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 delves into the specific impact of RPA on earnings management, a crucial aspect of financial reporting and corporate governance. Utilizing the Modified Jones Model to detect accrual-based earnings management and abnormal cash flow as a proxy for real activities manipulation(Cohen and Zarowin 2010), the study examines the tendencies of RPA-implementing firms in earnings management. Our findings reveal a significant trend: firms with RPA implementations show a reduced likelihood of engaging in both accrual-based earnings management and real activities manipulation, a pattern consistent across different proxies used in our analysis. Last, due to the limited availability of RPA-firm-year data, we also employ the propensity score matching method for our regression analysis to ensure robustness.

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
   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, our final sample comprises 10,100 firm-year observations originating from 1,776 firms across 33 distinct industries based on TEJ main industry codes.  
      (Insert Sample Description Table)
   2. Main interest of variable: RPA implementation Indicator   
      The approach to determine whether firms implemented Robotic Process Automation (RPA) centers around the comprehensive analysis of their annual reports. However, it is important to acknowledge certain limitations: Unlike some research in related areas, direct access to a proprietary database supplied by an RPA software provider is not available, which could provide a comprehensive list of companies implementing RPA (Brazel, 2008). For instance, Brazel (2008) utilized such a database to examine ERP system adopters, including detailed information on license agreements, implementation start dates, completion dates, and module implementations, for operational decisions by the ERP provider, ensuring its accuracy.  
        
      As for the methodology to use annual reports to obtain main interest variables, inspiration is drawn from the approaches used by previous researchers. (Gorden et al., 2010) and (Yen and Wang, 2021) have successfully employed similar methods to browse annual reports and obtain valuable information related to various topics, such as information security disclosure indicators and stock prices concerning blockchain technologies and cryptocurrencies, respectively. These studies serve as valuable references for the methodology and demonstrate the effectiveness of using annual reports for obtaining relevant information.

This systematic approach is adopted to determine whether companies had implemented Robotic Process Automation (RPA) due to limited access to such information. It offers two significant advantages. Firstly, the Ease of Digital Access is notable. The law mandates that every firm submits their annual reports in digital form, making it significantly easier to use programming languages or coding to retrieve and analyze the text of these reports compared to scanned form reports. This digital format facilitates efficient data extraction and processing, enhancing the accuracy and speed of the analysis. Secondly, the approach ensures Comprehensive Coverage as mandated by the law. The legal requirement stipulates that companies listed on TWSE (Taiwan Stock Exchange) or traded on TPEx (Taipei Exchange) must upload electronic copies of their annual reports. As these exchanges serve as the primary trading centers for Taiwanese stocks, the approach guarantees comprehensive coverage of all relevant firms within the selected samples. This comprehensive coverage minimizes potential biases and strengthens the representativeness of the research findings. The decision to undertake this initiative was rooted in the regulations set forth in the "Regulations Governing Information to be Published in Annual Reports of Public Companies," particularly Article 23. This legal requirement mandates that companies listed on TWSE or traded on TPEx upload an electronic copy of their annual reports to the FSC (Financial Supervisory Commission)'s designated information disclosure website at least 14 days before the shareholders' meeting.  
  
While the approach allows for working within the constraints of available data, it is important to acknowledge that the absence of direct access to an RPA software provider's database may impact the completeness and precision of the sample. Nonetheless, measures have been taken to address this limitation and ensure the reliability of the analysis within the scope of available resources.  
  
To identify RPA-related content, keyword searches were conducted, including terms such as "Robotic Process Automation," capitalized "RPA," and the Mandarin phrase "機器人流程自動化," within the annual reports of the samples. After examination and the elimination of instances where "RPA" did not refer to Robotic Process Automation, 215 samples directly related to RPA implementation were identified. The content of these samples varied, covering topics such as RPA staff education, estimated benefits attributable to bots, and consultancy processes provided by external firms for the development of RPA management policies. Subsequently, these firm-year samples were denoted with the RPA implementation indicator set to "1." The remaining 9,885 samples were categorized as "0."  
  
Furthermore, in instances where a firm described Robotic Process Automation (RPA) in its annual report for a given year, this firm was designated with the RPA implementation indicator set to "1" for the subsequent year as well, irrespective of whether the annual report of that subsequent year mentioned RPA. This approach acknowledges the lasting impact and continuity of RPA initiatives, reflecting the assumption that once a firm commits to RPA, the implementation and its effects persist beyond the initial year of adoption. This methodological decision allows for a more nuanced analysis of RPA's influence over time, capturing not just the moment of implementation but also the sustained engagement with RPA technologies and strategies.

* 1. Accrual-based Earnings Management  
     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, 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.
  2. 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. 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 2012). 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. 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) and advertising intensity (AD) are further incorporated as measures of a company's commitment to innovation and marketing, 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; 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 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. Consistent with H1, we find a positive relation between RPA implementation and the extent of the accrual-based earnings management, ABSDA. More specifically, the estimated coefficient on RPA is significantly positive (P < 0.01), suggesting that RPA implemented firms tend to manage earnings via accounting accruals.   
        
      In addition, the RM proxy for the real activities manipulation is significantly negative (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, consistence with the findings from prior studies. (Cohen et al., 2010; Zang 2006……)   
        
      However, 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=0.013), 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, ADV are significantly positively associated with absolute discretionary accruals (P<0.01,<0.01,<0.01,=0.06), indicating that firms with higher leverage, higher advertising intensity, and larger industry-adjusted ROA with nonlinear relation will be apt for performing accrual-based earnings management.  
        
      To sum up, we conclude that the firms with RPA implementation will be more likely to manage their earnings via accounting accruals, which supports our H1 from the multivariate regression model results.
   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 and combined proxy RM, the estimated coefficient of RPA is positive and significant (P = 0.08 and 0.011). As for the regression of ABPROD, RPA is negatively and significantly associated with abnormal production costs(P=0.031). 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 negatively (positively) for ABCFO and RM (ABPROD)(P=0.076, <0.01, and <0.01), consistent with the prior research. (Cohen et al., 2010; Zang 2006……) 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 negatively (positively) significantly in ABCFO, ABEXP, and RM (ABPROD) regression models (P=0.037, <0.01, <0.01, and 0.054), 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 OCF, MTB, ADJROA, square of ADJROA, RD, ADV, ESG, and BIG4 are all significantly positive related to RM proxy (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 and advertising intensity, 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 and AGE(P values are all less than 0.01), on the other hand, are negatively significant between RM proxy, indicating larger and older firms may be opt for managing earnings through real activities manipulation.  
  
In summary, we 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.

1. Additional Analyses
   1. Propensity Score matching samples
      1. GLM model to obtain matched pairs. ( Insert match pairs RPA0/1 versus)
   2. Alternative measures of discretionary accruals and audit quality (?)
   3. Alternative measures of Real activities manipulation (RM1/RM2 not use PSM XD )
2. Conclusion

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.