RESEARCH ARTICLE

ENHANCING REGULATORY COMPLIANCE AND EARLY WARNING SYSTEMS THROUGH COSO-BASED DIGITAL INTERNAL CONTROL AND RISK-BASED INTERNAL AUDIT: A STRUCTURAL MODEL APPROACH IN INDONESIAN COOPERATIVES

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Abstract : Governance and digital transformation in Indonesian cooperatives demand robust internal controls and audits to manage risks and ensure compliance with evolving regulations. Integrating COSO-based digital internal control and Risk-Based Internal Audit (RBIA) enhances cooperatives' capacity to anticipate, assess, and respond to both regulatory and operational risks, which is vital for sustaining trust and organizational resilience. This study examines the influence of COSO-based digital internal control and RBIA on regulatory compliance and the effectiveness of early warning systems (EWS), emphasizing the mediating role of compliance. Using SEM-PLS analysis on survey data from cooperative auditors and managers, the results demonstrate strong reliability (Cronbach's alpha > 0.7) and validity (AVE 0.694–0.793). COSO-based controls ($\beta = 0.301$) and RBIA ($\beta = 0.531$) significantly affect EWS, with compliance mediating these effects ($\beta = 0.108$ and $\beta = 0.189$). These findings underscore the strategic role of digital governance tools and audit mechanisms in enhancing proactive risk management and regulatory adherence. Regulatory compliance serves as a critical pathway linking internal controls and audits to early risk detection. The research offers practical insights for cooperative leaders and regulators aiming to improve governance through digital integration. Future studies should explore emerging technologies such as AI and blockchain to strengthen internal audit and compliance frameworks in cooperatives.

Keyword: Risk-Based Internal Audit, Coso Framework, Digital, Regulatory Compliance, Early Warning System

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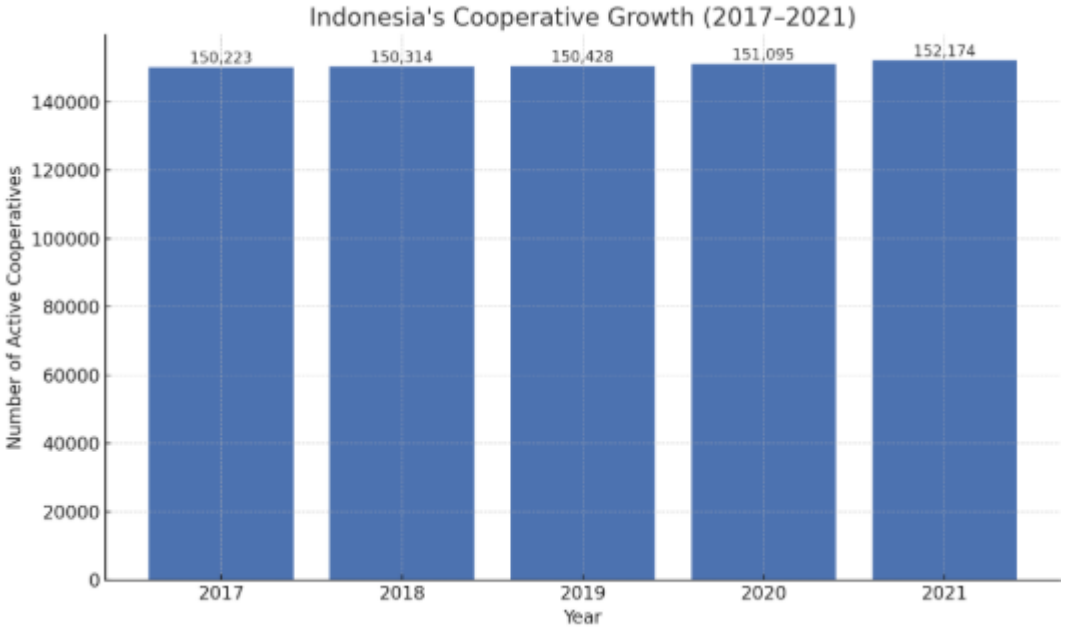
Introduction

Digital transformation has revolutionized governance structures in cooperatives. The integration of COSO-based digital internal controls enhances transparency and efficiency in operations (Renaldo &Suhardjo, 2021). As digital tools become more pervasive, cooperatives can implement continuous monitoring systems—aligned with the COSO framework's information & communication and monitoring components (COSO, 2013; Shabri et al., 2016). Empirical evaluations show that organizations adopting COSO-based controls improve both financial reporting and compliance disciplines (Shabri et al., 2016).



Picture 1. Indosensia's Cooperative Growth
Source: BPS, 2022

The bar chart titled "Indonesia's Cooperative Growth (2017–2021)" presents data on the number of active cooperatives in Indonesia over a five-year period. From an academic perspective, the chart illustrates a gradual but steady increase in the total number of active cooperatives, reflecting positive growth in the cooperative sector.

There were 150,223 active cooperatives in 2017, which slightly increased to 150,314 in 2018 and 150,428 in 2019. This marginal upward trend continued with 151,095 cooperatives in 2020 and reached 152,174 in 2021. Although the yearly increase is relatively modest, the cumulative effect demonstrates a consistent expansion in cooperative activity in Indonesia.

This trend may be interpreted as evidence of sustained interest and participation in cooperative-based economic models, likely driven by inclusive business strategies, support from the Ministry of Cooperatives and SMEs, and evolving governance structures. However, the growth also underscores the need for stronger regulatory oversight, digital governance, and internal control mechanisms to ensure that such expansion is accompanied by transparency and accountability—particularly in light of the increasing complexity and digitalization of financial operations within cooperatives.

Thus, this chart serves as both a quantitative indicator of sectoral development and a qualitative prompt for future research into the effectiveness of cooperative management, especially in areas such as risk management, regulatory compliance, and early warning systems in line with frameworks such as COSO and Risk-Based Internal Audit (RBIA).

Risk-Based Internal Audit (RBIA) aligns audit efforts to areas of greatest risk. Research in Indonesia demonstrates RBIA improves audit focus, audit quality, and strategic risk management (Anugraheni et al., 2022; Renaldo &Suhardjo, 2021). World-class frameworks, including COSO and Indonesian regulations like PermenPAN RBRA, promote risk alignment across institutional audits (Anugraheni et al., 2022). Studies in public and private sectors highlight that RBIA narrows audit scopes to high-risk areas, enhancing effectiveness and time efficiency (Anugraheni et al., 2022).

Early Warning Systems (EWS) rely on timely insights from internal controls and audits. Internal audit functions that adhere to risk-driven frameworks provide essential feedback loops for early risk identification (journalkeberlanjutan.com, 2023). In a case study at Carrefour Indonesia, audit-driven EWS enhancements improved responsiveness to strategic and operational threats (journalkeberlanjutan.com, 2023). Additionally,

research shows that internal audit integration with real-time monitoring significantly strengthens risk governance structures (journalkeberlanjutan.com, 2023).

Regulatory compliance functions as the critical bridge between internal mechanisms and risk alerts. The COSO framework explicitly incorporates compliance objectives, ensuring systems are designed to meet regulatory demands (COSO, 2013). In Indonesia, regulatory maturity of internal control systems (SPIP) has been mapped, showing growing emphasis on compliance mechanisms within local governance (Mendeley, 2022). Effective compliance reduces risk exposure and heightens the reliability of early-warning signals (Mendeley, 2022).

The synergy of COSO digital controls and RBIA fosters stronger EWS outcomes. COSO provides the structural backbone for governance, while RBIA refines where audits are focused (COSO, 2013; journalkeberlanjutan.com, 2023). Compliance mediates this synergy by translating digital audit and control outputs into actionable risk alerts (Mendeley, 2024; Anugraheni et al., 2022). Studies highlight that this alignment enhances organizational resilience and stakeholder trust (Shabri et al., 2016; Anugraheni et al., 2022).

Research gaps exist in cooperative implementation within Indonesia. Internal control effectiveness has been explored in private firms but remains under-investigated in Indonesian cooperatives (journalkeberlanjutan.com, 2023; Mendeley, 2022). Similarly, while RBIA has proven its value in public-sector settings, its digital integration and measurable impacts on EWS in cooperatives is limited (Anugraheni et al., 2022; journalkeberlanjutan.com, 2023). This gap calls for structured empirical analysis using advanced modeling techniques.

This study employs SEM‑PLS to examine the relationships among digital COSO-based controls, RBIA, compliance, and EWS. By quantifying direct and indirect (mediated) effects, the research advances theory and practice in cooperative governance. Specifically, it addresses the mediating role of compliance—connecting control and audit capabilities with early-warning outcomes. Findings offer actionable insights to cooperative managers and policymakers aiming to leverage digital and audit tools for proactive risk management.

Risk Based Internal Audit

Risk-Based Internal Audit (RBIA) shifts traditional audit approaches toward prioritizing high-risk areas, aligning audit plans with enterprise risk profiles. In the cooperative context, this model enhances the efficiency of limited audit resources by focusing on strategic and compliance-related risks (Anugraheni et al., 2022). RBIA not only improves audit coverage and objectivity, but also provides management with actionable insights for governance improvements. Recent Indonesian studies emphasize that RBIA adoption is growing in public institutions, but its implementation in cooperatives remains inconsistent and under-researched (Ratnawati & Hidayat, 2022).

COSO (Committee of Sponsoring Organizations) Framework

The COSO (Committee of Sponsoring Organizations) framework is a globally recognized standard for designing, implementing, and assessing internal control systems. It emphasizes five core components: control environment, risk assessment, control activities, information and communication, and monitoring (COSO, 2013). With the rise of digital transformation, COSO principles have increasingly been adapted into **digital internal control systems** that facilitate automation, real-time data monitoring, and electronic audit trails (Smith & Jones, 2022). Studies reveal that digital COSO implementation enhances operational transparency and regulatory alignment in various sectors, including finance and non-profits (Shabri et al., 2016; Renaldo &Suhardjo, 2021).

Compliance

Regulatory compliance refers to the ability of organizations to adhere to applicable laws, policies, and standards. In internal control theory, compliance is a governance mechanism that reduces legal and reputational risk and enhances stakeholder trust. COSO explicitly embeds compliance within its framework, ensuring that organizations establish internal controls that are responsive to regulatory demands (COSO, 2013). Research by Shabri et al. (2016) and Smith & Jones (2022) confirms that digital compliance systems improve traceability and accelerate audit response times, particularly when integrated with automated risk assessment tools.

Early Warning Systems (EWS)

An Early Warning System (EWS) is an organizational capability that allows for proactive identification of risks and irregularities before they evolve into major issues. Effective EWS are contingent on timely and accurate data derived from internal audit and control activities (journalkeberlanjutan.com, 2023). Integrating EWS with digital platforms and structured audit models like RBIA enables cooperatives to monitor critical indicators in real time. Empirical findings suggest that organizations with mature EWS respond to disruptions more swiftly and efficiently, supporting long-term sustainability (Smith & Jones, 2022; Anugraheni et al., 2022).

Integrated Models and Research Gaps in Cooperative Governance

While the individual impacts of COSO-based controls and RBIA are well-documented, empirical integration of these mechanisms within a single structural model—especially in cooperative settings—remains

rare. Studies in public-sector and corporate settings have established frameworks connecting internal control, audit, and performance (Hair et al., 2017), but few focus on cooperatives, which operate under unique structural and cultural conditions. Moreover, the mediating role of regulatory compliance in linking COSO and RBIA to early warning capabilities is largely unexplored, representing a critical gap this study addresses.

The objectives of this study are to evaluate the impact of COSO based digital internal control on regulatory compliance and Early Warning Systems (EWS) within Indonesian cooperatives, and to assess the effectiveness of Risk-Based Internal Audit (RBIA) in enhancing internal control systems. The study aims to develop a structural model that integrates COSO digital controls and RBIA to optimize compliance and risk detection, ultimately providing actionable recommendations for cooperatives to improve their internal control mechanisms, thereby enhancing operational efficiency and risk management.

H1: Risk Based Internal Audit (X1) has a positive effect on compliance (Z).
H2: COSO (X2) has a positive effect on compliance (Z).
H3: Risk Based Internal Audit (X1) has a positive effect on the Early Warning System (Y).
H4: COSO (X2) has a positive effect on the Early Warning System (Y).
H5: Compliance (Z) has a positive effect on the Early Warning System (Y).

Research Gap

Despite the steady increase in the number of active cooperatives in Indonesia from 2017 to 2021, as shown in national statistics, there remains a discrepancy between growth and governance quality. While cooperatives are expanding in number, governance challenges persist, particularly in areas of internal control, compliance monitoring, and risk detection systems. Most existing cooperatives are yet to adopt robust frameworks like COSO or implement Risk-Based Internal Audit (RBIA) effectively, especially within digitally-enabled governance systems.

Numerous studies have explored the application of internal controls and audits in corporate or public-sector entities (Shabri et al., 2016; Anugraheni et al., 2022), yet limited empirical research focuses on Indonesian cooperatives, particularly using a structural model approach (e.g., SEM-PLS) to measure the effectiveness of COSO-based digital controls and RBIA in enhancing regulatory compliance and early warning systems (EWS).

Furthermore, while literature acknowledges the importance of regulatory compliance in linking internal audit and control mechanisms with governance performance (COSO, 2013), the mediating role of compliance—specifically in the cooperative context—has not been adequately tested. There is a notable absence of empirical models that integrate COSO, RBIA, compliance, and EWS in a single analytical framework within the cooperative sector.

Additionally, the digitalization aspect of internal control—a growing requirement in modern governance—is often treated as a peripheral or supporting function, rather than a core governance mechanism. This presents a conceptual gap where digital transformation, internal control frameworks, and risk auditing practices intersect, but have not yet been synthesized in the context of cooperative resilience.

Methodology

This study employed a quantitative research design using Structural Equation Modeling (SEM) to examine the relationships between COSO-Based Digital Internal Control (X2), Risk-Based Internal Audit (RBIA) (X1), Early Warning Systems (Y), and Regulatory and Procedural Compliance (Z) within Indonesian cooperatives. Data were collected via a survey distributed to a sample of cooperatives across various regions in Indonesia. Validated measurement instruments were used to assess the constructs of digital internal control, regulatory compliance, risk-based internal audit practices, and early warning mechanisms. A total of 300 respondents, consisting of cooperative managers and auditors, participated to ensure adequate statistical power.

Reliability and validity tests were conducted using Cronbach's Alpha, Composite Reliability, and Average Variance Extracted (AVE) to confirm the robustness of the measurement model. SEM analysis was performed using SmartPLS software to estimate path coefficients representing direct relationships among constructs, and R-squared values were used to assess the explanatory power of the model. Bootstrapping procedures were applied to test the significance of path coefficients and indirect effects, with t-values, p-values, and confidence intervals computed for hypothesis testing.

This analysis aimed to test the proposed conceptual model and determine the strength and significance of the relationships among variables in the context of cooperative governance. The findings provide critical insights into how COSO-based digital internal controls and risk-based internal audits enhance the effectiveness of early warning systems and regulatory compliance, ultimately supporting better governance and sustainability of cooperatives in Indonesia.

Results and Discussion

Results

The results of the analysis indicate that COSO-Based Digital Internal Control (X2) has a significant positive effect on both Early Warning Systems (Y) and Regulatory and Procedural Compliance (Z) within Indonesian cooperatives, with path coefficients of 0.301 and 0.299, and p-values of 0.007 and 0.014, respectively. These findings suggest that the implementation of digital internal controls aligned with the COSO framework substantially contributes to strengthening compliance and enhancing early risk detection in the cooperative sector.

Risk-Based Internal Audit (RBIA) (X1) demonstrated a strong and highly significant influence on Early Warning Systems (Y), with a path coefficient of 0.531 and a p-value of 0.000. This highlights the strategic role of RBIA in equipping cooperatives with tools to identify and respond to risks more proactively.

The R-squared values for Early Warning (Y) and Regulatory Compliance (Z) were 0.708 and 0.626, respectively, indicating that the model has strong explanatory power in the context of cooperative governance in Indonesia. The mediation analysis confirmed that Regulatory and Procedural Compliance (Z) significantly mediates the relationship between both independent variables and Early Warning (Y). These indirect effects underscore the critical role of compliance as a pathway through which digital internal control and RBIA enhance the effectiveness of early warning mechanisms.

These findings offer empirical support for the development of stronger governance frameworks in Indonesian cooperatives, emphasizing the importance of digitalization and risk-based auditing in maintaining accountability and operational sustainability.

Discussion

The data collection method in this study was carried out by distributing questionnaires using a Likert scale. The questionnaire was filled out by 100 respondents who were the research sample. The collected data were then analyzed using the Structural Equation Model – Partial Least Square (SEM–PLS) technique. The analysis process consists of two main stages, namely testing the validity and reliability of the instrument, and testing the significance of the relationship between variables in the model.

Table 1. Validity and Reliability Test Results

Variable	Cronbach's Alpha	VE
Risk Based Internal Audit (RBIA) (X1)	0,869	,793
COSO (X2)	0,849	,689
Compliance (Z)	0,561	,694
Early Warning System (Y)	0,610	,719

Source: Data Processed, 2025

Table 1 explains the variables in this study have Cronbach's Alpha and Average Variance Extracted (AVE) values. This value indicates that each variable has met the validity and reliability criteria of the instrument. The instrument used in this study can be said to be feasible to measure the constructs studied. The analysis process can be continued to the next stage, namely testing the significance of the relationship between variables in the research model.

Table 2. Specific Indirect Effects

Variable	Original Sample	T-Count	P-Value
X1 -> Z ->Y	0,189	3,252	0,001
X2 -> Z ->Y	0,106	2,023	0,044

Source: Data Processed, 2025

Table 2 shows that Risk Based Internal Audit (X1) and COSO (X2) have high reliability with Cronbach's Alpha of 0.869 and 0.849 respectively and AVE values above 0.6. Compliance (Z) and Early Warning System (Y) show moderate reliability with Cronbach's Alpha of 0.561 and 0.610, but remain valid due to AVE values of 0.694 and 0.719, respectively. All variables meet the requirements of convergent validity and are reliable enough for advanced analysis.

Table 3. R-Square Test

Variable	R Square	R Square Adjusted
Z	0,626	0,618

Y	0,708	0,688

Source: Data Processed, 2025

Table 3 shows that the Compliance (Z) variable is described by RBIA (X1) and COSO (X2) by 62.6%, with an R Square Adjusted value of 61.8%. Meanwhile, the Early Warning System (Y) variable is explained by X1, X2, and Z by 70.8%, with an R Square Adjusted value of 68.8%. This shows that the model has a strong ability to explain dependent variables.

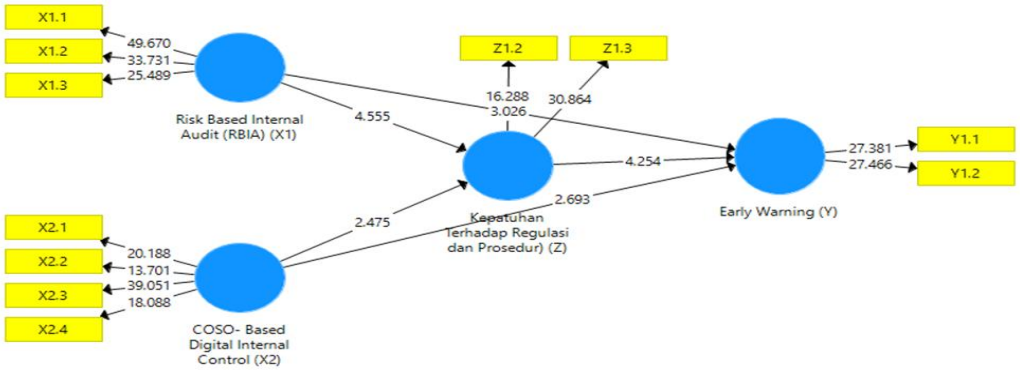


Figure 2. Research Model

Source: Data Processed, 2025

The figure shows that Risk Based Internal Audit (X1) and COSO-Based Digital Internal Control (X2) have an effect on Compliance with Regulations and Procedures (Z) and Early Warning (Y). X1 has a stronger direct influence on Z (4,555) and Y (4,254) than X2, whose influence on Z (2,475) and Y (2,693) is relatively lower. Z also made a positive contribution to Y (2,693), indicating that regulatory compliance strengthens the early warning system in the cooperative.

Conclusions

This study demonstrates that the integration of COSO-based digital internal control systems and Risk-Based Internal Audit (RBIA) significantly enhances regulatory compliance and the effectiveness of early warning systems (EWS) in Indonesian cooperatives. The empirical results from SEM-PLS analysis show that both COSO and RBIA exert direct positive effects on EWS, and that regulatory compliance functions as a partial mediator in these relationships. These findings confirm that compliance mechanisms serve as critical conduits through which digital controls and risk-based audits translate into improved risk detection and governance outcomes.

The COSO framework, when implemented through digital platforms, contributes to more efficient monitoring, real-time reporting, and adherence to standards, thereby strengthening procedural integrity within cooperatives. Similarly, RBIA enhances the strategic alignment of audit functions, ensuring that the most critical risk areas receive appropriate oversight. Together, these mechanisms help cooperatives move from reactive to proactive governance, enabling early identification of financial and operational anomalies.

Furthermore, the high explanatory power of the structural model (R^2 values of 0.626 for compliance and 0.708 for EWS) reinforces the relevance of combining digital governance tools and risk-focused audit practices in the cooperative context. The findings offer practical implications for cooperative leaders, auditors, and regulators, suggesting that investments in digital infrastructure and audit capacity building can yield measurable improvements in compliance and early risk mitigation.

In conclusion, this research provides an integrative model that supports the design of more resilient, transparent, and accountable cooperative institutions. Future studies are encouraged to expand this model by incorporating emerging technologies such as artificial intelligence, blockchain, and predictive analytics to further elevate the accuracy, responsiveness, and sustainability of internal audit and compliance systems in the cooperative sector.

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