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, Yigitbasioglu, 2019; Reinventing business, 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, Jazayeri, 2003; Matolcsy et al., 2005; Nicolaou, Bhattacharya, 2008; Kanellou, 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, 2000).

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 (Brazel and Dang 2008). 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.). Although recent studies have ventured into qualitative analyses, examining motivations for RPA adoption and its broader implications for the accounting profession (Asatiani et al. 2020; Fernandez and Aman 2018; Gotthardt et al. 2020; Korhonen et al. 2021; Moffitt et al. 2018; Yoon 2020; Zhang 2019), 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 and accrual-based earnings management, which are key aspects of financial integrity and corporate governance. Through the application of the Modified Jones Model to identify accrual-based earnings management and the use of abnormal cash flow as a measure for real activities manipulation, as suggested by Cohen and Zarowin (2010), our analysis delves into the conduct of firms that have adopted RPA.  
  
The outcomes of our investigation present a nuanced view of RPA's impact on earnings management:

Reduction in Real Activities Manipulation: Our findings clearly demonstrate that RPA implementation is associated with a significant decrease in real activities manipulation. This suggests that RPA, by automating processes and enhancing transparency, helps firms to adhere more closely to ethical financial reporting practices.

No Direct Association with Accrual-based Earnings Management: The analysis indicates that the presence of RPA within a firm does not have a direct correlation with accrual-based earnings management. This highlights that RPA's effectiveness in influencing earnings management practices may be more nuanced and specific to the type of earnings management being considered.

Indirect Influence Through Accrual-based Management: Interestingly, we observe that firms utilizing RPA and engaging less in accrual-based earnings management also show a reduced tendency to partake in real activities manipulation. This implies that while RPA itself may not directly impact accrual-based earnings management, its implementation could be indicative of a firm's broader commitment to ethical financial practices. In essence, firms that leverage RPA and concurrently demonstrate restraint in accrual-based earnings management are likely to exhibit lower levels of real activities manipulation.  
  
Given the limited availability of data on firms' RPA implementations, our study 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 earnings management practices.

This study stands out for its novel approach, being among the first to link RPA with empirical accounting research. It opens avenues for future research on the multifaceted impacts of RPA across various business sectors. By highlighting the relationship between RPA implementation and earnings management practices, the research not only adds to the academic dialogue but also provides practical insights for industry professionals and policymakers. This marks a step towards enhanced financial transparency and integrity in an increasingly digitized business environment.

1. Literature Review & Development of Hypotheses  
   H1: A firm with RPA implementation will be more likely to engage in accrual-based earnings management.

H2: A firm with RPA implementation will be less likely to engage in real activities manipulation.  
H3a: The presence of RPA amplifies the positive effects (or mitigates the negative effects) of real activities manipulation on accrual-based earnings management.

H3b: The presence of RPA increases the positive effects (or decreases the negative effects) of accrual-based earnings management on real activities manipulation.

1. Sample Selection and Research Design (參考ERP2018那篇)
   1. Sample  
      The data collection commenced by gathering firm-year observations from the TEJ database spanning 2017 to 2022. To ensure relevance, I focused on firms continuously listed on TSE or OTC until the end of 2023. The choice of initiating the sample period in 2017 stems from the absence of any annual reports disclosing RPA implementation before that year. After addressing missing variables and the minimum observation threshold of AM/RM proxies calculation, final sample comprises 9,780 firm-year observations originating from 1,730 firms across 28 distinct industries based on TSE industry codes.  
      (Insert Sample Description Table)
   2. Main interest of variable: RPA implementation Indicator   
      Our research into the adoption of Robotic Process Automation (RPA) by firms hinges on an in-depth analysis of annual reports. This methodological choice is influenced by the foundational work of Gorden et al. (2010) and Yen and Wang (2021), who demonstrated the utility of annual reports in extracting information on a variety of topics, from information security to the impact of blockchain technologies. This background underscores the value of leveraging publicly available documents for academic research, providing a rich dataset for exploring technological adoption.  
        
      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 the TWSE or traded on TPEx, 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 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.
   3. Accrual-based Earnings Management (陳述 at least 15 minimum)  
      In the analysis of earnings management, 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; Subramanyam 1996; DeFond and Subramanyam 1998; Warfield et al. 1995; Klein 2002), emphasizing the significance of capturing the full spectrum of earnings management activities. The estimation of these discretionary accruals is conducted using the cross-sectional modified Jones model (Dechow et al., 1995), which compares actual total accruals against forecasted figures from an accrual prediction model. The differences are considered to represent the discretionary component of accruals (see Appendix A for details), thereby serving as an indicator of earnings management. This methodology underscores the nuanced understanding that earnings manipulation can involve both overstatements and understatements, aiming to provide a comprehensive measure of such practices.
   4. Real Activities Manipulation

Drawing upon established research, this study employs proxies for real activities manipulation as delineated by Roychowdhury (2006), with further refinement and validation by Cohen et al. (2010) and Kim et al. (2012). These proxies—abnormal cash flow from operations (ABCFO), production costs (ABPROD), and 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 sales acceleration, overproduction, and discretionary spending cuts, as mechanisms for short-term earnings enhancement at potential long-term detriment.  
  
Moreover, the 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 Cohen et al. (2010) and Kim et al. (2012), aims to provide a nuanced understanding of real activities manipulation and its consequences for financial integrity and governance. Through this analytical lens, the research aspires to contribute to the discourse on corporate ethics and regulatory practices, emphasizing the importance of transparency and fairness in financial reporting.

* 1. Empirical Models  
     To capture the relationship between earnings management and RPA implementation, the regression models are performed with accrual-based and real activities manipulation respectively:

We estimate Equations (1) and (2) with multiple regressions. Firms are likely to employ a combination of discretionary accruals and real activities manipulation to manage reported earnings, with the choice between the two mechanisms influenced by their relative costs (Cohen et al. 2008; Zang, Zhao et al. 2012; Kim and Park 2014; Paredes and Wheatley, 2018). To address the substitutive nature of these earnings management methods, we include the absolute value of discretionary accruals (ABSDA), a proxy for accrual-based earnings management, as a control variable in the real activities manipulation (RMPROXIES) regressions to adequately address the endogeneity present in earnings management activities. Conversely, a proxy for real activities manipulation is included as a control variable in the accrual-based earnings management regressions.  
  
In our study, we examine the relationship between Robotic Process Automation (RPA) implementation and earnings management, utilizing a set of control variables (CVs) to delineate the effects of various firm-specific and market factors. These CVs include Leverage (LEV) and Market-to-Book Ratio (MTB) to gauge financial structure and growth opportunities, Operating Cash Flows (OCF) for the firm's liquidity impact on earnings management, firm size (LGTA) for size effects, and the BIG4 Audit Firm Indicator (BIG4) to evaluate the influence of audit quality on earnings management practices. (DeFond and Jiambalvo, 1994; Becker et al., 1998; Zhou and Elder, 2002)  
  
Moreover, we also address the nonlinear relation between firm performance and abnormal accruals by including both industry-adjusted ROA (ADJROA) and the square of ADJROA. This approach, informed by the findings of Kothari et al. (2003), highlights the nonlinear dynamics between performance metrics and abnormal accruals, enriching our model's capacity to capture the complexity of these relationships. R&D Intensity (RD) is also incorporated as measures of a company's commitment to innovation, reflecting the firm's strategic orientation towards CSR/ESG initiatives and their potential influence on financial reporting practices, as discussed in the literature (Kim et al., 2012; McWilliams and Siegel, 2000). Through this comprehensive set of control variables, our analysis aims to provide a nuanced understanding of how RPA implementation might influence earnings management, considering a wide array of factors that could affect this relationship.

1. Univariate and Multivariate Results
   1. Descriptive statistics (Insert Full sample, RPA0/1 versus, correlation table)   
      The table presents descriptive statistics results. Panel A shows the summary statistics of full sample with 10,100 observations. All continuous variables are winsorized at the top and bottom 1 % of their distribution. Panel B shows the correlation tables between variables……
   2. The relation between RPA implementation and Accrual-based earnings management  
        
      The table presents the multivariate results of the absolute discretionary accruals analyses. We find no evidence showing the relation between RPA implementation and the extent of the accrual-based earnings management, ABSDA, which reject our hypothesis1.   
        
      In addition, the RM proxy for the real activities manipulation is significantly positive (P < 0.01), indicating that firms with accrual-based management also tend to take part in real activities manipulation. This implies that there exists a complementary relation between two approaches in terms of earnings management, consistent with prior studies. (CHF 2012; Paredes and Wheatley 2018).  
        
      Nevertheless, the interaction term between RPA and RM is not significant, which is not supporting H3a. We cannot conclude that the relationship between real activities manipulation and accrual-based earnings management is moderated by RPA, such that the presence of RPA amplifies the positive effects (or mitigates the negative effects) of real activities manipulation on accrual-based earnings management in full sample.  
        
      As for the other control variables, we find that OCF(P<0.01), LGTA(P<0.01), RD(P<0.01), BIG4(P<0.05), and ESG(P<0.01) are negatively significant, suggesting that the firms with more operating cash flow, larger scale, higher R&D intensity, and audited by big four audit firms are less likely to involve accrual-based earnings management. Consistent with Kim et al. (2012), firms with better ESG(CSR) performance will be less likely to engage in accruals management.  
        
      On the other hand, we also find that LEV, ADJROA, square ADJROA are significantly positively associated with absolute discretionary accruals at 1% significance level, indicating that firms with higher leverage and larger industry-adjusted ROA with nonlinear relation will be apt for performing accrual-based earnings management.  
        
      To sum up, we cannot conclude that the firms with RPA implementation will be more likely to manage their earnings via accounting accruals, which rejects our H1 from the multivariate regression model results in the full sample.
   3. The relation between RPA implementation and Real activities manipulation  
        
      The table presents the multivariate results of the real activities manipulation analyses. For the multivariate regression of ABCFO, ABPROD and combined proxy RM, the estimated coefficient of RPA are all negative and significant (P<0.01, <0.05, <0.01), showing that the firms with RPA implementation will less likely to use the measures of real activities manipulation given the higher (lower) levels of abnormal operating cash flows and overall real activities manipulation (abnormal production costs).  
        
      With the control of accrual-based earnings management, the estimated coefficient of ABSDA is significantly positively at 1% significant level for ABCFO, ABPROD, and RM regression models, consistent with the prior research. (CHF 2012; Paredes and Wheatley 2018) It implies that the firms engage in accrual-based earnings management will be more likely to take real activities manipulation at the same time to manage the earnings of the firms.   
        
      Interestingly, the estimated coefficient of the interaction term RPA\*ABSDA, is positively significantly in ABCFO and RM regression models (P<0.01, <0.05), indicating that the presence of RPA increases the positive effects (or decreases the negative effects) of accrual-based earnings management on real activities manipulation, which supports the Hypothesis3b.

In terms of control variables, we find that the estimated coefficients of LEV, OCF, MTB, ADJROA, square of ADJROA, RD, ESG, and BIG4 are all significantly negative related to RM regression model (P values are all less than 0.01), meaning that the firms with higher operating cash flows, higher market-to-book ratio, higher ADJROA with nonlinear relation, higher R&D, better ESG performance, and audited by big four audit firms will be less likely take real activities manipulation as a kind of measures to manage earnings. As for LGTA, on the other hand, are negatively significant between RM proxy (P<0.01), indicating larger firms may be opt for managing earnings through real activities manipulation.  
  
In summary, we first obtain the evidence shows that RPA-implemented firms use real activities manipulation to manage earnings less than the firms without RPA implementation, consistent with H2. Importantly, the interaction term with the accrual proxy and RPA supports our hypothesis that a firm with the presence of RPA implementation will be more likely to manage earnings via both measures in a complementary approach.

1. Additional Analyses
   1. Alternative measures of discretionary accruals and audit quality  
      Aside from using modified Jones model to calculate discretionary accruals, we rerun our sample data through that from standard Jones model and obtain similar results regarding our testing main interest variables in both earnings management regression models.
   2. Alternative measures of Real activities manipulation  
      To capture the total comprehensive effects of real earnings management, we follow Cohen and Zarowin (2010) to adopt the two comprehensive metrics of real earnings management activities, RM1 and RM2 respectively. RM1 is defined as the aggregation of ABPROD and ABEXP, whereas RM2 is derived from sum of ABCFO and ABEXP. The testing results remain robust after applying these two measures in the real activities manipulation regression, which still supports the hypothesis 2 and hypothesis 3b.
   3. Propensity score matching  
      Due to the fundamental difference across several aspects such as firm size (LGTA) between RPA and non-RPA observations within our full sample, we take propensity score matching method (PSM) as the robustness testing approach to capture the effect of the RPA on earnings management. To test this alternative approach, we follow the suggestions and methodology from Shipman et al. (2017). First, we perform logistics regression based on both accrual-based earnings management and real activities manipulation specifications, which regresses the main interest variable RPA on the same independent variables from the specifications. Both matching logistics regression without caliper settings end up matching 328 observations with nearest propensity score. This way, we obtain total samples 656 as matched dataset after PSM with half of RPA implementation observations and half of matching samples without RPA implementation. The matched dataset statistics as following tables. There seems no significant difference in means between the two groups compared with the full sample scope, indicating that the two groups are similar in the observable aspects, and our matching process is valid.  
        
      Consistent with the results via full sample, the rerun regression results about the main interest variable and its interaction terms remain the same. (要全放嗎XD，matched data 每個psmodel都會不一樣)
2. Conclusion
3. Appendix A
   1. Consistent with the prior literatures, we run the following prediction model for each year within each TSE industry code that contains at least 15 firms. (Zang, 2008; Brazel and Dang, 2008; Paredes and Wheatley, 2018 etc.)
   2. Accrual-based proxy  
      We use the modified Jones model to calculate the accrual-based earnings management proxy. As described by Dechow et al. (1995), 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:
   3. Real activities manipulation proxies
      1. ABCFO  
         Following prior studies (Roychowdhury 2006, Zang 2007, Cohen et al. 2008, Gunny 2010, etc.), sales manipulations are expected to lead to lower current-period operating cash flows. We use Roychowdhury’s (2006) model to estimate the normal level of operating cash flows:
      2. ABPROD  
         Another measure of real activities manipulation as mentioned from prior studies is abnormal production costs.
      3. ABEXP  
         The last measure of real activities manipulation as mentioned from prior studies is abnormal production costs.
4. Appendix B Variables Definition

Brazel, J. and L. Dang (2008). "The Effect of ERP System Implementations on the Management of Earnings and Earnings Release Dates." Journal of Information Systems **22**.

Cohen, D. A. and P. Zarowin (2010). "Accrual-based and real earnings management activities around seasoned equity offerings." Journal of Accounting and Economics **50**(1): 2-19.