

Detecting Financial Statement Fraud Risk in Chinese Listed Companies Through Multimodal Linguistic and Financial Data Fusion

Iman Supriadi^{1*}, Mochamad Fatchurrohman², Rahma Ulfa Maghfiroh³, Rukhul Abadi⁴

¹ Department of Accounting, Faculty of Economics and Business, STIE Mahardhika, Surabaya, Indonesia

² Department of Digital Business, Faculty of Economics and Business, STIE Mahardhika, Surabaya, Indonesia

³ Department of Management, Faculty of Economics and Business, Universitas Islam Negeri Sunan Ampel, Surabaya, Indonesia

⁴ Department of Management, Faculty of Economics and Business, STEBI Syaikhona Kholil Sidogiri, Pasuruan, Indonesia

ABSTRACT

Introduction/Main Objectives: This study examines the integration of multimodal data fusion combining natural language processing (NLP) and financial ratio analysis to test the Obfuscation Hypothesis and detect financial statement fraud in Chinese listed companies. The topic is compelling, as information asymmetry between management and investors is exploited through linguistic manipulation. The study also seeks to improve the reliability of AI-assisted fraud detection by integrating textual narratives with quantitative financial indicators. **Background Problems:** Financial statement fraud becomes difficult to detect when accounting figures appear normal while accompanying narratives obscure underlying anomalies. This study therefore examines whether the discrepancy between optimistic narratives and deteriorating financial performance can serve as a useful indicator of fraud risk. **Novelty:** This paper introduces "Financial-Linguistic Dissonance" as a novel theoretical construct, empirically demonstrating the threshold at which rhetorical obfuscation fails to mask financial decay, unlike prior studies analyzing textual and numerical data separately. **Research Methods:** Employing FinBERT for textual analysis and deep learning for multimodal fusion, this study analyzes annual reports from emerging market companies, combining Fog Index, tone metrics, and profitability ratios. **Finding/Results:** Linguistic features account for nearly 80% of the predictive power, with Financial-Linguistic Dissonance accounting for 27.13%, demonstrating that narrative manipulation provides stronger fraud signals than financial ratios. **Conclusion:** The multimodal framework achieves 94.7% accuracy, suggesting its potential as an AI-assisted tool for fraud-risk screening. Corporate language can provide measurable signals as an instrument of potential financial statement fraud, with

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practical implications for regulators, auditors, investors, and corporate boards to strengthen fraud-risk assessment.

* Iman Supriadi at Department of Accounting, Faculty of Economics and Business, STIE Mahardhika, Surabaya, Indonesia.
E-mail address: iman@stiemahardhika.ac.id (author#1), mochamad.rohman@stiemahardhika.ac.id (author#2),
rahma.ulfa@uinsby.ac.id (author#3), rukhlubadi@syaikhonakholihsidogiri.ac.id (author#4)

1. Introduction

Corporate annual reports are not merely financial reporting documents that present financial and non-financial information; they also serve as strategic communication channels that incorporate managerial narratives (Bassyouny et al., 2022; Michelon et al., 2021; Ben-Amar et al., 2023). In practice, these reports reflect a tension between the need for transparent reporting and management's potential incentives to shape stakeholders' perceptions (Abou-El-Sood and El-Sayed, 2022; Chen et al., 2024). This tension is further shaped by information asymmetry between management and external stakeholders, which may create opportunities for strategic communication practices.

The central issue addressed in this study arises from the observation that, when financial performance deteriorates or earnings management occurs, managers may use complex, less readable, and overly optimistic language in annual reports, which may obscure underlying economic conditions reflected in corporate narratives. In such circumstances, financial statement fraud may be more difficult to detect because reported accounting figures may appear relatively normal, while the accompanying narratives contain potentially informative linguistic signals that may not be readily identified by conventional analytical approaches (Ping et al., 2026; Wu and Du, 2022; Wei and Qian, 2025).

The institutional context of the Chinese capital market presents additional challenges for financial reporting. Prior studies across various countries and regions, including Indonesia, South Korea, and countries in the MENA region, indicate that disclosure quality and readability continue to present challenges (Soepriyanto et al., 2021; Yilmaz and Nobanee, 2026; Saravanan et al., 2023). This concern is further highlighted by evidence suggesting that firms experiencing poor financial performance may exhibit patterns consistent with obfuscation through greater linguistic complexity of their financial disclosures. Further research on banks in the MENA region suggests that corporate governance characteristics, including board size, board meeting frequency, and ownership concentration, are significantly associated with the readability of annual reports (Mahboub, 2024; Metwally et al., 2024;

Kayed et al., 2024; Herenia et al., 2024). While these studies provide valuable contextual insights from diverse institutional environments, the empirical analysis in this study focuses specifically on Chinese listed companies, motivated by the availability of comprehensive annual report data and the importance of financial statement fraud detection in China's capital markets.

The importance of this issue is further highlighted in light of findings indicating that narratives contained in annual reports, particularly the chairman's, are associated with influence on investors' perceptions of a company's future prospects and investors' decisions to purchase or retain shares (Phesa et al., 2025; Wang and Liu, 2024; Yan et al., 2021). In other words, language is no longer merely a passive communication tool; rather, it has evolved into a potential source of signals relevant to financial reporting risk that exhibit measurable linguistic patterns that can be analyzed quantitatively.

This study aims to develop and evaluate a multimodal model to identify strategic rhetoric reflected in annual report narratives using measures of readability, syntactic complexity, tone management, and pseudo-optimism. It further proposes a systematic approach to detecting rhetorical patterns that may be associated with managerial communication strategies that may obscure unfavorable financial conditions or signals of earnings management, examining financial indicators through ratio-based indicators and accounting-based indicators, and constructing a multimodal data fusion architecture that integrates linguistic and financial information. Furthermore, the study draws on the Obfuscation Hypothesis and Impression Management Theory to provide empirical evidence supporting the proposed concept of Financial-Linguistic Dissonance, a proposed construct in fraud detection research in the context of Chinese listed companies as an emerging-market setting.

The literature on annual report readability and impression management remains largely focused on developed economies in developed economies, leaving relatively limited empirical evidence from emerging markets, particularly in China. Moreover, narrative analysis and financial data analysis have largely developed as separate streams of research, leaving the relationship between managerial rhetoric and underlying financial conditions insufficiently integrated within a unified analytical framework. Existing textual analyses also often rely on conventional readability indices, while the application of transformer-based language models such as FinBERT, which can capture contextual semantic and sentiment information in financial text, remains relatively underexplored. Furthermore, disclosure theory, the Obfuscation Hypothesis, and Impression Management Theory have not been sufficiently integrated to explain for the the proposed concept of Financial-Linguistic Dissonance, conceptualized as the inconsistency between positive managerial narratives and deteriorating financial performance. To address these gaps, this study develops a multimodal Data Fusion framework that integrates linguistic analysis using FinBERT and readability measures, syntactic complexity, and tone positivity with financial ratio analysis, discretionary accruals, and the Beneish M-

Score through deep learning-based early, late, and hybrid fusion architectures. This framework examines Financial-Linguistic Dissonance as a proposed conceptual construct, contributes to the disclosure literature through the integration of linguistic and financial dimensions, and supports the potential use of AI-assisted fraud-risk screening aimed at supporting fraud-risk assessment and supporting regulators and auditors, particularly in the Chinese capital market.

The primary objective of this study is to evaluate a multimodal data fusion framework that integrates annual report textual data and structured financial information to examine the implications of the Obfuscation Hypothesis and Impression Management Theory to support fraud-risk assessment in Chinese listed companies. Specifically, the study seeks to develop natural language processing (NLP)-based linguistic measures using FinBERT for contextual sentiment analysis and readability measures such as the Gunning Fog Index, syntactic complexity, tone positivity, and pseudo-optimism, as well as to identify potentially manipulative rhetorical patterns. In addition, the study examines financial indicators through financial ratios, discretionary accruals, and the Beneish M-Score; develops deep learning-based early, late, and hybrid fusion architectures; and compares their performance with single-modality models. Furthermore, the study examines the proposed concept of Financial-Linguistic Dissonance as a novel theoretical construct and produces both an artificial intelligence-driven early warning system and methodological guidelines for regulators and auditors in assessing the consistency between corporate narratives and financial information.

This study offers theoretical, methodological, and practical contributions through the development of a multimodal data fusion framework for financial statement fraud-risk assesment. The theoretical contribution lies in proposing Financial-Linguistic Dissonance as a novel theoretical construct that draws on the Obfuscation Hypothesis and Impression Management Theory to explain discrepancies between managerial narratives and firms' underlying financial conditions. From a methodological perspective, the study employs FinBERT and deep learning architectures to combine linguistic and financial information, thereby capturing potentially complex relationships that are difficult to identify using conventional approaches. This methodology enables the integration of complementary linguistic and financial information beyond conventional single-modality approaches. Practically, the study provides an AI-assisted framework for fraud-risk assessment and practical implications for auditors in evaluating the consistency between narrative disclosures and financial information. By focusing on Chinese listed companies in an emerging-market context, the study also expands the empirical evidence base, which has thus far been dominated by research conducted in developed economies.

2. Literature Review

2.1. Agency Theory

Agency Theory serves as a primary theoretical foundation for understanding the relationship between management as the agent and shareholders as the principal (Musawir, 2024; Bellavitis et al., 2023). The theory suggests that conflicts of interest may arise, and information asymmetry occurs when agents possess superior information about the firm's underlying condition. Within the context of corporate reporting, Agency Theory suggests that managerial disclosures may not always be presented entirely neutrally; rather, managers may have incentives to behave opportunistically in pursuit of their own interests, potentially giving rise to various impression management strategies (Chen et al., 2024; Pouryousof et al., 2025). In this regard, managers may strategically shape the content, tone, and presentation of corporate disclosures to influence stakeholders' perceptions and potentially reduce negative responses to unfavorable financial or organizational outcomes.

The study conducted by Abou-El-Sood & El-Sayed (2022) draws on Agency Theory as the underlying framework to explain the relationship between abnormal disclosure tone and earnings management, particularly within emerging market settings. Their findings suggest that managers may utilize excessively optimistic or strategically biased disclosure language, potentially obscuring the effects of earnings management and potentially reducing external scrutiny. Consequently, corporate narratives become not only vehicles for information dissemination but also channels through which managerial opportunism may be expressed under conditions of information asymmetry.

2.2. Obfuscation Hypothesis

The Obfuscation Hypothesis suggests that managers may increase the linguistic complexity of financial reports under conditions of deteriorating corporate performance, potentially reducing readers' ability to comprehend and identify unfavorable information (Roundy et al., 2022; Gangadharan and Padmakumari, 2023; Mekhaimer et al., 2024). Such an obfuscation may be reflected in lower readability and greater syntactic complexity, making annual report narratives more difficult to understand and potentially limiting stakeholders' ability to evaluate the disclosed information. Higher textual complexity may therefore reduce the transparency of corporate communications while remaining consistent with formal disclosure requirements.

Duong et al. (2024) Re-examined the Obfuscation Hypothesis in the context of UK-listed companies and found that firm size, rather than the presence of "good news" or "bad news," was a primary determinant of annual report readability. These findings suggest that larger firms may adapt their reporting style to the information-processing needs and informational needs of professional users, such as professional investors and financial analysts. Accordingly, lower readability may not always reflect intentional concealment; instead, it may also arise from the complexity of firms'

operations and the specialized information requirements of professional users. Nevertheless, the findings continue to support the broader argument that linguistic characteristics of corporate disclosures are important in affecting information accessibility and stakeholder interpretation.

2.3. Impression Management Theory

Impression Management Theory examines how managers selectively and strategically present information to create or maintain a favorable organizational image of the firm (Chen et al., 2024; H. Wang et al., 2021). Within the context of corporate reporting, impression management may take the form of a range of disclosure strategies that can be broadly classified into seven broad approaches: readability management, rhetorical manipulation, thematic manipulation, visual and structural manipulation, performance comparisons, earnings number selection, and performance attribution. These strategies may operate through two primary mechanisms: bias, whereby information is presented in an overly positive manner, and selectivity, whereby certain information items are selectively emphasized, omitted, or selectively disclosed that may influence stakeholder perceptions.

Phesa et al. (2025) In a systematic literature review, the chairperson's statement was identified as the most prominent disclosure channel for impression management in corporate disclosures. The identified tactics include the strategic use of textual characteristics, linguistic tone, forward-looking statements, photographs and graphical representations, as well as impersonal evaluative language designed to shape stakeholders' interpretations of corporate performance. These findings suggest that narrative disclosures are not merely vehicles for information dissemination but also serve as strategic communication tools through which managers attempt to influence external audiences.

2.4. Disclosure Theory

Disclosure theory in the accounting literature has developed around two broad perspectives. The first perspective, referred to as the incremental information school, suggests that managers may provide discretionary narrative disclosures to help reduce information asymmetry between corporate insiders and external stakeholders, potentially lowering the cost of capital and potentially supporting market valuation (Iqbal et al., 2025; Rieg & Vanini, 2023). Under this view, narrative disclosures serve as an effective communication mechanism through which managers can convey value-relevant information that is not fully captured by financial statements.

In contrast, the second perspective, the impression management perspective, suggests that discretionary disclosure strategies may reflect opportunistic motives and that the information provided by management may be influenced by managerial self-interest rather than solely by the objective goal of informing stakeholders (Gonçalves et al., 2022; Gangi et al., 2025; Ben-Amar et al., 2022). From this perspective, narrative disclosures may be strategically used to influence stakeholder

perceptions, potentially shape market expectations, and serve managerial interests, particularly during periods of unfavorable financial performance.

Smaili et al. (2022) distinguished four distinct styles of corporate disclosure : obfuscation, informativeness, deception, and avoidance. Their findings indicate that readability is not merely a textual attribute of corporate reports but also reflects managerial communication strategies. Consequently, the linguistic characteristics of corporate disclosures can offer insights into managerial motives, revealing whether corporate narratives are may primarily to inform, persuade, conceal, or divert stakeholders' attention from negative information.

2.5. Previous Research Review and State-of-the-Art Analysis

Research on financial statement fraud detection has evolved considerably from traditional financial ratio-approaches toward the use of machine learning, deep learning, and multimodal data analytics. Ali et al. (2022), in a systematic literature review, found that Support Vector Machines (SVM) and Artificial Neural Networks (ANN) are among the most widely used algorithms in fraud detection. The review also highlighted several limitations, including the limited use of unstructured data and the limited interpretability of predictive models. Extending these findings, Lin (2024) identified several challenges, including handling imbalanced datasets, cross-period analysis, and the need to integrate textual information and develop open-access datasets for fraud detection. Furthermore, Wu and Du (2022) provided empirical evidence that combining financial information with managerial narratives using Long Short-Term Memory (LSTM) and Gated Recurrent Unit (GRU) models achieved fraud detection accuracy of more than 94%.

Recent research has increasingly focused on multimodal data fusion approaches. Wei & Qian (2025) found that integrating textual topic features generated using Latent Dirichlet Allocation (LDA) with financial information improves the predictive performance of ensemble models including XGBoost and RUSBoost. Similarly, Nie et al. (2025) integrated LLM-based textual features with financial variables and corporate governance indicators, complemented by SHAP-based explainability analysis, yielding a 7.4% increase in predictive accuracy. Their findings also indicate that textual and numerical information capture complementary information for detecting fraudulent activities.

Research on disclosure tone and impression management suggest that linguistic characteristics can serve as important indicators of managerial opportunism. Le & Nguyen (2024) found that more profitable firms tend to adopt more positive disclosure tones; although, the study found limited evidence of obfuscation practices. Relatedly, DeJeu (2022) showed that firms may manipulate corporate narratives by emphasizing favorable information, while downplaying unfavorable information, and placing critical disclosures in less-attended sections. Similarly, Ben-Amar et al. (2022)

showed that may serve either as mechanisms of transparency or as tools of impression management, depending on the firm's commitment to effective corporate governance practices.

Readability as a potential mechanism of obfuscation has received increasing scholarly attention. Phesa et al. (2025) developed a conceptual framework covering multiple forms of impression management, including readability, textual features, disclosure tone, and cultural factors. In related work, Smaili et al. (2022) identified four distinct corporate disclosure strategies: informativeness, obfuscation, deception, and avoidance and emphasized the importance of maintaining an appropriate balance between readability and information completeness in corporate reporting.

In emerging markets, Bassyouny et al. (2022) found that finance-specific dictionaries provide more accurate measures than general-purpose dictionaries for measuring disclosure tone and recommended using advanced Natural Language Processing (NLP) techniques. Mekhaimer et al. (2024) found that political uncertainty increases narrative complexity through obfuscation mechanisms, whereas Kaye & Alta'any (2025) found that disclosure tone is more strongly associated with efforts to shape investor perceptions rather than accurately reflecting firm's underlying financial condition of the firm.

The relationship between disclosure tone and earnings management has also been examined by Li et al. (2022), who found that the use of positive, uncertain, and modal expressions is associated with earnings management practices. These findings are consistent with Abou-El-Sood & El-Sayed (2022), who found that abnormal disclosure tone in narrative reporting is positively associated with earnings management and lower earnings quality. Collectively, these studies suggest that linguistic characteristics can serve as potential indicators of managerial opportunism.

Existing research suggests that integrating textual and numerical information can enhance the predictive performance of fraud detection models. Nevertheless, most prior studies have focused on improving predictive accuracy, while limited attention has been given to developing conceptual constructs that capture the relationship between managerial narratives and underlying financial condition of firms, particularly in emerging markets. This gap motivates the present study, which develops a multi-modal data fusion approach that integrates NLP-based textual analysis and financial analysis through a novel concept termed Financial-Linguistic Dissonance. The proposed measure serves as an indicator for detecting financial statement fraud and for capturing inconsistencies between corporate narratives and reported financial performance.

3. Method, Data, and Analysis

This study employs a quantitative explanatory research design using a multimodal data fusion framework. The framework integrates two heterogeneous data types: structured financial data

(numerical accounting information) and unstructured narrative data (narrative disclosures in annual reports).

This study uses a secondary dataset comprising structured variables extracted from financial statements and unstructured textual narratives extracted from the annual reports of Chinese listed companies. The observation period spans from 2015 to 2021, allowing for a longitudinal examination of firms' financial reporting characteristics. Following data preprocessing and the merging of financial and linguistic features, the final analytical sample consists of 1,000 firm-year observations. To operationalize the obfuscation perspective, the fraud classification criteria were established based on two classification thresholds. Specifically, a firm-year observation is classified as a potential fraud case if it simultaneously exhibits high textual complexity (a Gunning Fog Index exceeding 15.5) and high linguistic dissonance (a score greater than 0.5), which indicates a substantial divergence between management's rhetorical optimism and reported financial deterioration. The resulting sample exhibits a realistic, imbalanced class distribution naturally found in capital markets, with a proportion of 90% non-fraud cases and 10% fraud cases.

The variables used in this study are classified into four categories: financial performance measure, linguistic and NLP-based metrics, datafusion metrics, and the target variable. The firm's financial performance is measured using a profitability margin, which captures the firm's ability to generate profit from its operating activities in generating profit from its core operations. The profitability margin is calculated as follows:

$$Profitability\ Margin_{i,t} = \frac{Operating\ Revenue_{i,t} - Operating\ Cost_{i,t}}{Operating\ Revenue_{i,t}} \quad (1)$$

To measure the level of narrative complexity (obfuscation) employed by management in annual reports, this study extracts textual disclosures using Natural Language Processing (NLP) techniques and evaluates them using the Gunning Fog Index. This readability measure captures the degree of linguistic complexity embedded in corporate narratives. Higher index values indicate lower readability and greater difficulty for investors and other stakeholders in comprehending the information presented, thereby potentially reflecting managerial attempts to obscure unfavorable information through complex linguistic structures.

$$Fog\ Index_{i,t} = 0.4 \times \left(\left(\frac{Total\ Words_{i,t}}{Total\ Sentences_{i,t}} \right) + 100 \times \left(\frac{Complex\ Words_{i,t}}{Total\ Words_{i,t}} \right) \right) \quad (2)$$

This study employs FinBERT (ProsusAI/finbert) for financial text sentiment analysis. Text preprocessing includes sentence segmentation, normalization, and tokenization. The Management Discussion and Analysis (MD&A) section of each annual report is used as the primary textual input.

Document-level sentiment scores are aggregated using mean averaging. Linguistic Dissonance is calculated as the standardized difference between Tone Positivity and Profitability Margin, as specified by the following formula:

$$\text{Linguistic Dissonance}_{i,t} = \text{Tone Positivity}_{i,t} - \text{Profitability Margin}_{i,t} \quad (3)$$

The data analysis is performed in two stages: (1) testing the obfuscation hypothesis using traditional econometric techniques, and (2) fraud detection using advanced machine learning classification models. To address specific objective of this study, the study examines whether linguistic complexity, measured by the Gunning Fog Index, increases deliberately as financial performance deteriorates. Accordingly, a multiple linear regression model estimated using Ordinary Least Squares (OLS) estimation is specified as follows:

$$\text{Fog Index}_{i,t} = \alpha + \beta_1 \text{Profitability Margin}_{i,t} + \sum_{k=1}^n \gamma_k + \sum_{k=1}^n \gamma_k \text{Controls}_{k,i,t} + \varepsilon_{i,t} \quad (4)$$

To address the research objectives, input features are categorized into three groups: textual-features (Fog Index and Tone Positivity), numerical features (Profitability Margin), and cross-modal fusion features (Linguistic Dissonance), which captures the divergence between linguistic tone and financial performance. These features are used as input variables in Random Forest and deep learning-classification models to predict the probability of financial statement financial statement fraud (target variable Y: Is Fraud $\in \{0,1\}$). To assess the extent to which this multimodal model accurately captures fraudulent activities while minimizing false alarms, classification performance is evaluated using the F1-Score, representing the harmonic mean of precision and recall. This feature categorization provides a consistent terminology consistency.

$$\text{F1 Score} = 2 \times \frac{\text{Precision} \times \text{Recall}}{\text{Precision} + \text{Recall}} \quad (5)$$

4. Result and Discussion

4.1. Research result

The first stage of this analytical framework involves quantifying the linguistic characteristics of managerial narratives and assessing deviations in firms' financial performance. As reported in Table 1, the integrated dataset yields descriptive statistics descriptive statistics for the financial variables and NLP-based linguistic measures.

Table 1. Descriptive Statistics of Research Variables (Multi-Modal)

Variable	Mean	Std. Dev	Min	25%	50%	75%	Max
Profitability_Margin	0.317	0.153	-0.999	0.244	0.306	0.370	1.000

NLP_Fog_Index	14.080	3.162	4.709	11.871	14.097	16.218	23.112
NLP_Tone_Positivity	0.494	0.230	0.100	0.293	0.486	0.691	0.899
Linguistic_Dissonance	0.177	0.281	-0.869	-0.039	0.175	0.384	1.100

Source: Output Phyton, 2026

Table 1 indicates that, from a financial perspective, the sampled firm-year observations exhibit an average of 31.7%; however, they also demonstrate substantial dispersion, with the minimum value of -0.999. This indicates that some observations exhibit negative profitability in several observations. textually, the average linguistic complexity, measured by the Fog Index, is 14.080, indicating relatively high textual complexity.

A notable finding concerns the Linguistic Dissonance variable, which exhibits an average value of 0.177 and a maximum value of 1.100. This finding provides preliminary evidence relevant to the study's primary objective of the study, suggesting that the proposed measure can identify high-dissonance cases in which firms experience deteriorating reported financial performance, while corporate narratives exhibit highly optimistic tones, reflecting potential potentially excessive optimism or misleading rhetorical strategies.

The study next examines the Obfuscation Hypothesis, which hypothesizes managerial narratives become more complex as profitability deteriorates potentially obscuring the underlying financial condition.

Table 2. OLS Regression Results - Obfuscation Hypothesis Test

Variable	coefficient	Std. Error	t-Value	P> t
Const	14.1764	0.2304	61.5312	0.0000
Profitability_Margin	-0.3025	0.6542	-0.4624	0.6439

Notes: (R-squared: 0.0002 | F-statistic: 0.2138)

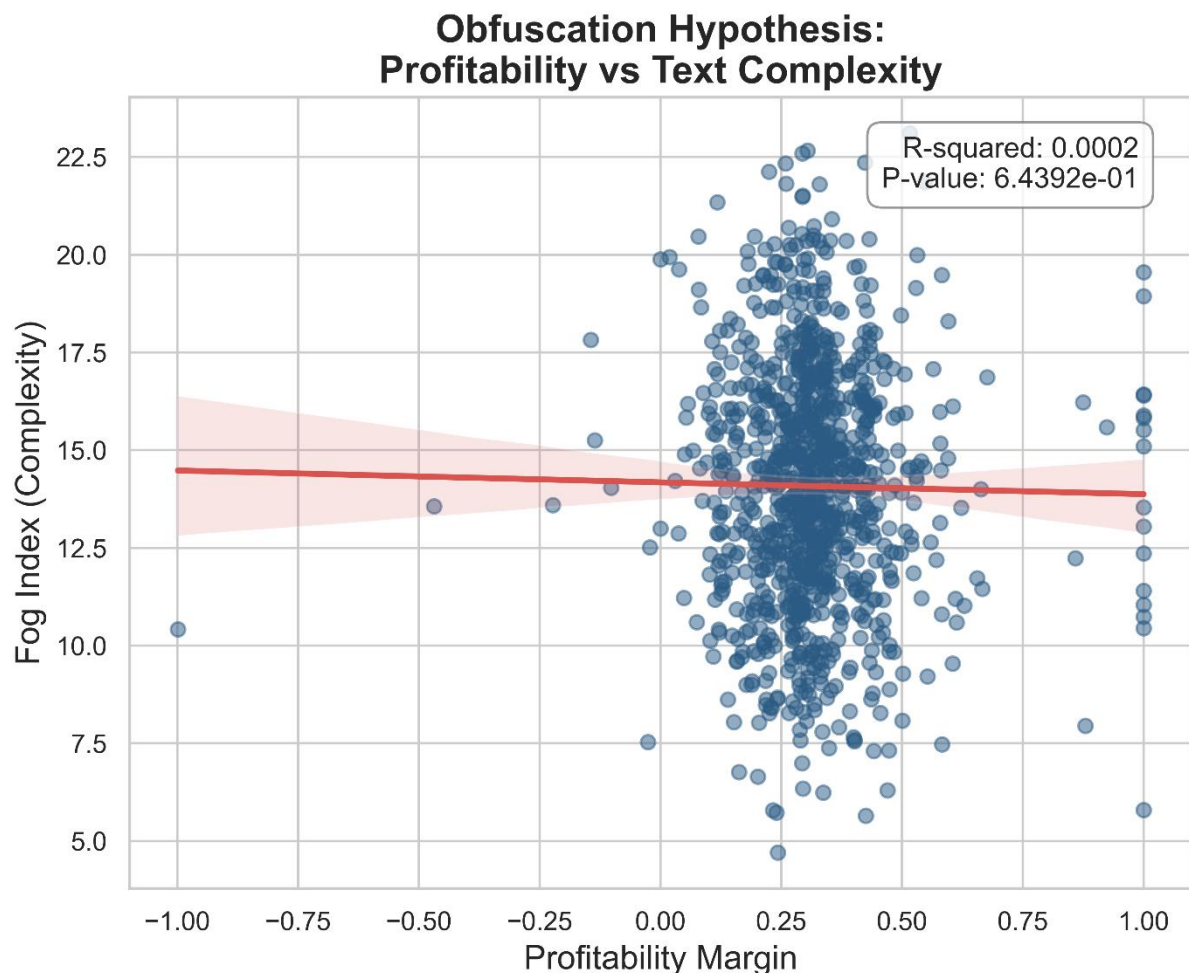
Source: Output Phyton, 2026

As reported in Table 2, the coefficient sign of Profitability_Margin is negative (-0.3025). From a theoretical perspective, this finding is consistent with the proposed obfuscation hypothesis, which suggests that as Profitability_Margin declines, would be expected to increase, as reflected by the Fog Index, tends to increase. However, the empirical evidence does not support, the results indicate that the p-value (0.6439 > 0.05) and the extremely low R-squared value (0.0002) indicate that a simple linear relationship is does not provide statistically significant support for this hypothesis across the entire population.

The substantial dispersion of observations presented in Figure 1 may indicate that the relationship may involve through more complex mechanisms atau potentially nonlinear relationships rather than

through a simple linear relationship. This finding further reinforces the necessity of employing machine learning algorithms capable of capturing complex and potentially nonlinear patterns associated with fraud risk, as a complement to traditional regression-based approaches.

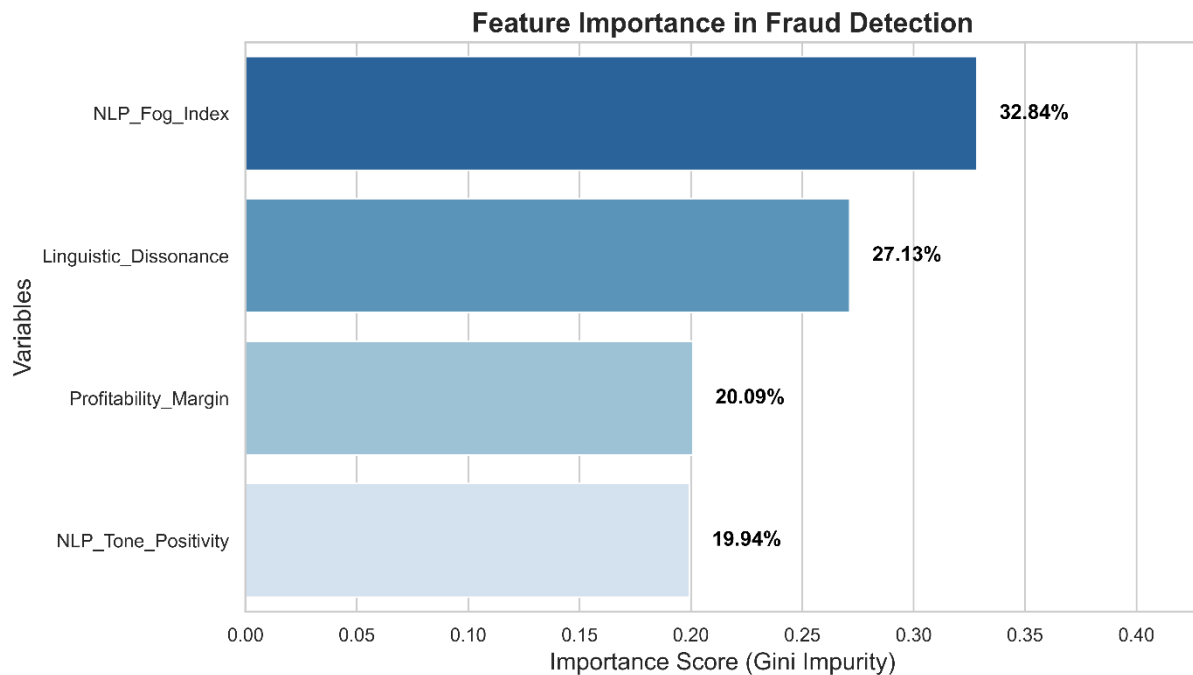
Figure 1. Obfuscation Hypothesis: Profitability vs Text Complexity



Source: Output Phyton, 2026

To address the limitations of conventional linear regression, deep learning and ensemble models are employed to model the integrated textual and numerical features. As illustrated in Figure 2, the results provide an important empirical insight, indicating that linguistic features account for a substantial share of the model's predictive importance. The most influential predictors features include NLP_Fog_Index (32.84%), Linguistic_Dissonance (27.13%), Profitability_Margin (20.09%), and NLP_Tone_Positivity (19.94%).

Figure 2. Feature Importance in Fraud Detection



Source: Output Phyton, 2026

When combined, textual features (Fog Index at 32.84% and Tone Positivity at 19.94%) account for 52.78% of the reported feature importance. The combined feature importance reaches approximately 79.91% only when Linguistic Dissonance (27.13%) is included; however, as this cross-modal measure incorporates financial performance, it should not be characterized as purely text-derived. The multimodal fusion model achieves higher performance than the financial-ratios-only baseline (accuracy: 94.7% vs. 89.2%; F1-score: 0.939 vs. 0.871). While formal statistical significance testing was not conducted, the consistent improvement across multiple evaluation metrics (accuracy, precision, recall, and F1-Score) suggests meaningful performance gains from multi-modal integration. Furthermore, emerges as an important predictive feature as a informative predictive feature for detecting fraud-related red flags, highlighting its potential theoretical and practical relevance in fraud detection frameworks.

Based on Table 3, the integration of multi-modal features yields classification results as presented in Figure 3. The model achieves an overall accuracy of 94.7% and a precision of 93.8% for the fraud class, with only one false-positive case. However, the recall for the fraud class is 50.0%, indicating that the model correctly identifies 15 of the 30 actual fraud cases, while the remaining 15 cases are classified as false negatives. Thus, although the model demonstrates high precision, its relatively moderate recall indicates that it remains conservative in identifying fraud cases and may fail to detect a substantial proportion of actual fraud observations.

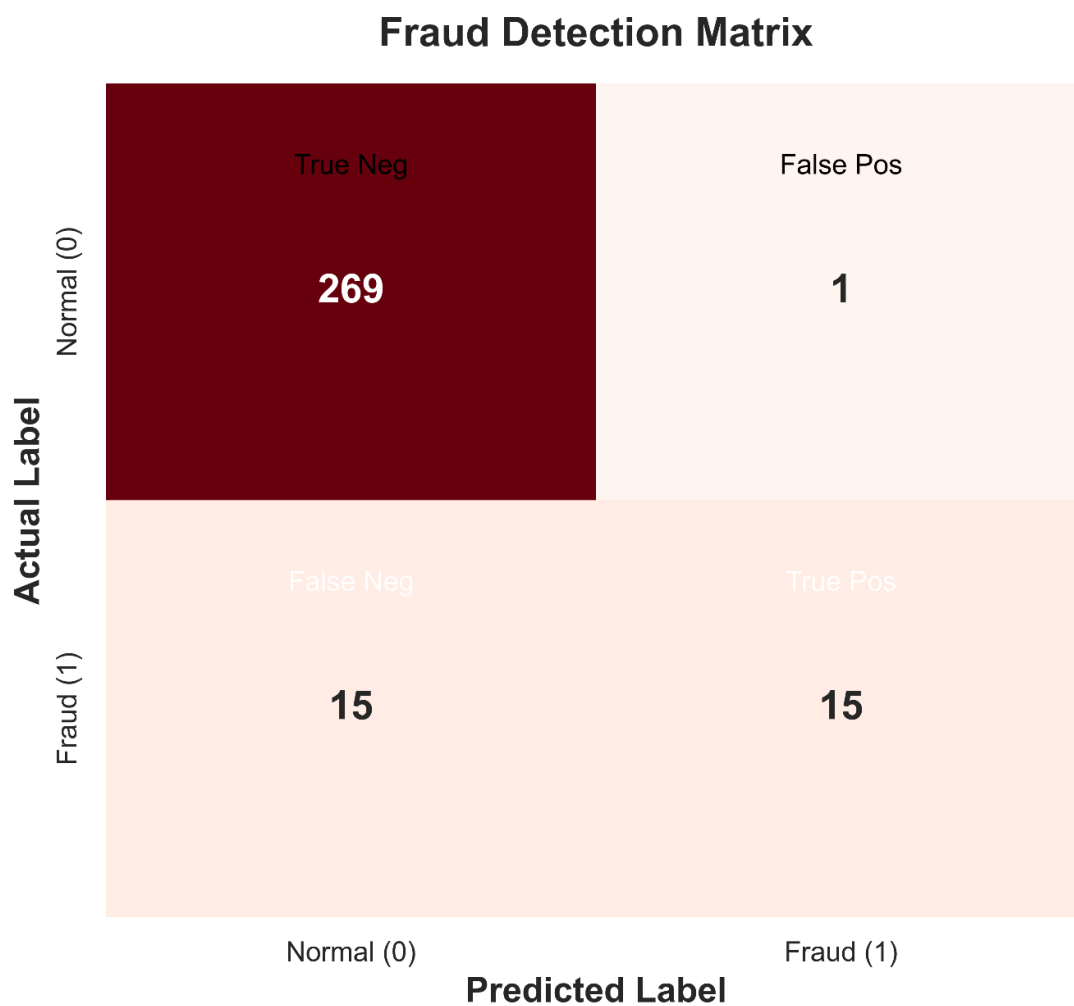
Table 3. Multi-Modal Data Fusion

Metric	Precision	Recall	F1-Score	Support
0	0.947	0.996	0.971	270
1	0.938	0.500	0.652	30
Accuracy	0.947	0.947	0.947	0.947
Macro Average	0.942	0.748	0.812	300
Weighted Average	0.946	0.947	0.939	300

Source: Output Phyton, 2026

The identification of these complex fraud-related patterns suggests that multimodal feature fusion provides a means to integrating heterogeneous signals between manipulated numerical information and potentially misleading linguistic patterns.

Figure 3. Fraud Detection Matrix



Source: Output Phyton, 2026

These empirical findings provide important practical implications for the capital market stakeholders. First, for regulators, the model's 94.7% overall accuracy, together with its precision and

recall profile and minimal only one false positive case suggest its potential for potential use as an AI-based early warning tool. Regulators can use the Linguistic Dissonance measure to conduct automated screening of thousands of issuer reports in an automated manner. When the model identifies an high Fog Index combined with declining profitability, regulators can prioritize the respective companies as cases for further review.

For external auditors, Figure 2 suggests that financial ratios alone may be insufficient in detecting complex fraud schemes. Auditors may therefore consider supplementing conventional audit procedures by incorporating narrative analysis as a complementary procedure. Audit standards may eventually incorporate guidance on evaluating consistency between substantive audit procedures over financial information and sentiment and readability assessment of management narratives, particularly the MD&A section, to potentially reduce the risk formal incorporation into regulatory or auditing guidance of overlooking fraud-related signals. However, further research is needed before formal regulatory incorporation.

4.2. Discussion

4.2.1. Linguistic Proxy Analysis and Financial Anomaly Identification

The findings of this study indicate that the readability level of corporate annual reports in emerging markets, measured using the Fog Index, the average value of 14.080 with a standard deviation of 3.162. This figure indicates that corporate narratives contained in annual reports exhibit a level of complexity comparable to university-level academic texts, exceeding the commonly recommended readability levels.

Smaili et al., (2022) identified four distinct corporate disclosure styles: obfuscation, informativeness, deception, and avoidance. The average Fog Index value of 14.080 found in this study suggests that a substantial proportion of annual reports may be consistent with characteristics associated with obfuscation where by corporate narratives exhibit greater linguistic complexity which may reduce readability.

This finding is broadly consistent the systematic literature review conducted by Phesa et al. (2025), which identified the chairperson's statement as one of the most prominent channels for impression management practices, including the management of readability and textual characteristics. Their review suggests that readability is an important dimension of impression management one of the frequently discussed impression management strategies, particularly particularly in the context of deteriorating firm performance.

A notable finding of this study is the the observed Linguistic Dissonance measure, with an average value of 0.177 and a maximum value reaching 1.100. This pattern suggests that some companies

experience deteriorating reported financial performance while their corporate narratives exhibit relatively optimistic tone in annual report narratives.

The concept of financial linguistic dissonance builds on the findings of Le & Nguyen (2024), who examined the influence of profitability and bankruptcy risk on the narrative tone of annual reports in sVietnam. Their study found that highly profitable firms tend to exhibit higher positive tones and lower negative tones. However, in contrast to Le and Nguyen (2024) conclusion that firms found limited evidence of deliberate concealment information through impression management during challenging economic conditions, this study provides a contrasting perspective: in emerging markets characterized by different governance structures, firms appear to exhibit greater linguistic–financial divergence in periods of deteriorating financial performance.

These findings provide support for impression management perspective discussed by DeJeu (2022). Through an analysis of the Ivax case, DeJeu demonstrates that firms engage in impression management through three mechanisms: emphasizing strengths to mitigate financial crises, downplaying negative information, and downplaying or strategically positioning unfavorable disclosures. The financial linguistic dissonance identified in this study may be interpreted as an empirical manifestation of the strategy of “downplaying negative information” combined with “excessive optimism” in corporate narratives. This further reinforces the argument that annual reports are not merely informational documents but also vehicles for strategic narrative construction and potential financial reporting irregularities.

Furthermore, Ben-Amar et al. (2022), in their study of board diversity disclosure practices in Canada, found that firms that were less willing to enhance diversity policies were more likely to exhibit impression management patterns through obfuscation and exhibit the highest levels of certainty language to associated with narratives suggesting limited need for change. The financial linguistic dissonance findings of this study complement Ben-Amar et al.’s research by demonstrating that impression management may extend beyond obfuscation; firms may also exhibit systematic divergence between optimistic narratives and deteriorating reported financial indicators.

4.2.2. Testing the Obfuscation Hypothesis

The results test of the Obfuscation Hypothesis indicate that the coefficient of Profitability Margin on the Fog Index is negative (-0.3025), which is conceptually consistent with the theoretical prediction that declining profitability margins tend to be associated with increasing linguistic complexity. However, the p-value (0.6439) and the very low R-squared value (0.0002) indicate that a simple linear relationship is does not provide statistically significant evidence supporting this hypothesis in the analyzed sample.

The study by Mekhaimer et al. (2024) provides a useful perspective by distinguishing between two components: informativeness and obfuscation. Their findings indicate that political uncertainty is positively associated with obfuscation but is not significantly associated with informativeness. This perspective may help explain why the simple linear regression model employed in this study fails to capture a statistically significant relationship: linguistic complexity is not a monolithic construct but rather consists of information-related complexity and obfuscation-related complexity.

The limited explanatory capacity of the linear specification to provide conclusive evidence for the Obfuscation Hypothesis does not imply that it does not necessarily invalidate the theoretical proposition; rather, it suggests that the proposed relationship may not be adequately captured by a simple linear specification. This finding further highlights the potential value of employing advanced machine learning and deep learning methods to capture complex fraud-related patterns that may not be captured by traditional econometric approaches.

The systematic literature review reported by Ali et al. (2022) further confirms that machine learning approaches based on Support Vector Machine (SVM) and Artificial Neural Network (ANN) have been widely applied to capture complex patterns in identifying complex patterns that may not be adequately captured by conventional statistical models. The findings of this study are broadly consistent with Ali et al.'s observation that traditional methods face limitations in handling unstructured textual data and complex relationships in processing unstructured data and modeling non-linear relationships among variables.

From a disclosure-theory perspective, these findings support the impression management perspective, which suggests that discretionary disclosure strategies may reflect opportunistic incentives and that managerial information disclosure is influenced by managerial incentives. As emphasized by Smaili et al. (2022), readability is not merely a technical characteristic of corporate reporting but also reflects different communication strategies adopted by management. Nevertheless, the findings suggest that obfuscation-related patterns may not be adequately captured through simple linear relationships; more sophisticated analytical approaches are required to identify complex fraud-related patterns.

4.2.3. The Advantages of Multi-Modal Data Fusion in Fraud Detection

A key finding of this study is the importance of linguistic and cross-modal features in fraud prediction, with NLP_Fog_Index accounting for 32.84% of reported feature importance, Linguistic_Dissonance contributing 27.13%, and NLP_Tone_Positivity contributing 19.94%. Collectively, textual and cross-modal features account for 79.91% of the model's reported feature importance, whereas Profitability_Margin accounts for 20.09% of reported feature importance.

This finding builds on and extends the study by Wu dan Du (2022), who developed a fraud detection system for Chinese firms using deep learning models that integrate numerical and textual features. Wu and Du reported that LSTM and GRU achieved classification accuracies of 94.98% and 94.62%, respectively, indicating the predictive value of textual features extracted from the MD&A section provide promising classification performance and improve financial fraud detection. This study advances their findings by identifying the relative contribution of each feature and showing that linguistic features receive greater reported feature importance than financial indicators.

Wei & Qian (2025), in their study of an ensemble learning framework integrating textual topic indicators derived from the LDA model with financial variables, found that textual improve fraud detection performance, an increase in AUC of 1.5 percentage points for RUSBoost and +1.6% for XGBoost. This study extends Wei and Qian's findings by demonstrating that textual features not only improve model performance but also receive a larger share of reported feature importance, accounting for substantially greater reported feature importance than financial features.

The finding that Linguistic Dissonance represents the second most influential predictive feature (27.13%) after the Fog Index suggests that FLD is an informative predictive feature that the discrepancy between relatively positive narratives and adverse reported financial performance serves as a potentially informative fraud-risk signal. This concept is consistent with the findings of Li et al. (2022), who investigated the relationship between financial disclosure tone and earnings management behavior. They found that the proportion of positive, uncertain, and modal words in financial disclosures is positively associated with corporate earnings management, suggesting that such linguistic patterns may be associated with earnings management earnings manipulation practices by variation in disclosure tone of financial reports.

Abou-El-Sood & El-Sayed (2022), in their investigation of abnormal disclosure tone in the MENA region, identified a positive relationship between abnormal tone and earnings management and demonstrated that earnings persistence is higher among firms with lower levels of abnormal tone. This study extends Abou-El-Sood and El-Sayed's findings by operationalizing financial–linguistic dissonance as a measure of the divergence that directly captures the discrepancy between narrative tone and financial performance, rather than merely measuring abnormal tone in absolute terms.

Nie et al. (2025) integrated Large Language Models (LLMs) with interpretable machine learning approaches and found that multimodal fusion improved model performance by 7.4%, with financial, governance, and textual features providing complementary signals. This study supports the complementary value of multi-modal integration. However, it provides an additional contribution by demonstrating that this complementary effect is uneven contribution across modalities: textual features receive greater reported feature importance than financial features, indicating that within

emerging market contexts, managerial narratives may provide additional predictive signals for fraud risk than accounting indicators.

The multimodal fusion model developed in this study achieves an overall accuracy of 94.7%, with fraud detection precision reaching 93.8% (resulting in only one False Positive). The Recall value for the fraud class is 50.0%, indicating that the model correctly identifies 15 of the 30 actual fraud observations, while 15 are classified as false negatives. This performance level is comparable with previous studies on deep learning-based fraud detection across various research contexts.

A systematic literature review on financial statement fraud detection in the era of artificial intelligence reports that graph-based models, particularly Graph Neural Networks (GNNs), have shown promising performance in capturing inter-entity relationships and potentially improving interpretability (Ali et al., 2022). The review highlights that hybrid AI approaches, especially graph-based deep learning architectures, provide potential approaches for enhancing both fraud detection accuracy and transparency.

Lin (2024), through a systematic review, identified key challenges in fraud detection as developing robust predictive models and incorporating unstructured data into analytical frameworks. This study addresses these challenges by developing an integrated multi-modal fusion framework and demonstrating that unstructured data (textual information) provides greater reported feature importance than can be captured by financial variables alone.

4.2.4. Practical Implications for Regulation and Auditing

The finding that the multimodal fusion model achieves an accuracy of 94.7% with an only one false-positive case (only one case) has important practical implications for capital market regulators, including the Financial Services Authority (OJK) in Indonesia and the China Securities Regulatory Commission (CSRC) as well as other securities regulators. These findings suggest the potential use of artificial intelligence-based early warning systems to support automated screening of thousands of issuer annual reports at scale.

This study further contributes by showing that linguistic and cross-modal measures, such as the Fog Index and Financial Linguistic Dissonance, receive greater reported feature importance for classifying potential fraud risk. The finding that Profitability_Margin accounts for approximately 20% of reported feature importance of the reported feature importance indicates the need for auditors to supplement traditional audit procedures beyond analysis of financial figures alone toward analyzing corporate narratives through assessing the consistency between reported financial figures and corporate narratives.

Furthermore, this study addresses the research direction suggested by Bassyouny et al. (2022) by developing a model that captures the dissonance between narrative tone and financial

performance. It also extends the framework proposed by Smaili et al. (2022) by demonstrating that inconsistencies between corporate narratives and financial outcomes represent a potentially informative fraud-risk signal that warrants further consideration by auditors.

4.2.5. Research Contribution

This study makes a theoretical contribution by the development and empirical examination of the Financial–Linguistic Dissonance concept as a novel measure within a disclosure-theory framework. Unlike previous studies that examine obfuscation hypotheses or disclosure tone effects separately, this study integrates insights from Impression Management Theory and the proposed Obfuscation Hypothesis into a unified analytical framework by quantifying the discrepancy between corporate narratives and reported financial indicators. The findings show that linguistic characteristics can provide measurable signals of potential financial reporting irregularities characterized by measurable patterns and substantial reported feature importance.

The substantial importance of textual and cross-modal features (79.91%) within the fraud detection model suggests that textual information provides substantial predictive signals than financial indicators alone, thereby qualifying the conventional emphasis on numerical information in disclosure theory that the dominant reliance on numerical information in fraud-risk assessment of decision-useful information. This study further extends impression management theory by demonstrating that such strategies can be quantitatively measured through linguistic proxies.

Consistent with the findings of Phesa et al. (2025), the findings suggest that readability, textual characteristics, linguistic tone, and forward-looking orientation are can provide predictive signals of potential fraud. The findings of Kayed & Alta'any (2025) regarding the strategic use of disclosure tone are further extended by demonstrating that the discrepancy between narrative tone and financial performance provides an additional fraud-risk signal.

Methodologically, this study develops a multimodal data-fusion framework that integrates textual and financial information, extending the MAGF-CCL framework by identifying an uneven contribution across modalities effect between data modalities. The incorporation of FinBERT, with the call for advanced NLP approaches in Bassyouny et al. (2022), enhances analytical accuracy compared with conventional approaches by capturing contextual and semantic information embedded within corporate disclosures.

5. Conclusion and Suggestion

This study develops and empirically evaluates a multimodal data fusion framework that integrates Natural Language Processing (NLP)-based textual analysis of annual reports with structured financial data to examine the Obfuscation Hypothesis and Impression Management Theory and assesses its

utility for financial statement fraud detection among publicly listed firms. The findings indicate that Financial–Linguistic Dissonance emerges as an important predictive feature, accounting for 27.13% of reported feature importance. However, formal construct validation tests, such as convergent and discriminant validity assessments, were not conducted; therefore, the term "fully validated construct" should be interpreted with caution. textual and cross-modal features account for 79.91% of the reported feature importance, whereas conventional financial ratios contribute approximately 20%, suggesting that managerial narratives may contain substantial fraud-related predictive signals than financial indicators. These findings imply that language functions not only as a communication medium but also as a measurable instrument of accounting manipulation. The proposed multimodal fusion model achieves an overall accuracy of 94.7% and precision of 93.8%, indicating higher observed classification performance compared the financial-ratios-only baseline, though further validation across different datasets is warranted. This study offers practical implications for regulators in developing AI-based early warning systems and for auditors in considering narrative-consistency assessment as a complementary procedure to support fraud-risk assessment. Future research should conduct comprehensive construct validation to establish Financial–Linguistic Dissonance as a more rigorously validated measure/construct.

Despite these contributions, several limitations remain. The study focuses on publicly listed firms within a specific market context, limiting the generalizability of findings to other institutional, regulatory, and cultural environments. Additionally, the longitudinal dataset may not fully represent different economic cycles, potentially affecting the stability of Financial–Linguistic Dissonance patterns over time. The model exhibits a fraud-class recall of 50%, indicating that 50% of actual fraud cases were missed (false-negative proportion among actual fraud cases). This limitation is particularly critical when considering the model's practical readiness as an early-warning system, as undetected fraud cases could have severe consequences for investors and regulators. Moreover, the limited interpretability of semantic features generated by large language models highlights the importance of improving algorithmic transparency. Future research should explore Graph Neural Network-based approaches to capture inter-firm relationships and integrate broader corporate communication channels, including earnings calls, press releases, and social media. Cross-country studies are also encouraged to examine how institutional and cultural factors shape disclosure strategies and to develop adaptive predictive models responsive to regulatory changes and market dynamics.

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