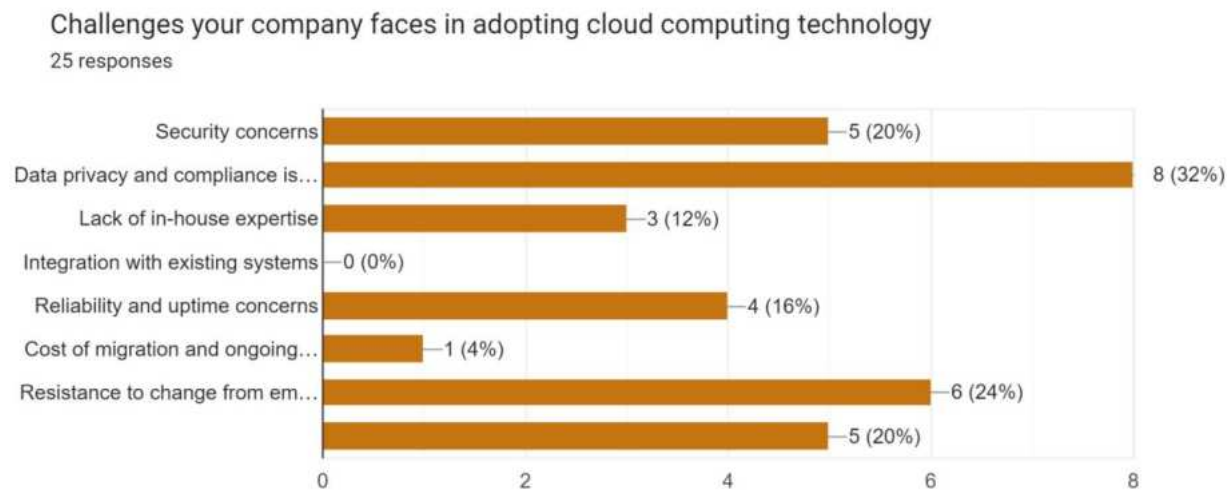


Figure 6.

Keeping your business sales and expense record is vital in operation as this will be the basis of most of your decisions in making actions for the business. Some were hesitant in the adoption of cloud-based accounting due to house expertise, security concerns, data privacy, and resistance to change from employees from manual to digital.

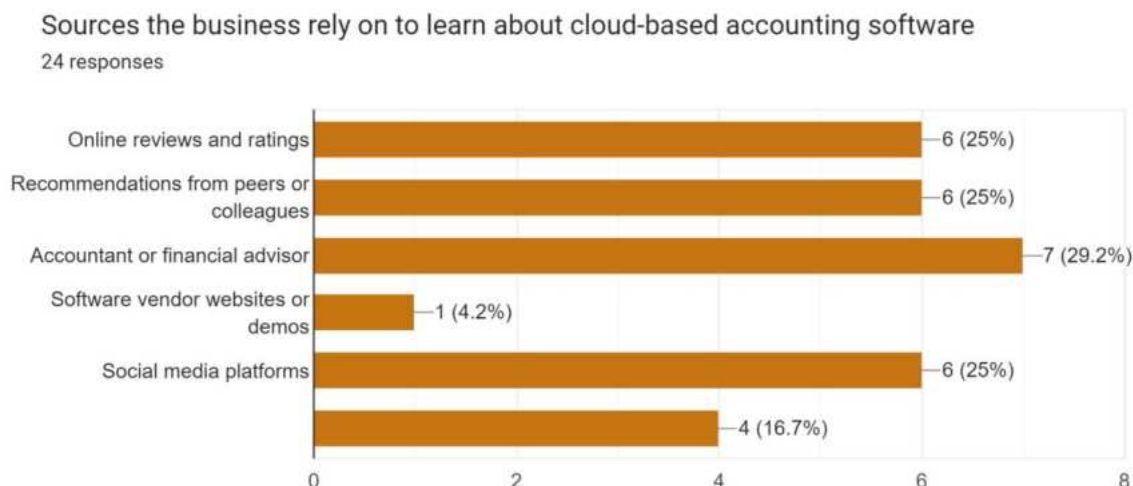


Figure 7.

Figure 7 Online resources and the recommendations from peers and accountants were the basis for them to consider adopting the cloud-based accounting system.

Likely to consider adopting cloud-based accounting software in the next 6-12 months

26 responses

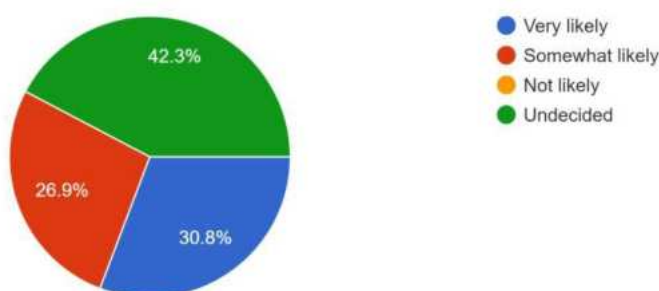


Figure 8.

More than half of the respondents clearly show hesitation in adopting cloud-based accounting as seen in Figure 8.

#### IV. CONCLUSIONS

Based on the findings of this study, the following are concluded:

1. The findings indicate that 50% of MSME respondents lack familiarity with cloud-based accounting software.
2. Despite the lack of awareness, a portion of MSMEs is utilizing basic cloud-based tools, such as Google Sheets or Cloud-based MS Excel, to manage their financial records.

3. The primary motivations for adopting cloud accounting among MSMEs include remote data access, effective collaboration with accountants, and automatic data backup.

4. Data backup emerged as a critical concern, with only five respondents recognizing the importance of two-factor authentication.

5. The survey reveals that many MSMEs are hesitant to adopt cloud accounting due to concerns over expertise, security, data privacy, and resistance to change from traditional methods.

6. Recommendations from peers and accountants play a crucial role in influencing MSMEs' decisions to consider cloud accounting systems, as highlighted by the survey results.

7. Overall, the findings highlight a widespread hesitance among MSMEs regarding the adoption of cloud-based accounting solutions.

### RECOMMENDATION

Training should be put in place to increase awareness and comprehension of cloud-based accounting software to close the large knowledge gap among MSMEs. Since many MSMEs currently use Google Sheets and other basic cloud technologies, training programs can expand on this by showcasing the sophisticated features and advantages of specialized cloud accounting solutions. Furthermore, highlighting the significance of security features like data privacy protocols and two-factor authentication may assist in alleviating worries that impede adoption. Finally, using peer and accountant recommendations can be a strong incentive for MSMEs to upgrade to more advanced cloud accounting systems, giving them more confidence in their leanings and decision-making (Subia, et al., 2019).

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# Exploring Business Dynamics in the Printing Industry of Nueva Ecija

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**Abstract**— The study measured the business dynamics of the printing industry in Nueva Ecija, Philippines as to their organization and management, marketing, technical, financial, and socio-economic aspects. The study employed a descriptive type of research, and a survey method of research was applied. The study was carried out among 50 printing businesses chosen in different parts of Nueva Ecija. The printing industry in Nueva Ecija is largely made up of small, owner-managed enterprises with a focus on maintaining low costs and labor-intensive operations. The limited workforce size and moderate wage levels indicate restricted opportunities for both growth and wage progression. Analysis of business practices shows strong organization and management structures that contribute to effective operations and employee productivity; however, financial management practices received lower assessments, highlighting a need for improved financial planning. To address these challenges, it is recommended that businesses consider strategies for scaling operations and investing in workforce development to create growth opportunities. Additionally, implementing enhanced financial management practices, such as strategic budgeting and resource allocation, can strengthen business resilience and support long-term sustainability. These improvements could provide a foundation for more dynamic growth within the industry, enabling businesses to better meet operational goals and improve financial outcomes.

**Keywords**— Business dynamics, financial, marketing, socio-economic, technical

## I. INTRODUCTION

From handwritten to printed copies. The printing press has had a great impact on the history of mankind. Publications have led to the reformation of many denominational teachings and more understanding of different religions, cultures, traditions, and environments.

A purposive effort to study the printing business by giving an idea in terms of profit to some entrepreneur who wants to engage in the printing business and to give ideas on how to satisfy the needs of the clients through providing good services and the best quality of the printed product.

The printing business also needs to scrutinize its organization and management aspects, marketing aspects, technical aspects, financial aspects, and socio-economic aspects, which can bring self-perspectives. Social backgrounds and life experiences are included in the discussion. While these initiatives might choose to take the nature of practice into account to achieve a nuanced understanding, they should not be constrained by

professional concerns and objectives (Hinks, 2020; Poynor, 2019).

The emergence of new technology modernization through the arrival of electronic media, which includes television, radio, computer technology, and the internet, brought some information and sharing of thoughts or ideas (Ibiwoye et al., 2020). Hearing and watching the news on the radio and television fascinated people instead of reading it. This fierce competition to adapt to the challenges that reduce the demand for newspapers, books, glossy magazines, and advertising printed media is also experienced by many (Berculescu et al., 2019).

Technologies are facilitated by the internet (Mathai et al., 2021), and they play an important role in improving the economy and social development of the country. And it has driven the rapid spread of information globally. In an article by Jill Walker Rettberg that refers to Pettitt, he claims that when we look backward from the rise



of print and print literacy, we see that we produced digital social media (Graham, 2016).

The province of Nueva Ecija is a totally agricultural province as a whole, with limited manufacturing firms, unlike the nearby provinces of Bulacan, Tarlac, Pampanga, Zambales, and Bataan, with economic activities. Nueva Ecija lags much behind its neighbors in terms of economic activities.

The governor of Nueva Ecija and other city mayors, together with their constituents, are determined to develop the business industry, one of which is the printing business. The cities of Gapan, & the Science City of Munoz, and other Municipalities of Sta. Rosa, San Leonardo, San Isidro, Cabiao, Jaen, San Antonio, Zaragoza, Aliaga, Quezon, Licab, Sto. Domingo and Talavera are involved in the printing business needed by individuals and some different agencies, such as business establishments, schools, individuals, local government, etc.

To complement these studies, the researcher employed a methodology that extracted information from printing business owners to give others the idea and opportunity to venture into the printing business. Specifically, this study explored the business profile of the printing industry in terms of Specifically, this study explored the business profile of the printing industry in terms of the type of business ownership, years of operation, organizational structure, and compensation per day of regular employees. Additionally, this research on the business dynamics of the printing industry in Nueva Ecija in terms of organization and management, marketing, technical, financial, and socio-economic.

## II. METHODOLOGY

This study employed a descriptive type of research, and a survey method of research was applied. Calderon (2006) defined descriptive research as a purposive process of gathering, analyzing, classifying, and tabulating data about prevailing conditions, practices, processes, trends, and cause-effect relationships and then making adequate and accurate interpretations about such data with or without or sometimes minimal aid of statistical methods.

This research study was conducted among printing businesses chosen in different parts of Nueva Ecija. Purposive sampling was employed in this study (Subia, 2018), and it was done when selecting the 50-printing business sample.

This study focused on describing and assessing the organization and management, marketing, technical,

financial, and socio-economic aspects of selected printing businesses in Nueva Ecija.

Likert scale questions were the main instrument used in gathering the needed data.

The questionnaire was self-made and validated by the experts in the field. It dealt with the five aspects of business operation, namely organization and management, marketing, technical, financial, and socio-economic.

Statistical tools such as frequency, percentage, and weighted means were utilized to compute the gathered data of the researcher.

## III. RESULTS AND DISCUSSION

### 1. Profile of the Business

In analyzing the data on business ownership types, years of operation, organizational structure, employee numbers, and compensation, notable findings emerge regarding the highest and lowest frequencies within each category. With 94% of firms being sole proprietorships, this type of business ownership is the most common, suggesting that the majority of establishments are privately held. Corporations, on the other hand, only make up 2% of the sample, indicating that there aren't many larger, more organized companies. Similarly, 90% of enterprises are run by their owners, indicating a hands-on attitude common in sole proprietorships, whereas just 10% have management tasks delegated to others (Riisgaard, et al., 2016).

Similar trends may be observed when looking at workforce-related indicators, such as the number of regular employees; 90% of enterprises employ between two and five individuals, which is suggestive of small-scale operations. Just 2% of companies have 10–13 regular employees, highlighting the small workforce and probably reflecting the size of the organization. The most prevalent pay range, according to compensation levels, is PhP176–PhP200 per day (28%), which is in line with the wage level required for small business operations.

On the other hand, just 6% of companies provide PhP201–PhP225 and PhP226–PhP250 every day, which is consistent with the sample's low operational scale tendency and suggests little opportunity for upward pay mobility. This data suggests a low-cost, labor-intensive structure in Nueva Ecija's printing industry by highlighting the prevalence of small, owner-managed enterprises with few employees and moderate wage levels.

Type of Business Ownership	Frequency	Percent
Single Proprietorship	47	94
Partnership	2	4
Corporation	1	2
Total	50	100
Years of operation	Frequency	Percent
1 to 7	27	54
8 to 14	18	36
15-21	4	8
22 and above	1	2
Total	50	100
Organizational Structure	Frequency	Percent
Owner is Manager	45	90
The manager is different from the Owner	5	10
Total	50	100
Number of Regular Employees	Frequency	Percent
2– 5	45	90
6 – 9	4	8
10 – 13	1	2
Total	50	100
Compensation per day of Regular	Frequency	Percent
PhP176 – PhP200	9	28
PhP201 – PhP225	3	6
PhP226 – PhP250	3	6
PhP276 – PhP300	7	14
PhP301 – PhP325	9	18
PhP326 – PhP350	5	10
PhP351 - PhP375	8	16
Others	6	12
<b>Total</b>	<b>50</b>	<b>100</b>

## 2. Business Dynamics

Business Dynamics	A.W.M	V.I.
1. Organization and Management	4.80	Agree
2. Marketing	4.52	Agree
3. Technical	4.72	Agree
4. Financial	4.41	Agree
5. Socio-Economic	4.49	Agree
	4.59	Agree

Legend:

Scale	Range	Verbal Description
5	4.20-5.00	Agree
4	3.40-4.19	Moderately Agree
3	2.60-3.39	Somewhat Agree
2	1.80-2.59	Fairly Agree
1	1.00-1.79	Disagree

The means of the statements are mostly verbally interpreted as “Agree.” The average weighted mean of 4.59,

which is described as “Agree,” implies that the printing businesses' business practices are assessed by the respondents.

The table indicates that among the business practices of the respondents, item number 1, “Organization and Management,” obtained the highest average weighted mean of 4.80 and described as “Agree.” Meanwhile, item number 4, “Financial Aspects,” had a least average weighted mean of 4.41 and was described as “Agree.”

The finding shows that the organization and management of the printing businesses are aware of its structure, planning, and directing the employees and business resources directed towards the achievement goal of the printing business. The printing business structure ensures that each function of the business operates easily and their employees perform accordingly (Kusalasaiyanon, Thammakorn & Kesssang, 2023).

Having a mission, vision, and goals provides a purpose and sense for a clear direction for digital transformation to achieve the goals of the printing business. To help the employees to understand the objectives of the printing business for digital transformation. By integrating digital technology in all aspects of the printing business.

Furthermore, effective decision-making skills and time management of the printing business owner/manager for a quality printing service to satisfy the needs of the clients/customers.

Based on the result of the research study conducted by Akhigbemidu et al. (2021), it was suggested that need to identify the management development and the consultants who have years of experience that will enable external and initiative generated domestically for the best outcomes of the organization.

However, in the least rank item number 4, some respondents “Agree,” “Financial Aspects” refers to the utilization of financial resources of the printing business for strategic objectives in budgeting, analyzing, forecasting, and planning. It helps the printing business owner/manager to know the current financial position of the printing business.

#### IV. CONCLUSIONS AND RECOMMENDATIONS

Nueva Ecija's printing industry is predominantly composed of small, owner-managed enterprises, reflecting a low-cost, labor-intensive structure. Additionally, limited workforce size and moderate wage levels indicate a constrained opportunity for growth and wage progression within the industry. Further, the effectiveness of business practices in the printing industry, with the highest emphasis

placed on organization and management practices that support structured operations and employee performance. However, financial management received the lowest assessment, suggesting that while operational goals are clear, there is room for improvement in strategic financial planning and resource utilization.

To support growth and increase wage opportunities, it is recommended that Nueva Ecija's printing industry explore avenues for scaling operations and implementing targeted workforce development initiatives. Additionally, enhancing financial management practices through strategic budgeting, forecasting, and resource allocation could strengthen long-term sustainability and improve financial resilience within these businesses.

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# Exploring the Impact of Limited Teacher Training on Pedagogical Approaches in Business Education: A Case Study

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**Abstract**— This case study investigates the repercussions of limited teacher training on pedagogical approaches within business education. Findings reveal a significant consensus among respondents regarding the adverse effects of restricted pedagogical methods, indicating a perceived decline in educational effectiveness. Additionally, the study highlights a concern that limited assessment techniques constrain evaluation practices, with mixed perceptions of their impact on comprehensive understanding among students. The analysis further identifies a detrimental influence of inadequate pedagogical strategies on classroom management which correlates with decreased student engagement. These insights stress the urgent need for enhanced teacher training programs to foster diverse and effective pedagogical approaches, ultimately improving educational outcomes in business education. The study calls for further research to explore innovative training solutions that can address these challenges and promote more engaging learning environments.

**Keywords**— Learning Outcomes, Pedagogical Approaches, Professional Development, Student Engagement, Teacher Preparation.

## I. INTRODUCTION

For students to be ready to handle the intricacies of today's business environment, educational approaches must be effective in the ever-changing field of business education (Bratianu, Stanescu & Mocanu, 2021). The involvement of teachers, who facilitate learning by guiding pupils through theoretical concepts and real-world applications, is crucial to its efficacy.

However, there can be wide variations in the caliber of instruction provided in business education, which is frequently impacted by elements like professional development and teacher preparation (Intasena & Poonputta, 2022). The purpose of this research is to examine how pedagogical techniques in business education are impacted by insufficient teacher training. Specifically, the study will look at how insufficient preparation may

impact teaching tactics, student engagement, and learning results (Mei, 2021).

This study is important because it may shed light on the effects of inadequate teacher preparation on the caliber of business education. It is becoming increasingly important to make sure that educators have the requisite knowledge and abilities as the need for qualified business professionals rises. This study aims to give insights that can guide governmental decisions, institutional practices, and professional development activities targeted at improving the quality of business education by exploring the relationship between teacher training and pedagogical practices (Jiao, Jamaludin & Yi, 2023).

This study uses a case study methodology to accomplish its goals, which enables a thorough investigation of the phenomenon in a particular setting. The utilization of a case study design provides an adaptable

means of investigating the complex relationships among different elements, such as teacher preparation, pedagogical strategies, and learning objectives, in the complex context of a specific school or initiative. This research can gather rich, detailed data that provide important insights into the intricacies of the problem under examination by concentrating on a particular case.

II. METHODOLOGY

The methodology of this study includes the research design, respondents, research locale, sampling procedure, research instrument, data-gathering process, and the statistical treatment of the findings. A descriptive research design was employed, which aims to systematically and accurately describe the population, situation, or phenomenon without manipulating any variables. This approach answers questions related to what, where, when, and how, focusing on observation and measurement (Baek & Yang, 2023).

The study's respondents comprised 50 business education teachers, teaching various business-related

subjects at both the college and senior high school levels. The research was conducted in different schools offering business courses in Cabanatuan City, Nueva Ecija, and Novo Ecijanans are the respondents (Subia, Mangiduyos & Turgano, 2020). To select the respondents, a quota sampling procedure was used. This non-probability sampling method involves selecting participants based on predefined quotas or characteristics such as age, educational attainment, and years of service, ensuring a representative sample of the population.

The research instrument utilized was a Likert-scale model questionnaire, which evaluated the impact of limited teacher training on pedagogical techniques used in business education. Data collection was carried out among the 50 business education teachers in Barangay Bitas, Cabanatuan City, with the responses being confidentially gathered and analyzed. Frequency and Likert scale were the statistical tools that were utilized in this study.

III. RESULTS AND DISCUSSION  
IMPACTS OF LIMITED PEDAGOGICAL APPROACHES

Table 1. Instructions

INSTRUCTIONS	Weighted Mean	Verbal Description
1. The limited range of pedagogical approaches restricts the variety of instructional methods available to deliver course content effectively.	3.16	Agree
2. Students receive a less engaging and interactive learning experience due to limited instructional strategies.	2.98	Agree
3. The diversity of students' learning styles is not adequately addressed when pedagogical approaches are limited.	3.10	Agree
4. Limited pedagogical approaches hinder the ability of instructors to adapt instructions to students' individual needs.	2.78	Agree
5. The effectiveness of instructional delivery is compromised by the lack of diverse pedagogical techniques.	3.22	Agree
Overall Weighted Mean	3.05	Agree

The results show that respondents generally agree that a lack of different pedagogical approaches has a major impact on how effectively education is delivered, with the highest mean score of 3.22 expressing worries about this issue. On the other hand, the lowest mean score of 2.78 highlights the unique difficulty of customizing training to fit the needs of each individual student, indicating that this area needs immediate attention. The range of results highlights varying degrees of worry over engagement and adaptability in teaching approaches, even though there is general agreement on the shortcomings of existing educational strategies. The results show that respondents generally agree that a lack of different pedagogical

approaches has a major impact on how effectively education is delivered, with the highest mean score of 3.22 expressing worries about this issue.

The findings reveal a general agreement that limited pedagogical approaches lead to a narrower range of assessment methods, as indicated by the highest mean score of 3.00, which highlights the reliance on traditional testing methods that may not accurately reflect student learning. Conversely, the lowest mean score of 2.32 suggests that there is some disagreement about whether restricted assessment strategies prevent comprehensive evaluation of student's understanding and mastery of content.

Table 2. Assessments

ASSESSMENTS	Weighted Mean	Verbal Description
1. Limited pedagogical approaches result in a narrower range of assessment methods being used.	2.56	Agree
2. Students' understanding and mastery of content are not comprehensively evaluated due to restricted assessment strategies.	2.32	Disagree
3. The ability to assess higher-order thinking skills is diminished when assessment methods are limited.	2.54	Agree
4. Limited assessment approaches lead to a reliance on traditional testing methods, which may not reflect true learning.	3.00	Agree
5. Students receive less constructive feedback on their performance due to a lack of diverse assessment techniques.	3.02	Agree
<b>Overall Weighted Mean</b>	2.69	Agree

Table 3. Classroom Management

CLASSROOM MANAGEMENT	Weighted Mean	Verbal Description
1. Limited pedagogical approaches negatively impact the ability to manage classroom dynamics effectively	2.18	Disagree
2. The diversity of classroom management strategies is reduced due to limited teaching methods.	1.44	Strongly Disagree
3. Students' engagement and participation in class are adversely affected by the lack of varied pedagogical approaches.	2.60	Agree
4. Handling disruptive behaviors becomes more challenging when classroom management techniques are not varied.	2.74	Agree
5. The overall classroom environment suffers due to the limited range of pedagogical strategies available to teachers.	2.50	Agree
<b>Overall Weighted Mean</b>	2.29	Disagree

According to the overall weighted mean of 2.29 and the particularly low score of 1.44 for reducing different management tactics, the results show widespread disagreement with the idea that limited pedagogical approaches greatly impair effective classroom management. Nonetheless, a mean score of 2.60 indicates that there is a consensus that a lack of diverse teaching strategies has a detrimental effect on student participation and engagement.

#### IV. CONCLUSIONS

The following are concluded based on the findings of the study:

1. There is a strong consensus on the negative impact of limited pedagogical approaches on educational effectiveness, particularly highlighted by the highest mean score of 3.22.

2. The respondents agree that limited assessment methods narrow evaluation techniques, the disagreement on

whether these methods hinder comprehensive understanding suggests variability in perceptions.

3. The extent to which limited pedagogical approaches affect classroom management, there is recognition of their detrimental effect on student engagement, as shown by a mean score of 2.60.

#### RECOMMENDATION

To enhance educational effectiveness, it is crucial to adopt a variety of pedagogical methods, as there is a strong consensus on their positive impact (Croes & Vermeulen, 2021). Additionally, implementing a wider range of assessment techniques can address the limitations of current practices and the variability in perceptions regarding their effectiveness in fostering comprehensive understanding. Finally, recognizing the detrimental effects of limited pedagogical approaches on student engagement, educators should prioritize innovative classroom management strategies to boost participation and improve learning outcomes.

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