1. Introduction  
   In today's business world, disruptive technologies have significantly reshaped various sectors, particularly in finance and accounting. The advent of digital transformation has been instrumental in driving value creation and competitive advantage. Technologies such as artificial intelligence, machine learning, cloud computing, blockchain, and robotic process automation (RPA) have particularly impacted the finance and accounting functions, reflecting the rapid evolution in this domain (Moll and Yigitbasioglu 2019).

A pivotal example of such technological influence is the introduction of enterprise resource planning systems (ERP). ERPs have revolutionized financial operations, enhancing cross-functional integration, centralizing control, and advancing automation. (Scapens and Jazayeri 2003; Matolcsy et al. 2005; Nicolaou and Bhattacharya 2008; Kanellou and Spathis 2013). This transformation has led to more efficient financial reporting and transparency, where accounting transactions are easily traceable and financial reports are generated automatically, marking a shift from manual to automated processes (Sutton 2006).

Empirical evidence supports the positive impact of such technologies. The integration of ERP systems has been extensively analyzed, showcasing its diverse impacts on organizations. The immediate value of these systems is evident through positive market responses post-implementation (Hayes et al. 2001). Furthermore, ERP adoption is correlated with enhanced financial performance, indicating its significant economic benefits (Hitt et al. 2002). In terms of operational efficiency, ERP systems have been shown to significantly improve business process effectiveness (Hunton et al. 2003). The strategic implications of ERP on corporate finances, especially in areas like earnings management, have been thoroughly examined, presenting a comprehensive view of its influence beyond traditional performance measures (Morris 2010). Additionally, Paredes and Wheatley (2018) extend this examination by investigating how the increase in managers' access to accounting data via ERP systems influences managerial behavior, particularly regarding real activities manipulation. Their findings suggest that after the implementation of an ERP, earnings management through real activities declines, indicating that ERP implementations enhance the quality of financial reporting by constraining opportunistic managerial behavior. This underscores the multifaceted benefits of ERP systems, not only in improving financial and operational performance but also in promoting more transparent and reliable financial reporting practices.

Despite extensive research on ERP systems, Robotic Process Automation (RPA) in accounting is a nascent field. Current literature predominantly explores theoretical aspects and potential impacts of RPA on accounting and auditing, primarily utilizing secondary data to understand its role in the digitization of accounting and interaction with related technologies (Tiron-Tudor et al. 2023). Although recent studies have ventured into qualitative analyses, examining motivations for RPA adoption and its broader implications for the accounting profession (Fernandez and Aman 2018; Moffitt et al. 2018; Zhang 2019; Asatiani et al. 2020; Korhonen et al. 2021), studies employing quantitative methodologies are conspicuously sparse.

This research examines the effect of Robotic Process Automation (RPA) on different facets of earnings management, specifically focusing on real activities manipulation (denoted as RM) and accrual-based earnings management (denoted as AM), which are key aspects of financial integrity and corporate governance. Our multivariate regression analysis reveals a nuanced impact of Robotic Process Automation (RPA) on EM. We find a significant reduction in RM with RPA implementation, suggesting its role in promoting ethical financial reporting by automating processes and enhancing transparency. However, there's no direct link between RPA and AM. Interestingly, firms utilizing RPA with restrained AM practices also show lesser RM, indicating an indirect influence of RPA on promoting broader ethical financial practices. Furthermore, our study uses various proxies and employs the propensity score matching method in our regression analysis to ensure the robustness of our findings. This approach helps to mitigate potential biases and provides a more accurate assessment of RPA's impact on RM.

This pioneering empirical study utilizing model regression analysis to explore RPA's impact on EM highlights its significance for various stakeholders, including industry professionals, policymakers, and academic researchers. For industry professionals, the findings suggest integrating RPA can lead to more ethical financial practices. Policymakers may consider these insights to guide regulatory frameworks that encourage transparency and integrity. For researchers, this study opens new avenues for investigating RPA's effects across business sectors. It underscores the importance of RPA in advancing financial transparency and integrity in the digital age, marking a significant contribution to both academic dialogue and practical application.  
  
The remaining sections of this study is as follows: The second section is literature reviews and development of hypotheses; the third part is sample selection and research design; the fourth section is the univariate and multivariate results, the fifth section is additional analyses; and the last section is the conclusion of this study.

1. Literature Review & Development of Hypotheses
   1. What is RPA?  
      Robotic Process Automation (RPA) is a transformative technology that automates manual, rule-based, and repetitive tasks by mimicking human interactions with digital systems. According to UiPath, leading RPA software provider, RPA is designed to operate across various applications and systems without modifying existing infrastructures, emphasizing efficiency and productivity enhancements by automating mundane tasks (UiPath Website). This aligns with Jędrzejka (2019), who discusses RPA's role in automating tasks that were traditionally manual, enhancing operational efficiency and allowing employees to focus on more strategic tasks.  
        
      The finance and accounting sector, as outlined by Jędrzejka (2019) and supported by Fernandez and Aman (2018), has been the primary adopter of RPA technologies. This sector has utilized RPA to automate tasks such as transaction processing, audit preparation, and financial reporting, driven by the sector's need for precision and the high volume of repetitive transactions. The accounting department, in particular, benefits from RPA's ability to execute tasks with high accuracy and efficiency, addressing the industry's challenge of managing routine, error-prone tasks.  
        
      RPA's benefits, particularly in finance and accounting, are manifold. Jędrzejka (2019) and Le Clair (2017) highlight RPA's potential to reduce operational costs, enhance process speed, and improve accuracy. RPA's ability to operate continuously, its scalability, and ease of implementation make it a valuable tool for the sector. These benefits directly address the needs of the accounting department, emphasizing RPA's role in transforming the industry by making operations more efficient and reducing the likelihood of errors in financial reporting.
   2. Automation Tools: from ERP to RPA  
      Enterprise Resource Planning (ERP) systems have been foundational in automating business processes, as discussed by Shehab et al. (2004) and Al-Jabri and Roztocki (2015). These systems have enabled significant improvements in productivity, data sharing, and decision-making across organizations. ERP systems have streamlined financial data integration, inventory management, and resource planning, contributing to operational efficiency and improved decision-making capabilities. (Jędrzejka 2019; Sutton 2006).  
        
      In terms of finance and accounting, as noted by Jędrzejka (2019), ERP systems have facilitated an unprecedented level of cross-functional integration, centralized control, and automation. This has led to considerable efficiency improvements, revolutionizing how accounting transactions are managed. Specifically, ERP systems have enabled the detailed tracking of accounting transactions to individual employees or specific events, such as scanning a barcode, enhancing accountability and traceability within financial operations. Moreover, the automation capabilities of ERP systems have transformed the generation of financial reports. As highlighted by Sutton (2006), financial reports, which traditionally required intensive manual effort by teams of accountants, are now increasingly generated automatically. This shift results from ERP systems' ability to encode procedures and rules into the software, thereby streamlining the reporting process. This evolution has not only improved efficiency but also reduced the potential for human error, leading to more accurate and reliable financial reporting.   
        
      However, ERP systems' limitations become apparent in handling highly repetitive, rule-based tasks requiring interactions with multiple systems, often necessitating manual intervention (Tiron-Tudor et al., 2023). RPA addresses these limitations by automating such tasks without the need for direct system integration, serving as a complementary technology to ERP. This combination enhances the automation capabilities within finance and accounting departments, particularly in improving data processing transparency and data quality, essential for financial reporting and earnings management (Jędrzejka, 2019; Al-Jabri and Roztocki, 2015).

Namely, RPA acts as a vital extension and complementary role to ERP systems, specifically targeting the automation of tasks that ERP systems struggle with due to their rigid structure, particularly in handling specific, repetitive tasks like data entry and report generation. By operating at the user interface level, RPA seamlessly fills this flexibility gap without the need to modify existing systems, ensuring tasks are performed with greater speed and accuracy. This capability enhances organizational efficiency, data accuracy, and transparency in finance and accounting, thereby supporting earnings management and boosting competitiveness. Importantly, both ERP and RPA technologies are united by their core objective to elevate operational efficiency and data accuracy within organizations. While ERP systems provide a comprehensive integration and automation of core business processes to ensure data consistency and aid in decision-making, RPA complements these functions by addressing the automation of rule-based, repetitive tasks, minimizing errors, and liberating human resources for more strategic roles. (Jędrzejka, 2019; Shehab et al., 2004).

* 1. Earnings Management with automation tools  
     EM, according to Healy and Wahlen (1999), can be divided into two main types: accruals-based management and real earnings management. AM allows managers to influence reported earnings through the accounting flexibility. On the other hand, RM involves managerial actions that alter the timing or structure of real business operations.   
       
     Exploring the Robotic Process Automation (RPA) and EM relationship opens a novel research avenue. With scant direct empirical evidence linking RPA, especially to EM, we're charting new territory rather than facing a traditional limitation. RPA's role in boosting operational efficiency and data accuracy in finance mirrors the documented benefits of Enterprise Resource Planning (ERP) systems. Although prior studies have shed light on ERP's effects on EM, RPA's specific impact awaits thorough exploration. Viewing RPA as an ERP extension, especially in tasks challenging for ERP, frames this gap as an alternative research path. This stance enables leveraging ERP studies as a base, while considering RPA's unique potential in EM. The subsequent sections will detail prior ERP and both types of EM research and propose hypotheses connecting RPA to earnings management. This approach not only bridges the current knowledge gap but also sets the stage for future work, aiming to broaden our grasp of automation's role in financial practices.  
     1. Accrual-based earnings management with automation tools  
        The integration of technological advancements in accounting and financial reporting processes, particularly through Enterprise Resource Planning (ERP) systems and Robotic Process Automation (RPA), has been a subject of academic interest and debate for several decades. This interest has been partly driven by the evolving nature of internal controls and the potential of these technologies to influence earnings management practices. The advent of RPA, despite being a relatively newer field of study, necessitates a nuanced understanding of its implications on financial reporting quality and earnings management, drawing parallels and distinctions from ERP implementations.  
          
        Brazel and Dang (2008) initiate this discourse by highlighting the dual-faceted impact of ERP systems on earnings management. They argue that while ERPs can enhance the financial reporting process and managerial decision-making through accurate and timely information provision (Poston & Grabski, 2001), they also afford management greater discretion over financial information, potentially exacerbating earnings management practices. This assertion is grounded in the belief that enhanced internal information asymmetry and managerial access to financial data could embolden discretional accruals to meet market expectations (Graham et al., 2006).

Contrary to Brazel and Dang's findings, subsequent research by Morris (2010) presents a more nuanced view. They report a reduction in accrual-based earnings management post-ERP implementation, attributed to improved internal controls and audit quality, potentially as a response to regulatory changes such as the Sarbanes-Oxley Act. Morris (2011) further reinforces this perspective by suggesting that the structured nature of ERP systems, coupled with stringent compliance requirements, bolsters the effectiveness of internal controls over financial reporting.  
  
Drawing parallels to RPA, the research by Ashraf (2024) extends the discussion to automation technologies at large, documenting an improvement in financial reporting quality through a reduction in internal control weaknesses. However, Ashraf's inability to differentiate the impacts of various automation technologies, including machine learnings, artificial intelligence, and RPA, underscores a gap in the literature. Specific for the RPA, this gap is critically discussed by Hong et al. (2023), who elucidate the distinct risks and control challenges posed by RPA, emphasizing its operational and managerial separation from traditional IT governance frameworks.  
  
Given the aforementioned discourse, it is evident that RPA embodies a complementary yet distinct role in financial reporting and internal control landscapes. While ERP systems have been extensively studied for their impact on earnings management, the unique characteristics and deployment contexts of RPA necessitate a separate inquiry. Particularly, the decentralized management and highly customized nature of RPA solutions present both opportunities and challenges for earnings management practices. Therefore, in light of the mixed outcomes from ERP-related studies and the nascent but insightful research on RPA, we propose the following hypothesis:  
  
Hypothesis: he implementation of Robotic Process Automation will not be associated with earnings management through discretionary accruals.  
  
This hypothesis is predicated on the assumption that RPA, while enhancing operational efficiencies and potentially improving internal control environments, does not inherently provide management with increased opportunities to influence earnings through discretional accruals. This stance is further supported by the evolving nature of internal controls and audit practices in response to technological advancements, suggesting a more sophisticated and nuanced relationship between automation technologies and earnings management.  
  
In developing this hypothesis, it is crucial to acknowledge the complementary roles of ERP and RPA within the broader context of technological integration in financial reporting processes. While ERP systems have paved the way for standardized, integrated information systems, RPA offers a layer of agility and customization, addressing specific operational efficiencies outside the traditional scope of ERP systems. The interaction between these technologies, coupled with regulatory and governance frameworks, forms the bedrock of our understanding of how automation influences earnings management practices.  
  
As this field of research evolves, future studies should aim to disentangle the effects of different types of automation technologies on earnings management, focusing on the specific mechanisms through which RPA influences internal controls and managerial discretion. Additionally, the role of regulatory compliance, particularly in the post-SOX era, warrants further examination to understand how governance frameworks adapt to and influence the adoption and impact of technologies like RPA on earnings management practices.

* + 1. Real activities manipulation with automation tools  
       Given that Lenard et al. (2016) identified a positive relationship between firms reporting internal control weaknesses (ICWs) and real activities manipulation, and those firms utilizing RM to meet earnings benchmarks exhibit lower performance in subsequent years, it is evident that ICWs significantly contribute to the propensity for RM as a form of EM. This inclination towards RM among ICW-firms underscores the challenge of maintaining robust internal controls to mitigate earnings management through operational means.  
         
       Morris (2011) complements this understanding by showing that firms implementing ERP systems are less likely to report ICWs compared to non-ERP-implementing firms. This suggests that ERP systems might enhance internal control quality, thereby reducing the likelihood of RM by improving the accuracy and reliability of financial reporting and operational efficiency.  
         
       H2: The firm with RPA implementation will be less likely to engage in RM.

1. Sample Selection and Research Design
   1. Main interest of variable: RPA implementation Indicator   
      Building on this foundation, our study specifically targets the domain of RPA technology adoption. The approach mirrors the document analysis strategy utilized by Paredes and Wheatley (2018) in their examination of ERP implementations through 10-K SEC filings. Their meticulous analysis, which highlights the insights that can be garnered from corporate disclosures despite potential biases, serves as a methodological benchmark for our work.  
        
      Employing a systematic keyword search strategy within the digital annual reports of firms listed on Taiwan Stock Exchange (TSE) or Gre Tai Securities Market (OTC), we aim to compile an exhaustive dataset on RPA implementation. This strategy is enabled by the digital accessibility and legal requirement for these firms to submit their annual reports electronically, which facilitates a more efficient and accurate data extraction process. The search terms included "Robotic Process Automation," "RPA," and its Mandarin counterpart "機器人流程自動化," ensuring that our identification of relevant disclosures was as precise as possible.  
        
      In addition, our methodology assumes continuity in RPA initiatives; if a firm reported RPA adoption in one year, we marked it as continuing its RPA engagement (indicator denoted as 1) in the following year, even if the subsequent report did not explicitly mention RPA. This approach acknowledges the ongoing impact of RPA projects, if once a firm embarks on RPA, the effects and implementations are sustained over time. This assumption allows for a deeper analysis of the influence and permanence of RPA technology within firms.
   2. Sample  
      In our study, we meticulously outlined the selection and classification of sample firms that have adopted RPA between 2017 and 2022, as detailed across three distinct panels. Panel A elucidates the selection steps, beginning with an analysis of text from annual reports, ensuring that each company was publicly listed during the specified period, and belonged to an industry with at least 15 firm-year observations for EM proxies calculation, resulting in 83 unique firms. Notably, financial institutions coded with M2800 were excluded, despite their potential prevalence in our sample. Panel B further categorizes these firms by industry, revealing a diverse representation across 21 different sectors according to the TSE industry codes. Lastly, Panel C delves into the implementation timeline, offering a year-by-year breakdown of RPA adoption among these firms from 2017 to 2022, thereby providing a comprehensive overview of our sample selection methodology and the industry-wide spread of RPA utilization.

Following Morris (2010) and Paredes and Wheatley (2018), we match another 83 comparable individual firms without RPA implementation as a control group, based on the pairing criteria of the same industry code and closest average total assets during sample periods from 2017 to 2022.

* 1. Accrual-based Earnings Management

In the analysis of AM, the absolute value of discretionary accruals is employed as a proxy, reflecting the dual potential for managers to manipulate earnings both upwards and downwards. This choice is supported by seminal studies (e.g., Jones 1991; Becker et al. 1998), emphasizing the significance of capturing the full spectrum of AM activities. The estimation of these discretionary accruals is conducted using modified Jones model. The differences are considered to represent the discretionary component of accruals (see Appendix A for details), thereby serving as an indicator of AM. This methodology underscores the nuanced understanding that earnings manipulation can involve both overstatements and understatements, aiming to provide a comprehensive measure of such practices.

* 1. Real Activities Manipulation

Drawing upon established research, this study employs proxies for RM as Zang (2012). These proxies—abnormal production costs (ABPROD) and abnormal discretionary expenses (ABEXP)—serve as indicators of managerial strategies aimed at influencing financial reports to meet earnings expectations. (see Appendix A for details) This framework identifies key manipulative tactics, including overproduction, and discretionary spending cuts, as mechanisms for short-term earnings enhancement at potential long-term detriment. As the concerns Zang (2012) mentioned, another proxy abnormal cash flows delineated by Roychowdhury (2006) is featured by its ambiguous net effect and manipulation directions. As a results, we also exclude this proxy as a RM measurement in our research.   
  
Moreover, this study introduces a combined measure (RM) that aggregates the three proxies to offer a comprehensive view of managerial manipulation impacts on financial reporting. This approach, rooted in the methodologies of prior research like Cohen and Zarowin (2010), aims to provide a nuanced understanding of real activities manipulation and its consequences for financial integrity and governance.

* 1. Empirical Models

Building on the methodologies of previous studies such as Zang (2012) and Chen et al. (2012), we apply simultaneous equations for AM and RM to address potential endogeneity issues that could lead to biased and inconsistent coefficient estimations through Ordinary Least Squares (OLS). Diverging from the Hausman test traditionally used to ascertain the presence of endogeneity in the equations, we adopt an alternative approach. Initially, we regress AM and RM on the exogenous (control) variables of each equation model to calculate the residuals of AM and RM. Subsequently, we regress AM (RM) on RM (AM) along with the residuals of RM (AM) to assess whether the coefficient of the residuals equals zero. A non-zero coefficient of the residuals allows us to reject the null hypothesis that RM (AM) is exogenous in the equation, indicating a correlation between the error term and RM (AM). This finding prompts the selection of the Two-Stage Least Squares (2SLS) method to mitigate endogeneity bias inherent in OLS.   
  
Following the precedents set by Cohen and Zarowin (2010) and Zang, as well as Chen et al. (2012), we meticulously consider common control variables for both equations, alongside variables specific to AM and RM. This approach is to construct simultaneous equations that accurately capture the relationship between earnings management (EM) and RPA implementation, ensuring a comprehensive analysis that accounts for both shared and unique factors influencing the two types of earnings management.  
Below simultaneous equations aim to test for the within RPA implementers group:

Below simultaneous equations, on the other hand, is utilized to test for both RPA implementers group and control group:

In our study, we focus on main variables of interest, where POST serves as an indicator, assigned a value of 1 for firm-year observations during and after RPA implementation. RPA acts as an indicator distinguishing the treatment group (assigned a value of 1) from the control group (assigned a value of 0).  
  
We include a set of common control variables (CVs) to capture the effects of various firm-specific and market factors in both equations. These CVs consist of leverage (LEV) and the market-to-book ratio (MTB) to assess the financial structure, Operating Cash Flows (OCF) to evaluate the firm's liquidity impact on earnings management (EM), and firm size (LGTA) to examine size effects and evaluate the influence of audit quality on EM practices, following Becker et al. (1998).  
  
To explore the costs associated with accrual-based earnings management (AM) and real earnings management (RM), we incorporate industry-year market share (MS), the percentage of institutional investors (INST), Altman’s Z-score (ZSCORE), the net business operating cycle (CYCLE), and net operating assets (NOA). We opt for industry-adjusted ROA (ADJROA), following Kim et al. (2012), and include the square of ADJROA, as considered by Kothari et al. (2003), to account for the non-linear relationship between a firm’s performance and its abnormal accruals. Additionally, we include a measure of short-term credit risk (CL), following the study by Roychowdhury (2006).  
  
Specific variables tailored to each equation include the big four audit firm indicator (BIG4) for the AM equation, in line with Chen et al. (2012). For the RM equation, we incorporate R&D intensity (RD) and advertising intensity (ADV) as measures of a company’s commitment to innovation and marketing promotion, as discussed in the literature (Chouaibi et al. 2019; Tanveer et al. 2022). Through this comprehensive set of control variables, our analysis aims to provide a nuanced understanding of how RPA implementation might influence EM, considering a broad array of factors that could affect this relationship.

1. Univariate and Multivariate Results
   1. Descriptive statistics  
      Table 2 shows the overall sample univariate statistics results of both treatment and control sample. Table 2 panel A shows the descriptive statistics for the selected variables. All continuous variables are winsorized at the top and bottom 1% of their distribution. The mean value of ABSDA is about 5%. The mean value of ABPROD, ABEXP, and RM are -0.00592, -0.00063, and -0.0154 respectively, showing that in general, firms do not appear to take RM initiatives like overproduction and reduction of discretionary expenses. Table 2 panel B shows the spearman correlation matrix of the selected variables. For the correlation between AM and RM proxies, only ABEXP is negatively correlated with ABSDA, suggesting a substitutive effect between the abnormal discretionary expenses and discretionary accruals.  
      Table 3 panel A presents the statistics results for the comparison of RPA adopters with pre-versus post implementation periods. As for the measurements of EM, mean ABSDA is significantly different after the implementation at 5% significant level, showing the potential evidence that RPA truly affect EM, especially with AM as the EM approach. Nevertheless, there seems to be no difference between the pre and post periods of RPA implementation in RM. As for control variables, there seems no major difference between two periods despite some variables like LEV, MTB, LGTA, and BIG4. Table 3 panel B shows the comparison between treatment group and control group given the pre-implementation of RPA periods. There exists a significant gap between two groups in terms of ABSDA, which shows that firms in control group are more likely to engage in AM compared to those in treatment group. Again, it presents no significant difference for the RM measurements between two group. Table 3 panel C, on the other hand, display the comparison of selected variables between treatment and control groups after RPA adoption. Interestingly, it also shows the significant gap between two group for ABSDA. The firms of treatment group are more likely to engage in AM in the post implementation period, which is converted compared to the results of pre implement period. There are no differences between two groups in terms of all RM proxies after the RPA implementation.
   2. Testing for endogeneity and 2SLS  
      Based on the testing procedure outlined in Section 3.5, we have determined that the coefficients of the residuals in AM (RM) are significantly different from zero. This finding holds true not only across all equations tested within the implementers' regression models but also when compared with the control group. This indicates that the Two-Stage Least Squares (2SLS) method is more suitable than Ordinary Least Squares (OLS). Consequently, the upcoming multivariate analysis section will employ 2SLS for regression analyses. We regress AM (RM) against all control variables to derive the predicted AM (RM), which represents the fitted value from the first stage equation. Table 3 presents the multivariate results of this initial equation. In the second stage, these fitted values are used in place of the actual values of the proxies. The 25 percentiles of ZSCORE mean value is 1.96 larger than 1.81, meaning that most of the observations are not located in the distress zone for higher likelihood to go bankruptcy. Mean value of BIG four is larger than 90%, showing that most of our sample firms are audited by big four audit firms.
   3. Within treatment group analysis  
        
      Table 4 presents the multivariate results of the second stage for both equations across four models, examining implementer firms in the pre- versus post-RPA adoption period. The main variable of interest, POST, is positively significant at the 10% level in AM models, indicating that firms' engagement in AM increases following RPA adoption, in line with Hypothesis 1.   
        
      Similarly, in all RM proxy models that utilize AMhat (the AM proxy predicted from the first-stage equations), the coefficients of POST are consistently positive and significant in ABPROD, ABEXP, and RM models (P<0.05, <0.01, and <0.01, respectively). This suggests that firms' engagement in RM also increases post-RPA adoption, supporting Hypothesis 2.  
        
      Regarding the potential complementary or substitutive effects between the two EM approaches, the coefficients for RMhat and AMhat are significantly negative across the AM, ABEXP, and RM equations (P<0.1, <0.01, and <0.05, respectively). This indicates a substitutive effect between AM and RM, suggesting that firms are less likely to adopt both EM initiatives simultaneously, aligning with prior research (Zang 2012, Cohen and Zarowin 2010).  
        
      In the AM equation's control variables, we observe that larger firms are less likely to manipulate accruals, as evidenced by the negative coefficients of LGTA at a 1% significance level. The positive coefficient of ADJROA squared (P<0.01) indicates a nonlinear relationship between firm performance and abnormal accruals, implying that firms engage in AM when ADJROA is either very high or very low. Furthermore, the positive coefficient of CL, significant at the 10% level, suggests that firms with a higher ratio of current liabilities to total assets are more likely to engage in AM.  
        
      For the control variables in the RM proxy equations, firms with higher NOA are generally more inclined to engage in RM, as shown by the positive significance of NOA coefficients in ABPROD, ABEXP, and RM equations (P<0.01, <0.1, and <0.01, respectively). Conversely, firms with a lower net operating cycle, higher advertising intensity, and larger size tend to be less inclined towards the RM approach in EM, as indicated by the negative coefficients of CYCLE (P<0.01, <0.1, and <0.01), ADV (all P<0.01), and LGTA (P<0.1, <0.01, and <0.01) in the ABPROD, ABEXP, and RM equations.  
        
      In summary, our findings corroborate both hypotheses, demonstrating an increase in earnings management through either approach post-RPA adoption. This is supported by the multivariate results from the analysis of implementer firms during the pre- versus post-RPA adoption periods in our sample.  
         
      (insert Table4)
   4. Matched result analyses with RPA adopted and RPA non-adopted sample  
        
      Table 5 presents the multivariate results of the second stage for both equations across four models, comparing RPA non-adopted firms with RPA-adopted firms in the pre- versus post-implementation period. The coefficients of our main variable of interest, the interaction term between POST and RPA, are positively significant at the 1%, 5%, and 5% levels in the AM, ABEXP, and RM equations, respectively. This evidence suggests that firms adopting RPA software are more likely to employ either AM or RM as a means of earnings management (EM) after the implementation year, compared to a similar industry and firm size sample. These findings are consistent with our Hypotheses 1 and 2.  
        
      The regression analysis also reveals a substitutive relationship between AM and RM, as indicated by the negative significance of the RMhat coefficient (P<0.05) in the AM equation and the negative significance of the AMhat coefficients in both ABEXP and RM equations (P<0.05 and <0.1, respectively). This supports the conclusions of previous studies by Zang (2012) and Cohen and Zarowin (2010).   
        
      In the control variables of the AM equation, we find that firms with higher operating cash flows and larger sizes are less likely to engage in AM, as shown by the negative significance of the OCF (P<0.1) and LGTA (P<0.01) coefficients. Conversely, characteristics such as higher leverage and better performance are associated with a greater propensity to engage in AM, as evidenced by the positive and significant coefficients of LEV (P<0.01), ADJROA (P<0.1), and the square of ADJROA (P<0.01).   
        
      Regarding the control variables in the RM equations, the most prevalent characteristics across all three RM models indicate that firms with higher operating cash flows and more intensive advertising expenses are less likely to engage in RM activities, with the negative and significant coefficients of OCF and ADV at the 1% significance level.

In conclusion, our analysis confirms both hypotheses, indicating an increase in earnings management, whether through AM or RM, following RPA adoption. This conclusion is bolstered by the multivariate results from our sample of implementer firms during the pre- versus post-RPA adoption periods, taking into account a control group for comparison.

1. Conclusion  
     
   The advent of Robotic Process Automation (RPA) heralds a new era in the technological evolution of finance and accounting Despite the proliferation of empirical research on ERP technologies, the empirical examination of RPA, particularly in its relation to earnings management, remains largely unexplored. This study positions RPA as an innovative extension of ERP, venturing into novel empirical terrain to explore its potential implications on earnings management practices, thereby filling a significant gap in the existing literature.  
     
   This study discusses about association between the presence of RPA and earnings management among 9,780 firm-year observations from 2017 to 2022, sample collected the annual reports. AM is measure by the discretionary accruals from modified Jones model, while RM proxies re calculated from difference between normal levels of cash flows, production costs, and discretionary expenses. From the full sample results, AM seems no difference between RPA and non-RPA observations, on the other hand, the firms with the presence of RPA will be less likely to partake RM as an approach to manage earnings. Most interesting, the third hypothesis of the interaction terms indicates that the strategic choices firms make regarding AM and the adoption of RPA reveal a nuanced landscape. Firms that exercise restraint in AM and are cautious with RPA adoption demonstrate a commitment to transparency and ethical standards, resulting in more reliable financial statements and potentially higher firm valuation. This approach signals a dedication to upholding high governance and ethical practices. Conversely, when firms synergize AM with RPA, it leads to amplified effects to RM, indicating a move towards more aggressive earnings management strategies. This combination of EM tactics and advanced technology poses challenges for stakeholders like policymaker, auditors, or other stakeholders, emphasizing the importance of a nuanced understanding of their collective impact on financial integrity and the need for sophisticated analysis about this RPA application among the firms.  
     
   The limitations of this study can be delineated along two primary dimensions. Firstly, the unavailability of specific contract details necessitated reliance on annual reports as a methodology for gathering data on Robotic Process Automation (RPA), potentially leading to discrepancies when compared to the direct contract information. Secondly, the emergent nature of RPA within the Taiwanese context restricts the breadth and depth of empirical evidence, underscoring the importance of interpreting the findings with caution and indicating directions for future research to build upon these initial insights.  
     
   For subsequent research endeavors that aim to investigate the intersection of RPA with accounting or auditing, focusing on the potential weaknesses in internal controls related to Earnings Management (EM) could provide valuable insights, a topic not directly addressed in this study. Furthermore, given the constraints posed by the limited data availability due to the nascent stages of RPA development, future studies are encouraged to undertake a more detailed examination of RPA implementation levels. Drawing inspiration from the methodology of Brazel and Dang (2008) in their ERP research, which gauges the extent of ERP integration through the count of system modules, the depth of a company's RPA utilization could similarly be evaluated based on the quantity of both attended and unattended licenses, offering a direct measure of RPA's operational engagement.
2. Appendix A

Consistent with the prior literatures, we run the following prediction model for each year within each TSE industry code at minimum of 15 observations. (Zang 2012; Brazel and Dang 2008; Paredes and Wheatley 2018 etc.)

* 1. Accrual-based proxy  
     We use the modified Jones model to calculate the accrual-based earnings management proxy. As modified Jones model, this model is a firm-specific measure based on cross-sectional estimation. According to this model, total accruals are affected by the change in sales, level of property, plant, and equipment:   
     where TA is net income from continuing operations minus operating cash flows; A is total assets; S is net sales; PPE is gross property, plant, and equipment.
  2. Real activities manipulation proxies
     1. ABPROD  
        Another measure of real activities manipulation as mentioned from prior studies is abnormal production costs.

where production costs (PROD) are the sum of operating costs and change in inventory; A is total assets; S is net sales. Operating costs is defined as the necessary expenditure incurred to bring inventory to a salable condition and location or ready for production in TEJ database, which is the sum of costs of goods sold, cost- rent expenditure, cost- sale of land, cost- disposal of investment, and cost- investment loss.

* + 1. ABEXP  
       The last measure of real activities manipulation as mentioned from prior studies is abnormal production costs.

where discretionary expenses (EXP) is the operating expense; A is total assets; S is net sales. Operating expenses is defined as expenses incurred by a business from its operating activities in TEJ database, which is the sum of selling expenses, administrative expenses, R&D expenses, other expenses, and expected credit losses (loss) benefit- operating expenses.