International Journal of Management, Accounting and Economics
Volume 10, Issue 12, December 2023
ISSN 2383-2126 (Online)
DOI: https://doi.org/10.5281/zenodo.10659349
www.ijmae.com

Original Research

Discretionary Accruals-Earnings Management Across Industries: Implications for Financial Reporting Quality

Thakoor Sharma Geerawo[1]
Department of Accounting, Finance and Economics, University of Technology, Pointe-aux-Sables, Port Louis, Mauritius

Received 13 October 2023 Revised 18 December 2023 Accepted 22 December 2023

Abstract

This study explores the variations in discretionary accruals' specific earnings management practices across different industries and their implications for financial reporting quality. Discretionary accruals are part of earnings management which affect the quality of financial reporting. These can distort financial statements and mislead stakeholders. Understanding how these practices differ among industries provides valuable insights for regulators, investors, and financial analysts. Yet, literature is overly scarce on specific industries which are most affected by discretionary accruals. Delving into information from a robust principles-based economy adopting IFRS, this paper addresses a research gap with a dataset spanning multiple industries over a multi-year period from 2013 to 2022. The Dechow, Kasznik, and Kothari models are employed to assess the extent of discretionary accruals within each industry. Based on winsorized mean and standard deviation, the industries which appeared most in the list of signed and absolute discretionary accruals were Energy and Financials followed closely by the Technology industry. Additionally, applying panel data regressions with multiple fixed effects, the size of a firm, equity ratio, asset turnover, and past profitability were significant in the models which influence discretionary accruals whereas the impact of liquidity was not statistically significant.

Keywords: Discretionary Accruals, Financial Reporting Quality, Fixed Effects Regressions, Industry differences, Non-parametric tests.

[1] *Corresponding author's Email: tgeerawo@gmail.com*

International Journal of Management, Accounting and Economics
Volume 10, Issue 12, December 2023
ISSN 2383-2126 (Online)
DOI: https://doi.org/10.5281/zenodo.10659349

Introduction

Financial reporting relies on accurate, reliable and objective financial information to produce true and fair financial statements. Within these statements, accruals stand as a critical element, representing the managerial discretion in accounting choices (Jamadar et al., 2022). Accruals, while essential for matching and accruals concepts, also hold the potential for manipulation, thus impacting the quality of financial reporting. Understanding the dynamics of accruals across industries is essential to evaluate financial reporting quality and their broader implications on investors, creditors, and other stakeholders (Yuan et al., 2016). These accruals play a pivotal role in the financial reporting landscape, impacting not only the perception of a company's financial health but also the financial market stability.

As mentioned, total accruals represent a portion of accrual accounting that allows management to exercise judgment in recognise revenues and expenses for the accounting period, which might simply be necessary and unavoidable. These are termed as non-discretionary accruals (Altarawneh et al., 2022). On the other hand, the difference between total accruals and non-discretionary accruals is termed as discretionary accruals (Pham et al., 2019). While such discretion is essential for showing the economic substance of transactions, it also introduces an element of subjectivity into financial reporting. This subjectivity can lead to concerns about the quality and reliability of financial statements, as discretionary accruals can be manipulated to convey a more favourable financial picture than may truly exist (Jamadar et al., 2022). Therefore, studying discretionary accruals becomes a central focus in assessing financial reporting quality.

It is this interplay between discretion and transparency that defines the relevance of discretionary accruals in financial reporting. Discretionary accruals are not inherently negative; they can reflect legitimate managerial judgments (Pham et al., 2019). However, when used strategically to achieve certain financial objectives, they raise concerns about the integrity of financial statements. Uncovering the patterns and determinants of discretionary accruals in various industries is an endeavour that can shed light on the state of financial reporting practices today.

This study embarks on a journey to explore the world of discretionary accruals, with a particular focus on their industry-based variations in a principles-based economy adopting International Financial Reporting Standards (IFRS). The primary research objectives revolve around the identification of industries with the highest average discretionary accruals in signed and absolute terms, highest standard deviation and the exploration of factors contributing to this phenomenon. Thus, an analysis will delve into the relationship between critical financial performance metrics in common industry benchmarks to discretionary accruals.

Thus, this research aims to solve two important research questions which have not been studied extensively in literature:

International Journal of Management, Accounting and Economics
Volume 10, Issue 12, December 2023
ISSN 2383-2126 (Online)
DOI: https://doi.org/10.5281/zenodo.10659349

Research Question 1: Which industries show the highest average and variance of Discretionary Accruals?

This initial research question serves as the cornerstone of this investigation. It is essential to identify industries where discretionary accruals play a significant role in influencing financial statements. To achieve this, three distinct models are employed, each offering a unique perspective on discretionary accrual measurement. By utilising the Dechow (1995), Kasznik (1999) and Kothari (2005) models, it is aimed to ensure a comprehensive evaluation, accounting for variations in measurement methods and accounting practices. The actual mean and variance of the discretionary accruals are studied as well as the mean and variance of the absolute discretionary accruals. The use of the Dechow and the Kothari models stems from the high citations over the years.

In the second research question, the purpose is to try to discover several financial metrics which may contribute or deter the discretionary accruals to help policy makers. Therefore, the second question is:

Research Question 2: Do traditional Industries' Financial Performance Metrics influence Discretionary Accruals?

This paper's attention is spun to the financial performance metrics which are utilised in all industries. Metrics such as the return on assets, asset turnover, equity ratio (inverse leverage) and current ratio, are fundamental indicators of profitability, efficiency, gearing and liquidity ratios which are commonly used in all industries. These metrics will highlight which financial metrics influence discretionary accruals, which could be used for probing significant disparities that could provide insights into the implications of elevated discretionary accruals on overall financial performance.

Previous literature has only seen a limited number of dated studies associated with industry classification and discretionary accruals, whereby the authors discussed the different classifications by different organisations (Hrazdil & Scott, 2013). This is not the motive here, as this study seeks to make a meaningful contribution to the broader understanding of the financial reporting landscape. The implications extend beyond academia, resonating with regulators, investors, and financial practitioners. In the subsequent sections, a summary of literature, research methodology, data analysis, empirical findings and critical discussion of results of this study are presented.

Literature Review

The research on industry differences in discretionary accruals is scarce. Few studies find that discretionary accruals differ across industries. Ikram (2011) decomposes discretionary accruals into firm-specific and industry-specific components, finding that the accruals anomaly is driven by firm-specific discretionary accruals. However, industry-specific discretionary accruals negatively impact investors' ability to properly price firm-specific discretionary accruals (Ikram, 2011). This suggests discretionary accruals are reported differently across industries.

While some evidence suggests that industry differences matter for discretionary accruals, the overall research is mixed as often industry classification has been utilised as

International Journal of Management, Accounting and Economics
Volume 10, Issue 12, December 2023
ISSN 2383-2126 (Online)
DOI: https://doi.org/10.5281/zenodo.10659349
www.ijmae.com

a dummy variable of fixed effects (Lin & Yen, 2022; Moscariello et al., 2020; Yuan et al., 2016). Industry classification may improve discretionary accruals estimation for some research questions and samples, but it does not appear to universally enhance discretionary accruals models or provide a complete solution to the complexities of estimating discretionary accruals. Hrazdil and Scott (2013) show that the Global Industry Classification Standard (GICS) results in the most reliable industry groupings for estimating discretionary accruals. Using GICS, the author finds that initial public offering firms with high discretionary accruals do not experience poor long-term stock performance, contrary to previous findings using other industry classification systems.

However, other studies find little evidence that industry classification or industry differences improves discretionary accruals estimation. Acar and Coskun (2020) compare various models for estimating discretionary accruals across countries and industries, finding little difference in explanatory power between models that control for industry and country versus those that do not. Furthermore, a higher number of industries is more precise in modelling than having a few selected industries (Acar & Coskun, 2020). A handful studies even suggest that industry classification can be problematic for discretionary accruals research. Suk Yoon et al. (2022) argues that the Jones model and industry approach, two common methods for estimating discretionary accruals, are theoretically and empirically flawed. The authors find that the cash flow approach outperforms the industry approach.

The papers provide mixed evidence on which industries are most affected by earnings management. Ujah and Brusa (2014) found that consumer staples and consumer cyclical industries had the highest earnings management. They further deduct that the level and scope of managed earnings vary depending on the industry a corporation is in. The most manipulated industries are consumer cyclical and consumer staples with financial leverage and cash flow volatility being significant, while the least influenced ones are transportation and utilities (Ujah & Brusa, 2014). In contrast, Sun (2009) found substantial earnings management across nine Australian industries, with the effects most pronounced in periphery sector firms and the dual economy. Furthermore, the highest earnings management was discovered in Metals & Mining and Information Technology (Sun, 2009).

However, Wasiuzzaman (2018) found that capital intensity, volatility and profitability—not industry type but items of industry characteristics—were the main drivers of earnings management in Malaysia. The author also mentions that profitability is an appropriate variable in the discretionary model as it influences the discretionary measure but leverage is interestingly not able to explain variations in the discretionary accruals. Tran (2022) however tests similar variables of industry characteristics and conclude that leverage is an important predictor of earnings management whereas firm size has negative effects on discretionary accruals.

Several studies have been done with industry focus and not on industry differences. For instance, Chang et al. (2019) had studied the tourism industry's discretionary accruals, where they found out that China's tourism industry's earnings management is lower from Taiwan. Similarly, Roy and Debnath (2015) find that service sector industries in India engage in income-decreasing earnings management, while non-service sector

industries do the opposite. Kim and Lee (2019) studied the retail industry and uncovered that in Korea, discretionary accruals is limited and suggest a higher quality financial report. The same idea was endorsed by Negkakis (2021) who posited that larger maritime companies have a higher quality reporting and less discretionary accruals in the shipping industry. There are numerous researches within a specific industry and the reasons for studying individual industries sourced from the motives of the research problem denoted by the authors, which ranged from political, economic, social and reducing misinformation on the market. Yet, these studies are important to glean the independent variables for the analysis.

Cudia and Dela Cruz (2018) also found evidence of earnings management across Philippine industrial firms, driven by leverage, cash flows and profitability. Also, leverage and cash flow from operations are both significantly and positively related whereas profitability was negatively related to discretionary accruals (Cudia & Dela Cruz, 2018). The equity ratio, also known as the equity to total assets ratio, is an important financial metric since it takes into account both the debt level and the proportional size of a company. A higher equity ratio means lower leverage (Budhathoki et al., 2020). This has an impact on the size of discretionary accruals since companies with higher leverage typically have more rigidity in managing their earnings due to debt covenants and institutional scrutiny although studies have seen mixed results (Awuye & Aubert, 2022; Hoang & Phung, 2019). It therefore plays a crucial role in research looking at the factors affecting discretionary accruals since it acts as a gauge of leverage and indirectly affects the degree of earnings manipulation.

In similar vein, discretionary accruals are closely related to asset turnover, a gauge of operational effectiveness. Asset turnover measures the ratio of sales to total assets and offers important insights into how well an organisation operates whereby traditionally a higher asset turnover suggests that the company is efficiently employing assets to generate revenue (Harebottle, 2016). Higher asset turnover ratios may indicate that a company is less likely to use aggressive discretionary accruals since an efficient asset utilisation is linked to better profitability and less aggressive earnings management in general (Harebottle, 2016; Jansen et al., 2012).

Additionally, prior research has found a significant correlation between a company's previous success and the presence of discretionary accruals, highlighting the ongoing significance of prior financial performance as a factor in profits management practises. According to this correlation, businesses that have historically been profitable may be less inclined to manipulate results through discretionary accruals although mixed results exist in literature (Cuong et al., 2018; Kapoor & Goel, 2017; Mohaghegh, 2015; Mascarenhas et al., 2010). In order to determine if liquidity impacts discretionary accruals, the current ratio is included as an independent variable. Researchers learn more about the interaction between liquidity and earnings manipulation by directly investigating the link between current ratio and discretionary accruals. A firm's short-term liquidity status affects its earnings management practices (Cuong et al., 2018).

A company’s size may also influence the magnitude of earnings management. Size exhibits a complex relationship with earnings management, where larger organizations, as observed by Mai and Ngoc (2021), are often motivated to achieve specific financial

International Journal of Management, Accounting and Economics
Volume 10, Issue 12, December 2023
ISSN 2383-2126 (Online)
DOI: https://doi.org/10.5281/zenodo.10659349
www.ijmae.com

goals, resulting in a positive relationship. Conversely, as noted by Kurniawati and Panggabean (2020), size may exert a negative influence on earnings management when firms aim to smooth out profits for tax-related reasons. Thus, taken as a whole, these financial measures provide a framework for comprehending the factors influencing discretionary accruals in the field of accounting and finance research.

Methodology

To quantify earnings management (EM), a variety of techniques have been employed in previous research using discretionary accruals as proxy. Its alternative proxy is the real earnings management model which is not studied here as it can be more subjective due to its dependence on the adequacy of the indicators of real earnings management (Sitanggang et al., 2019). The different models either compare cash flow from operations against net income to estimate Discretionary Accruals or calculate modified accruals from working capital with adjustments of current assets, current liabilities, short term debts, cash and depreciation expense (Dechow et al., 1995; Suk Yoon et al., 2022). To describe normal accruals like those pertaining to working capital and depreciation, a regression analysis using a variety of variables is used. The research sample's accruals are predicted using proxies from the sample period. By examining the discrepancy between total accruals and anticipated normal accruals, unexpected accruals, or DA, are discovered. This approach may be used to examine the mechanisms behind EM since it is flexible and appropriate for both cross-sectional and time-series data. At start, however, the DA and Non-Discretionary Accruals are pooled together before the split. Thus:

$$TA_{i,t} = NDA_{i.t} + DA_{i,t} \quad (1)$$

Since Suk Yoon et al. (2022) argue that both the Jones model and industry approach are theoretically and empirically flawed and the cash flow approach outperforms the alternate approaches, the study will use the difference between the cash flow from operations and net income instead of the working capital adjustments method which were change in current assets, current liabilities, cash, short term debts and depreciation expense from Dechow (1995).

$$TA_{i,t} = CFO_{i.t} - NI_{i,t} \quad (2)$$

where $TA_{i,t}$ represents the total accruals of firm i in the current period (t); $NDA_{i,t}$ represents the non-discretionary accruals; $DA_{i,t}$ represents the discretionary accruals; $CFO_{i,t}$ denotes the cash flow from operating activities and $NI_{i,t}$ represents the profitability or net income.

The modified Jones model is a popular strategy that divides total accruals into discretionary accruals (DA) and non-discretionary accruals (NDA) (Dechow et al., 1995, 2012). TA is regressed on revenue change (ΔRev) and the amount of gross property, plant and equipment (PPE), which is scaled by lagged total assets (A_{t-1}) to mitigate potential issues arising from heteroskedasticity. In order to maintain statistical robustness, industry-years with fewer than six observations are removed from the analysis, as suggested in earlier research (Palacios-Manzano et al., 2021). The next step is to estimate the non-discretionary component of accruals (NDA) for each company in

International Journal of Management, Accounting and Economics
Volume 10, Issue 12, December 2023
ISSN 2383-2126 (Online)
DOI: https://doi.org/10.5281/zenodo.10659349
www.ijmae.com

the sample using the estimations for the regression parameters. This is achieved by compensating for the likelihood that businesses may have manipulated sales through changes in credit terms, as noted in the work of Dechow et al. (1995), by adjusting the change in sales for the change in accounts receivable (Rec). According to the recent study (Palacios-Manzano et al., 2021), this adjustment isolates non-discretionary accruals and gives us a more precise representation of a firm's underlying financial performance. Such modifications have been evaluated throughout time and determined to be especially dependable by a number of authors:

$$\frac{TA_{i,t}}{A_{i,t-1}} = \beta_0 + \beta_1 \frac{(\Delta Rev_{i,t} - \Delta Rec_{i,t})}{A_{i,t-1}} + \beta_2 \frac{PPE_{i,t}}{A_{i,t-1}} + \varepsilon_{i,t} \quad (3)$$

The aforementioned model is modified with the Kasznik model, which expands on the models suggested by Dechow et al. (1995), in order to increase the robustness of findings. In order to account for fluctuations in the focal company's net cash flow from operational operations, the Kasznik model adds an extra independent variable (Kasznik, 1999). This controls for variations occurring due to cash flow movements:

$$\frac{TA_{i,t}}{A_{i,t-1}} = \beta_0 + \beta_1 \frac{(\Delta Rev_{i,t} - \Delta Rec_{i,t})}{A_{i,t-1}} + \beta_2 \frac{PPE_{i,t}}{A_{i,t-1}} + \beta_3 \frac{\Delta CFO_{i,t}}{A_{i,t-1}} + \varepsilon_{i,t} \quad (4)$$

The Kothari et al. (2005) model, which contends that studies analysing accounting discretion without taking company performance into consideration may produce misleading results, is the third discretionary accruals detection model employed in this study. They use return on total assets (ROA) as a control variable in their model to solve this problem to depict the link between accounting discretion and other parameters. The model provides a more thorough study and improves comprehension of the factors that affect accounting discretion by incorporating ROA as a control (Kothari et al., 2005):

$$\frac{TA_{i,t}}{A_{i,t-1}} = \beta_0 + \beta_1 \frac{(\Delta Rev_{i,t} - \Delta Rec_{i,t})}{A_{i,t-1}} + \beta_2 \frac{PPE_{i,t}}{A_{i,t-1}} + \beta_3 \frac{ROA_{i,t}}{A_{i,t-1}} + \varepsilon_{i,t} \quad (5)$$

The corresponding measures of discretionary accruals (DA) are the residual estimates in the Dechow, Kasznik, and Kothari models for company i in period t. The relevance of DA, however, is dependent on both its direction and its strength. In order to determine the absolute value of the residuals from the prior equation, the magnitude of DA is therefore determined (Altarawneh et al., 2022; Gonçalves et al., 2021). Through this computation, the strength or intensity of DA is quantified, enabling a thorough assessment of its effects:

$$Abs(DA)_{i,t} = |\varepsilon_{i,t}| \quad (6)$$

The absolute DA is a step to check for robustness and reliability of the models. Absolute DA may uncover implications which are not visible from signed DA (Gonçalves et al., 2021). Undoubtedly, a higher DA indicates poorer earnings quality.

International Journal of Management, Accounting and Economics
Volume 10, Issue 12, December 2023
ISSN 2383-2126 (Online)
DOI: https://doi.org/10.5281/zenodo.10659349
www.ijmae.com

This study departs from the models proposed by previous researchers (Al-Shattarat, 2021; Altarawneh et al., 2022) whereby this investigation focuses on the financial ratios that affect discretionary accruals such as size of firm, book value of equity over assets, past year's return on assets (profitability), asset turnover and current ratio. The model proposed for explaining discretionary accruals are derived from accounting ratios:

$$\text{Abs (DA)}_{i,t} = \beta_0 + \beta_1 \text{SIZE}_{i,t} + \beta_2 \text{BVA}_{i,t} + \beta_3 \text{AT}_{i,t} + \beta_4 \text{CR}_{i,t} + \beta_5 \text{ROA}_{i,t-1} + \text{FE} + \varepsilon_{i,t} \quad (7)$$

The multiple fixed effects (FE) regression method to limit potential endogeneity concerns (Chi & Gupta, 2009). To address disparities in earnings management, the natural logarithm of total assets (SIZE) is employed as a proxy for company size (D'Amato & Falivena, 2020). SIZE exhibits a complex relationship with earnings management, where larger organizations, as observed by Mai and Ngoc (2021) have a positive relationship with earnings management whereas according to Kurniawati and Panggabean (2020), size may exert a negative influence on earnings management. Also, the equity-to-assets ratio (BVA) acts as an indicator of leverage, and asset turnover measures revenue generation efficiency (Budhathoki et al., 2020; Harebottle, 2016). These factors offer insights into a company's performance and influence its approach to earnings management. Furthermore, liquidity, as represented by the Current Ratio (CR), might play a role in discretionary accruals, while past profitability, measured through lagged return on assets (ROA_{t-1}), may influence profit-stabilization strategies driven by stakeholder expectations (Cudia & Dela Cruz, 2018; Cuong et al., 2018).

Data and Sample Selection

The Refinitiv Eikon (previously Thomson Reuters) database was used to gather accounting and financial data. The sample data cover an 11-year period from 2012 to 2022, however the actual range of years is 10 because the DA models track changes in the values of many variables. The first step was to choose all UK-listed firms with readily available accounting and financial data. It is axiomatic that the UK boasts a robust stock market with reliable data and regulatory monitoring that has adopted IFRS. The IFRS foundation also has a headquarter in the UK (IFRS Foundation, 2023). The primary condition was that companies with fewer than six firm-year observations as well as businesses with inadequate data to generate accruals-based EM measures were eliminated. Variable data whose values fall below the 1st percentile and above the 99th percentile was then eliminated in order to remove the effects brought on by outliers. In this way, winsorization was applied to each variable under study, making the study more reliable (Jain et al., 2021; Ramalingegowda et al., 2021). Therefore, the final sample consists of 404 listed companies and 11 industries, corresponding to 3,835 firm-year observations.

Data Analysis and Results

The Kruskal-Wallis test, a non-parametric test, is used to assess whether groups of readings are significantly different in order to warrant a study. As such, the results from the Kruskal-Wallis test reveal that the p-value (0.00) that the difference is significant, the null hypothesis of no difference between the industries is rejected and the result thus

International Journal of Management, Accounting and Economics
Volume 10, Issue 12, December 2023
ISSN 2383-2126 (Online)
DOI: https://doi.org/10.5281/zenodo.10659349
www.ijmae.com

favour the alternate hypothesis of having a significant difference between the industries. Previous studies has also used one sample t-test (Sun, 2009). However, the one sample t-test being a parametric test, requires that the data is normally distributed, which is not really the case for discretionary accruals. This is the reason why this study applies the Kruskal-Wallis test. Further non-parametric tests, the Friedman and the Kendall test as utilised by researchers (Bao & Bao, 2004; Ogutu, 2010), were run and they confirm significant differences in discretionary accruals between industries (p-value 0.00).

Following confirmation of significant differences between industries, the discretionary accruals, residuals of the models presented in methodology, are reported in the signed normal format and in their absolute format as well. It is possible that an industry mean with signed discretionary accruals is nearly zero, but in fact there is much variation. Thus, the absolute discretionary accruals are essential to be studied in Table 1 along with the signed discretionary accruals.

Table 1. Mean of signed and absolute winsorized Discretionary Accruals

	Mean of winsorized DA				Mean of winsorized absolute DA			
Industry	Kothari Model	Dechow Model	Kasznik Model	Average	Kothari Model	Dechow Model	Kasznik Model	Average
Education	-0.031	-0.019	0.008	-0.014	0.067	0.084	0.098	0.083
Basic Materials	-0.021	-0.088	-0.077	-0.062	0.061	0.113	0.108	0.094
C. Cyclicals	-0.026	-0.017	0.005	-0.013	0.074	0.101	0.094	0.089
C. Non-Cyclicals	0.006	-0.008	-0.015	-0.006	0.041	0.081	0.083	0.068
Energy	0.014	-0.109	-0.134	-0.076	0.077	0.149	0.159	0.128
Financials	0.007	0.143	0.159	0.103	0.106	0.155	0.160	0.140
Healthcare	-0.003	0.004	0.006	0.002	0.078	0.073	0.084	0.078
Industrials	-0.007	0.003	0.009	0.002	0.062	0.083	0.083	0.076
Real Estate	0.050	0.131	0.096	0.092	0.062	0.152	0.120	0.111
Technology	-0.061	0.003	0.062	0.001	0.095	0.083	0.109	0.096
Utilities	0.031	-0.059	-0.091	-0.040	0.036	0.093	0.121	0.083

Particularly noteworthy are the industries of Basic Materials, Energy, Financials and Real Estate which have emerged at the top of winsorized discretionary accruals whereas Energy, Financials, Real Estate and Technology emerged from winsorized absolute discretionary accruals, demonstrating their propensity for aggressive earnings management tactics. It is noted that Technology industry would not have been listed if the absolute discretionary accruals value not used. This variation would be best analysed in Table 2, using the standard deviation of each model and the average of the models.

International Journal of Management, Accounting and Economics
Volume 10, Issue 12, December 2023
ISSN 2383-2126 (Online)
DOI: https://doi.org/10.5281/zenodo.10659349
www.ijmae.com

Table 2. Standard Deviation of winsorized signed and absolute Discretionary Accruals

	Std Dev of winsorized DA				Std Dev of winsorized absolute DA			
Industry	Kothari Model	Dechow Model	Kasznik Model	Average	Kothari Model	Dechow Model	Kasznik Model	Average
Education	0.074	0.102	0.127	0.101	0.037	0.053	0.074	0.054
Basic Materials	0.080	0.115	0.116	0.104	0.056	0.091	0.088	0.079
C. Cyclicals	0.100	0.130	0.121	0.117	0.072	0.084	0.077	0.078
C. Non-Cyclicals	0.054	0.103	0.107	0.088	0.036	0.064	0.068	0.056
Energy	0.111	0.150	0.154	0.138	0.081	0.111	0.128	0.107
Financials	0.133	0.106	0.087	0.109	0.081	0.088	0.085	0.084
Healthcare	0.108	0.096	0.112	0.105	0.075	0.063	0.074	0.071
Industrials	0.084	0.107	0.106	0.099	0.057	0.068	0.066	0.064
Real Estate	0.047	0.110	0.103	0.087	0.028	0.078	0.074	0.060
Technology	0.122	0.111	0.126	0.120	0.098	0.074	0.089	0.087
Utilities	0.032	0.093	0.099	0.075	0.027	0.058	0.060	0.048

The sector of Academic & Educational Services clearly exhibits moderate variation across all three models in the examination of discretionary accruals. This implies that it may be as a result of variables like the various income sources and consistent accounting techniques used by educational institutions. The Basic Materials sector, in comparison, exhibits a modest amount of discretionary accrual variability but in absolute DA is among the top four. Both the Consumer Cyclicals and Consumer Non-Cyclicals industries show moderate to high variability in discretionary accruals in contrast to Ujah and Brusa (2014), reflecting the diverse nature of the enterprises in these industries. Companies operating in these areas could use different accounting procedures, which could result in bigger standard deviations. With particularly large standard deviations in discretionary accruals across all three models, the energy industry stands out and is a reflection of the complex and unstable accounting environment linked to variables like shifting commodity prices and regulatory changes. Contrarily, the Financials sector has low discretionary accruals variability based on one model but a noticeably greater standard deviation based on average of the 3 models, emphasising the possibility of unique features of financial reporting practises within this sector. While the Technology sector shows higher variability similar to Sun (2009), it is most likely a result of the rapid pace of technological change and its effects on various revenue recognition methods and accounting treatments. Healthcare, Industrials, and Real Estate sectors show moderate variability in discretionary accruals, indicating a relatively consistent pattern of financial reporting practises. As a result of its low to moderate fluctuation, the utilities sector, in contrast, suggests that the financial reporting environment in this sector is steady and constant.

Therefore, the standard deviation of the industries of Energy, Technology, Consumer cyclicals and Financials were largest, and the variance of the absolute discretionary accruals winsorized were greatest for Energy, Technology, Financials, and Basic Materials. This brings us to the subset of common connection among the top four of each

International Journal of Management, Accounting and Economics
Volume 10, Issue 12, December 2023
ISSN 2383-2126 (Online)
DOI: https://doi.org/10.5281/zenodo.10659349
www.ijmae.com

category, which thus are Energy and Financials followed closely by the Technology industry. The findings are novel to literature as Sun (2009) corroborated to only the findings of Technology industry. In order to assess the financial metrics effects on each discretionary accruals model, it is important to understand the impact of broad accounting ratios used as benchmarks in every industry. Table 3 subsequently shows the variables size, past profitability, leverage, efficiency and liquidity on discretionary accruals.

Table 3. Profitability, Leverage, Efficiency and Liquidity on Abs. Discretionary Accruals

	Dechow model	Kothari model	Kasznik model
SIZE	-0.0108***[2]	-0.0103***	-0.00826***
	(-3.37)	(-4.91)	(-3.42)
BVA	-0.0480***	-0.0405***	-0.0570***
	(-3.58)	(-4.63)	(-5.64)
CR	0.0009	(0.0004)	0.0012
	(1.01)	(-0.62)	(1.74)
AT	-0.0228***	-0.00898*	-0.0103*
	(-4.20)	(-2.53)	(-2.52)
$ROA_{i,t-1}$	0.0415*	0.0389***	0.0134
	(2.39)	(3.43)	(1.03)
Cons.	0.364***	0.291***	0.259***
	(5.31)	(6.50)	(5.01)
N	3,835	3,835	3,835
R^2	0.481	0.376	0.330
R^2_{adj}	0.419	0.300	0.249
F	6.677	9.532	8.524
p-value	0.000	0.000	0.000
AIC	(10,755)	(14,016)	(12,920)
BIC	(10,717)	(13,978)	(12,882)
Industry FE	Yes	Yes	Yes
Company FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

The Dechow model in Table 3 presents insights into the relationship between several key financial variables and absolute discretionary accruals. The size of an organisation is negatively related to discretionary accruals with a coefficient of 0.01. Although small, the coefficient is significant to 1% significance level. The Equity to Assets ratio (BVA) or inverse leverage is also negatively associated with the magnitude of discretionary accruals significant to the 1% significance level, showing that as leverage increases, the propensity to manage earnings increases. Asset turnover (AT) exhibit significant negative coefficients, implying that the greater asset turnover is associated with lower discretionary accruals. This suggests that companies with a more efficient asset utilization tend to have lower discretionary accruals, signifying more conservative financial reporting practices. The current ratio (CR) coefficient is relatively small and is

[2]* p<0.05, ** p<0.01, *** p<0.001; t statistics in parentheses

International Journal of Management, Accounting and Economics
Volume 10, Issue 12, December 2023
ISSN 2383-2126 (Online)
DOI: https://doi.org/10.5281/zenodo.10659349
www.ijmae.com

insignificant as per the p-value. Interestingly, lagged return on assets (ROAi,t-1) shows a positive coefficient, indicating that higher past profitability is linked to higher current discretionary accruals which is in line with Wasiuzzaman (2018) who state that "profitability influences the discretionary measure". The Dechow model maintains a quite a good fit with the data with a R-square of 48% indicating that variations in independent variables explain the variation of discretionary accruals (Kleiber & Zeileis, 2008).

The Kothari model aligns with the Dechow model in terms of the interpretation of size being negatively associated with discretionary accruals whereas leverage positively related to accruals earnings management which are in line with Tran (2022). This implies that when equity to assets ratio increases (leverage decreases), pressure to manage earnings decrease. On the other hand, the current ratio (CR) still has an insignificant take on the model. Similar to the Dechow model, past profitability reveals a positive coefficient, implying that a high profit last period is linked with higher current discretionary accruals probably to meet the expectations created by the past profits. The slight difference in the coefficient of asset turnover (AT) compared to the Dechow model does not preclude the significant negative relationship between AT and discretionary accruals. The F-statistic of the Kothari model combined with its significant p-value shows the model is significant and the lower AIC/BIC values shows a better fit with the data (Kleiber & Zeileis, 2008).

The Kasznik model aligns with the Dechow and Kothari models regarding the associations between Size and Equity over Assets (BVA) to discretionary accruals although there are slight differences. The asset turnover with the Kasznik model shows a significant negative coefficient in line with Jansen et al. (2012) and Harebottle (2016), indicating that higher asset turnover is associated with lower discretionary accruals. Current ratio was still insignificant with the Kasznik model and the main divergence from the other models was that past profitability was surprisingly also not significant. However, the Kasznik model did not have a high predictive power as denoted by the R-squared. As such, the highly cited Dechow and Kothari models take precedence in the analysis.

Discussion of Results

Research on the difference of discretionary accruals across industries is scarce. This paper agrees with Ikram (2011) where industry specific discretionary would influence the investor's ability of decision making, following evidence of non-parametric tests confirming the difference of discretionary accruals among industries. Analysis of the mean and standard deviation of signed and unsigned variances showed that consumer cyclical industries did not appear among the highest earnings management contrasting to Ujah and Brusa (2014). On the other hand, the Energy industry appeared as one of the industries with highest discretionary accruals, which is novel to literature and could be the results of volatility of prices, capital investments depreciation, environmental regulations amongst others. The results also showed that the technological industry had common high discretionary accruals corroborating with Sun (2009) with possible explanations relating to its dynamic business environment and modern organisational structures. Furthermore, the Financials industry was also reported to be among the high

International Journal of Management, Accounting and Economics
Volume 10, Issue 12, December 2023
ISSN 2383-2126 (Online)
DOI: https://doi.org/10.5281/zenodo.10659349
www.ijmae.com

discretionary accruals industries despite Hrazdil and Scott (2013) mentions that Financials industry is a regulated industry. However, potential explanations could include the unique nature of the financials industry including complex financial instruments measurement and presentation amongst others.

Size is negatively related to earnings management in concurrence with Tran (2022) and Mai and Ngoc (2021). This might be explained by the increased scrutiny by various committees of a larger firm compared to a smaller firm. This evidence contrasts the findings of Kurniawati and Panggabean (2020) due to potentially the country studied. Asset turnover is negatively related to discretionary accruals, relating to efficiency of using assets to generate revenue being a deterrent to discretionary accruals which is consistent with past research (Harebottle, 2016; Jansen et al., 2012). A high asset turnover means that a company is performing well and thus, managers do not feel the need to manage earnings. Current Ratio unanimously remains insignificant contrary to the findings of Cuong et al. (2018). Past profitability increases the pressure to manage earnings in the current period, thus there is a positive correlation between past profitability and current discretionary accruals. This is similar to the findings of Mohaghegh (2015), nonetheless Kapoor and Goel (2017) mention that managers of a profit-making business do not have incentive to manage earnings. Yet, this paper argues that past profitability generates expectation and thus is positively related to current discretionary accruals in this study. Furthermore, the higher the equity ratio (lower leverage), the lower the magnitude of discretionary accruals tend to be which is in line with Hoang and Phung (2019) whereby leverage was positively related to discretionary accruals but contrary to Awuye and Aubert (2022). This paper's findings are consistent with the debt covenant theory indicates that with higher leverage, there is a tighter scrutiny from all fronts. However, there is a trade-off between leverage and managing discretionary accruals, and it is seen that higher leverage could mean debt covenant violations or bankruptcy risk and thus generates pressure on management in agreement with Lazzem and Jilani (2018).

Robustness Tests

Following criticism of other approaches, the cash flow approach as concluded by Suk Yoon et al. (2022) was used in this study. The different models highlight the sensitivity of discretionary accruals to the chosen model specifications and underlying assumptions when using the signed discretionary accruals since companies may use smoothing techniques when profits are uneven or when profits are low, management may decrease discretionary accruals, thereby inflating earnings (Wasiuzzaman, 2018). It is essential to recognise that each model may emphasize different aspects of financial reporting behaviour, leading to differences in coefficients and model performance. In order to be robust in terms of sensitivity analysis, the study adopted a battery of non-parametric tests, studied both the signed and unsigned discretionary accruals and in later stages, preferred the use of absolute discretionary accruals in fixed effects regressions to mitigate sensitivity concerns when uncovering potential relationships. Thus, each variable showed the propensity of a probable increase in discretionary accruals with the increase in one unit of the variables. In order to control for other differences such as economy, industry, year differences, the fixed effects regression models were employed which have been adopted in literature (Alves, 2021; Khuong & Anh, 2022). The removal of the

International Journal of Management, Accounting and Economics
Volume 10, Issue 12, December 2023
ISSN 2383-2126 (Online)
DOI: https://doi.org/10.5281/zenodo.10659349
www.ijmae.com

insignificant variable (CR) did not influence the significance of the results of the remaining equation.

Implications for Investors and Analysts

For investors and financial analysts, understanding the standard deviation of discretionary accruals within an industry is crucial. High variability may indicate that financial statements in that industry are less predictable and may require deeper scrutiny. Conversely, low variability suggests a more stable and consistent financial reporting environment, which can be reassuring to stakeholders. It is essential to consider the specific characteristics of each industry when interpreting these standard deviations. Factors like industry regulations, business models, and market dynamics can all influence the variability of discretionary accruals. As such, understanding financial metrics from industry benchmarks such as asset turnover, size and leverage may provide for essential information for investors. Consequently, a differentiated approach to analysing discretionary accruals is essential for making informed investment and financial decisions. This paper provides thus provides a framework to identify 'risky' discretionary accruals' industries and to peruse industry ratios prior to taking decisions.

Conclusion

This research had a principal aim of understanding the intricate web of accruals earnings management practices that are unique to different industries and to identify the financial metrics in common industry benchmarks which influence discretionary accruals. This was undertaken in an effort to highlight how these practises eventually affect the accuracy and reliability of financial statements, which might have significant repercussions. Discretionary accruals can mask the real financial picture when used improperly, confusing stakeholders.

Discretionary accruals were examined for a multi-year dataset from 2013 to 2022. The dataset, which originated from a principles-based economy (UK) and covering a wide range of economic sectors, offered a solid framework for this investigation. This study included the well cited Dechow, Kothari and Kasznik models of discretionary accruals. The battery of non-parametric tests exposed the differences between industries. A set of statistical tests around mean and standard deviation of signed and unsigned discretionary accruals was undertaken. The industries which appeared to be in most of the lists were Energy, Financials and followed closely by Technology.

The fundamental causes of these sector-specific differences in discretionary accruals practices are also explored in the study. Critical indicators such as size of firm, book value of equity over assets, past profitability, asset turnover have all been carefully evaluated and were significant in the model. However, liquidity appeared to have little impact on discretionary accruals. Furthermore, robustness tests were carried out following the fixed effects regressions to help with sensitivity analyses.

The information uncovered by this research is essential for regulators, investors, and financial analysts. The users of financial statements would have a thorough awareness of

the variations in discretionary accruals that are specific to each industry, enabling them to develop appropriate tools and policies to make better informed decisions.

Limitations of study and Future Research

The financial environment is dynamic, and this paper's analysis is based on data of only one country. However, the author utilised data up to year 2022 and is deemed to be timely. Future investigations could research the particular drivers and effects of discretionary accruals practices for a wider range of countries. Furthermore, an interesting area for future study is the effect of individual external events, such as legislative changes or economic vicissitudes, on discretionary accruals. These were robustly controlled with year, industry and firm fixed effects regressions in this study. Therefore, future studies could adopt a different methodology to understand external events.

Abbreviations (Nomenclature)

β_i (1,2,3 ... k)	Regression coefficients
IFRS	International Financial Reporting Standard
Eq.	Equation
F	Fisher test
H_0	Null hypothesis
K	Number of explanatory variables included in the model
N	Sample size
p-value	Probability value
R^2	Coefficient of determination
$R^2{}_{adj}$	Adjusted coefficient of determination

References

Acar, G., & Coskun, A. (2020). A Comparison of Models for Predicting Discretionary Accruals: A Cross-Country Analysis. *The Journal of Asian Finance, Economics and Business*, *7*(9), 315–328.

Al-Shattarat, B. (2021). The consequence of earnings management through discretionary accruals on the value relevance in Saudi Arabia. *Cogent Business & Management*, *8*(1), 1886473.

Altarawneh, M., Shafie, R., Ishak, R., & Ghaleb, B. A. A. (2022). Chief executive officer characteristics and discretionary accruals in an emerging economy. *Cogent Business & Management*, *9*(1), 2024117.

Alves, S. (2021). CEO duality, earnings quality and board independence. *Journal of Financial Reporting and Accounting*, *21*(2), 217–231. https://doi.org/10.1108/jfra-07-2020-0191

Awuye, I. S., & Aubert, F. (2022). The impact of leverage on earnings management and the trade-off between discretionary accruals and real earnings management. *Journal of Accounting and Taxation*, *14*(1), 89–101.

Bao, B., & Bao, D. (2004). Income Smoothing, Earnings Quality and Firm Valuation. *Journal of Business Finance & Accounting*, *31*(9–10), 1525–1557. https://doi.org/10.1111/j.0306-686X.2004.00583.x

Budhathoki, P. B., Rai, C. K., Lamichhane, K. P., Bhattarai, G., & Rai, A. (2020). The impact of liquidity, leverage, and total size on banks' profitability: Evidence from nepalese commercial banks. *Journal of Economics and Business*, *3*(2). https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3577453

Chang, H.-Y., Liang, L.-H., & Yu, H.-F. (2019). Market power, competition and earnings management: Accrual-based activities. *Journal of Financial Economic Policy*, *11*(3), 368–384. https://doi.org/10.1108/JFEP-08-2018-0108

Chi, J. D., & Gupta, M. (2009). Overvaluation and earnings management. *Journal of Banking & Finance*, *33*(9), 1652–1663.

Cudia, C. P., & Dela Cruz, A. L. C. (2018). Determinants of earnings management choice among publicly listed industrial firms in the Philippines. *DLSU Business & Economics Review*, *27*(2), 119–129.

Cuong, T., Ha, N.-T., & Thi, N. (2018). Influence of financial ratios on earnings management: Evidence from Vietnam Stock Exchange Market. *Journal of Insurance and Financial Management*, *4*(1), 57–77.

D'Amato, A., & Falivena, C. (2020). Corporate social responsibility and firm value: Do firm size and age matter? Empirical evidence from European listed companies. *Corporate Social Responsibility and Environmental Management*, *27*(2), 909–924. https://doi.org/10.1002/csr.1855

Dechow, P. M., Hutton, A. P., Kim, J. H., & Sloan, R. G. (2012). Detecting earnings management: A new approach. *Journal of Accounting Research*, *50*(2), 275–334.

Dechow, P. M., Sloan, R. G., & Sweeney, A. P. (1995). Detecting earnings management. *Accounting Review*, 193–225.

Gonçalves, T., Gaio, C., & Ferro, A. (2021). Corporate social responsibility and earnings management: Moderating impact of economic cycles and financial performance. *Sustainability*, *13*(17), 9969.

Harebottle, J. L. (2016). *Identifying earnings management using changes in asset turnover and profit margin* [PhD Thesis]. https://wiredspace.wits.ac.za/items/1838aacd-8490-4912-8856-39f3d7717fdc

Hoang, K. M. T., & Phung, T. A. (2019). The effect of financial leverage on real and accrual-based earnings management in Vietnamese firms. *Economics & Sociology*, *12*(4), 299–333.

Hrazdil, K., & Scott, T. (2013). The role of industry classification in estimating discretionary accruals. *Review of Quantitative Finance and Accounting*, *40*, 15–39.

IFRS Foundation. (2023). *IFRS - Who we are*. https://www.ifrs.org/about-us/who-we-are/

Ikram, A. (2011). *Industry-Specific Discretionary Accruals and Earnings Management* [PhD Thesis]. Arizona State University.

Jain, A., Jackson, D., & Sakaki, H. (2021). Political, economic, financial uncertainty, and real earnings management. *Journal of Corporate Accounting & Finance*, *32*(2), 52–66. https://doi.org/10.1002/jcaf.22485

Jamadar, Y., Ong, T. S., Abdullah, A. A., & Kamarudin, F. (2022). Earnings and discretionary accruals. *Managerial and Decision Economics*, *43*(2), 431–439.

Jansen, I. Ph., Ramnath, S., & Yohn, T. L. (2012). A Diagnostic for Earnings Management Using Changes in Asset Turnover and Profit Margin*: A Diagnostic for Earnings Management. *Contemporary Accounting Research*, *29*(1), 221–251. https://doi.org/10.1111/j.1911-3846.2011.01093.x

Kapoor, N., & Goel, S. (2017). Board Characteristics, Firm Profitability and Earnings Management: Evidence from India. *Australian Accounting Review*, *27*(2), 180–194. https://doi.org/10.1111/auar.12144

Kasznik, R. (1999). On the association between voluntary disclosure and earnings management. *Journal of Accounting Research*, *37*(1), 57–81.

Khuong, N. V., & Anh, L. H. T. (2022). The mediating mechanism of earnings management on the relationship between life cycle and financial reporting quality: Finding from MRA and fsQCA. *Business Strategy & Development*, *5*(4), 375–389. https://doi.org/10.1002/bsd2.205

Kim, S.-S., & Lee, J.-H. (2019). Corporate social responsibility and financial reporting quality: Evidence from Korean retail industry. *Journal of Distribution Science*, *17*(6). https://repository.hanyang.ac.kr/handle/20.500.11754/151530

Kleiber, C., & Zeileis, A. (2008). *Applied Econometrics with R*. Springer Science & Business Media.

Kothari, S. P., Leone, A. J., & Wasley, C. E. (2005). Performance matched discretionary accrual measures. *Journal of Accounting and Economics*, *39*(1), 163–197.

Kurniawati, A., & Panggabean, R. R. (2020). Firm Size, Financial Distress, Audit Quality, and Earnings Management of Banking Companies. *Proceedings of the 1st Borobudur International Symposium on Humanities, Economics and Social Sciences (BIS-HESS 2019)*. https://doi.org/10.2991/assehr.k.200529.086

Lazzem, S., & Jilani, F. (2018). The impact of leverage on accrual-based earnings management: The case of listed French firms. *Research in International Business and Finance*, *44*, 350–358. https://doi.org/10.1016/j.ribaf.2017.07.103

Lin, H.-L., & Yen, A.-R. (2022). Auditor rotation, key audit matter disclosures, and financial reporting quality. *Advances in Accounting*, *57*, 100594.

Mai, D. D. T. V. T., & Ngoc, T. (2021). Too big to cheat? An empirical study of the impact of firm size on earnings management in Vietnam. *Journal of Contemporary Issues in Business and Government*, *27*(5), 234–247.

Mascarenhas, D., Cahan, S. F., & Naiker, V. (2010). The Effect of Audit Specialists on the Informativeness of Discretionary Accruals. *Journal of Accounting, Auditing & Finance*, *25*(1), 53–84. https://doi.org/10.1177/0148558X1002500103

Mohaghegh, A. (2015). Earnings management checked between changes in profit margins and asset turnover ratio. *International Journal of Innovation and Applied Studies*, *10*(3), 1028.

Moscariello, N., Fera, P., & Cinque, E. (2020). The information content of discretionary accruals during systemic crises. *Journal of Applied Accounting Research*, *21*(3), 455–476. https://doi.org/10.1108/JAAR-04-2018-0054

Negkakis, I. (2021). *Financial accounting for the shipping industry* [PhD Thesis, University of Bath]. https://ethos.bl.uk/OrderDetails.do?uin=uk.bl.ethos.828322

Ogutu, J. O. (2010). *Institutional investors perception of information disclosed in financial reports of companies listed in the Nairobi Stock Exchange* [PhD Thesis, University of Nairobi, Kenya]. http://erepository.uonbi.ac.ke/handle/11295/5929

Palacios-Manzano, M., Gras-Gil, E., & Santos-Jaen, J. M. (2021). Corporate social responsibility and its effect on earnings management: An empirical research on Spanish firms. *Total Quality Management & Business Excellence*, *32*(7–8), 921–937. https://doi.org/10.1080/14783363.2019.1652586

Pham, H. Y., Chung, R. Y.-M., Roca, E., & Bao, B.-H. (2019). Discretionary accruals: Signalling or earnings management in Australia? *Accounting & Finance*, *59*(2), 1383–1413.

Ramalingegowda, S., Utke, S., & Yu, Y. (2021). Common Institutional Ownership and Earnings Management*. *Contemporary Accounting Research*, *38*(1), 208–241. https://doi.org/10.1111/1911-3846.12628

Roy, C., & Debnath, P. (2015). Opportunistic Use of Accrual Earnings in Financial Reporting: A Study of BSE Listed Firms in India. *International Journal of Computational Engineering & Management*, *18*(4), 9–15.

Sitanggang, R. P., Karbhari, Y., Matemilola, B. T., & Ariff, M. (2019). Audit quality and real earnings management: Evidence from the UK manufacturing sector.

International Journal of Managerial Finance, *ahead-of-print*. https://doi.org/10.1108/IJMF-03-2018-0095

Suk Yoon, S., Kim, H. J., & Woodruff, G. S. (2022). A critical evaluation of the Jones models and the industry approach for the estimation of discretionary accruals. *Asia-Pacific Journal of Accounting & Economics*, *29*(2), 432–450.

Sun, L. (2009). *An investigation of earnings management practices in Australian firms* [PhD Thesis, Curtin University]. http://espace.curtin.edu.au/handle/20.500.11937/2113

Tran, D. T. H. (2022). The impact of firm characteristics on accrual-based earnings management: The case of listed companies in the manufacturing industry. *VNUHCM Journal of Economics, Business and Law*, *6*(3), Article 3. https://doi.org/10.32508/stdjelm.v6i3.931

Ujah, N. U., & Brusa, J. (2014). Earnings Management, Financial Leverage, and Cash Flow Volatility: An Analysis by Industry. *Journal of Business and Economics*, *5*(3), 338–348. https://doi.org/10.15341/jbe(2155-7950)/03.05.2014/005

Wasiuzzaman, S. (2018). Industry characteristics and earnings management: A study of Malaysian industries. *International Journal of Emerging Markets*, *13*(5), 837–854. https://doi.org/10.1108/IJoEM-09-2017-0336

Yuan, R., Cheng, Y., & Ye, K. (2016). Auditor industry specialization and discretionary accruals: The role of client strategy. *The International Journal of Accounting*, *51*(2), 217–239.

HOW TO CITE THIS ARTICLE

Geerawo, T. (2023). Discretionary Accruals-Earnings Management Across Industries: Implications for Financial Reporting Quality. *International Journal of Management, Accounting and Economics*, *10*(12), 1039-1057.

DOI: https://doi.org/10.5281/zenodo.10659349

URL: https://www.ijmae.com/article_190037.html