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Governance, Risk, Compliance Assesment for Sustainable Village-Owned Enterprises Using Fuzzy AHP-SAW

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ABSTRACT:*The number of Village-Owned Enterprises (BUMDesa) in Indonesia has grown to more than 51,000 units, positioning them as a key vehicle for achieving Village SDGs 2030. However, national audit findings (BPK RI) indicate that a large proportion of BUMDesa remain inactive or operate as mere formalities, largely due to weak governance, unmanaged risk, and low regulatory compliance. Existing GRC (Governance, Risk, Compliance) maturity instruments were mostly designed for private corporations and are not readily applicable to the hybrid social-business character of BUMDesa. This study proposes GRC-Dex, a web-based decision support system that measures BUMDes GRC maturity using Fuzzy Analytical Hierarchy Process (Fuzzy AHP). Three GRC criteria—Governance, Risk Management, and Compliance—were derived from Indonesian Government Regulation No. 11/2021 on BUMDesa and validated through content validity testing with practitioners. Raw indicator scores are converted into a five-level fuzzy scale (Very Good to Poor) and processed through pairwise comparison to obtain criteria weights and consistency ratios. The method was tested on three East Java BUMDesa—KertoRaharjo, Larasati, and Sumber Sejahtera—producing consistent priority vectors (CR < 0.1) and a final ranking with KertoRaharjo scoring highest (0.4430), followed by Larasati (0.3863) and Sumber Sejahtera (0.1706). The resulting index and its underlying model were implemented as the GRC-Dex web application, enabling BUMDesa managers, village governments, and other stakeholders to independently self-assess and monitor GRC maturity, supporting more objective and transparent decision-making for sustainable village-level economic development.*

KEY WORD*: Governance, Risk, Compliance; Village-Owned Enterprise; BUMDesa; Fuzzy AHP; Decision Support System*

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I. INTRODUCTION

Village-Owned Enterprises (BUMDesa) are business entities established under Indonesia's Village Law to drive local economic growth and generate employment at the village level. As of recent records, the number of BUMDesa in Indonesia has reached 51,134 units, reflecting the strong national push to use BUMDesa as an engine of village economic rebound (Trisnawati, 2021). Despite this rapid growth, the 2021 audit summary of the Indonesian Supreme Audit Board (BPK RI) reveals persistent structural weaknesses: 1,670 BUMDesa have not yet contributed to Village Original Income (PAD), 2,188 units are not yet fully operational, 1,462 lack business feasibility support, 1,033 have not submitted proper reports, 863 show weak administrative order and accountability, and 585 are managed by incompetent operators(Widyastuti & Affan, 2022).

These findings indicate that the establishment of BUMDesa has, in many cases, not translated into effective operations. Government Regulation No. 11 of 2021 on BUMDesa mandates that management be carried out with prudence—particularly with regard to risk management—while also opening BUMDesa to third-party partnerships and investment, which in turn raises the urgency of sound governance and regulatory compliance. Without adequate Governance, Risk management, and Compliance (GRC) practices(Spanaki, 2014), BUMDesa face elevated reputational risk and reduced public trust, both of which are essential for long-term sustainability and for realizing their role as a driving force behind the Village SDGs agenda(Puyvelde & Raeymaeckers, 2020).

Existing GRC maturity assessment instruments have largely been developed since 2005 in the context of private, profit-oriented corporations(Racz et al., 2011). To date, no validated instrument specifically accommodates the hybrid social-business character of BUMDesa as a social enterprise. This gap motivates the present study, which aims to: (1) identify GRC practice patterns relevant to BUMDesa sustainability, (2) design a validated GRC assessment instrument tailored to BUMDesa, and (3) develop GRC-Dex, a decision support system that applies Fuzzy Analytical Hierarchy Process (Fuzzy AHP) to compute an objective, multi-criteria GRC maturity index.

The remainder of this paper is organized as follows. Section II reviews related work on BUMDesa governance and GRC assessment methods. Section III describes the proposed GRC-Dex framework and the Fuzzy AHP procedure. Section IV presents the case study and implementation. Section V discusses the results, and Section VI concludes the paper.

BUMDesa exhibits the characteristics of a social enterprise: an organization that pursues a social mission while operating through market-based business mechanisms(Erin et al., 2018). As a hybrid organization combining business and social objectives, BUMDesa faces a distinctive governance challenge—balancing the trade-off between commercial and social activities while sustaining revenue generation without compromising its social purpose(Svinarky, 2022). Prior studies also emphasize that governance in social enterprises should be participatory, involving all stakeholders in establishment, development, and oversight (Grossi & Argento, 2022); for BUMDesa, this translates into active community participation in institutional decision-making.

Several structural constraints have been identified in BUMDesa management: limited managerial capacity and competence of operators, ineffective communication concentrated among village elites, inconsistent interpretation of BUMDesa regulations, low community participation, and limited business scale (Puspitasari, 2021). Mitchell, (2007) found that the level of governanceThe GRC concept applied in this study follows the integrated framework promoted by the GRC Forum Indonesia, which defines Governance, Risk Management, and Compliance as three interrelated subjects, each built upon four common components: strategy, process, people, and information/communication/technology. Governance ensures that boards and management define clear roles, responsibilities, and oversight; Risk Management focuses on identifying, analyzing, and mitigating the impact of uncertainty; and Compliance ensures conformity with laws, regulations, and internal policies. Related empirical work on GRC and organizational risk includes (Wibowo et al., 2022) [9] and (Ayurini & Wijayati, 2025),(Frigo& Anderson, 2009) while BUMDesa-specific risk and sustainability research includes studies on financial risk (Leal Filho, 2020), governance risk (Aida Makaš, 2023), and fraud/accounting risk(Nasal & Gani, 2023). This study builds on Stewardship Theory, which is considered suitable for the BUMDesa context because it emphasizes collective welfare and long-term custodianship of shared community resources rather than purely agency-based, self-interested behavior.

II. RELATED WORK

2.1 GRC Maturity Assesment

For multi-criteria decision support, Analytical Hierarchy Process (AHP) is a well-established method for structuring a complex, unstructured decision situation into a hierarchy of criteria and alternatives, using pairwise comparison to derive relative priority weights (Erkut, 2020), (Batenburg et al., 2014). To accommodate the inherent subjectivity and imprecision of qualitative GRC assessment, this study integrates AHP with a fuzzy scoring scale (Fuzzy AHP)(Wang et al., 2012), converting raw quantitative indicator scores into qualitative maturity levels before priority computation.

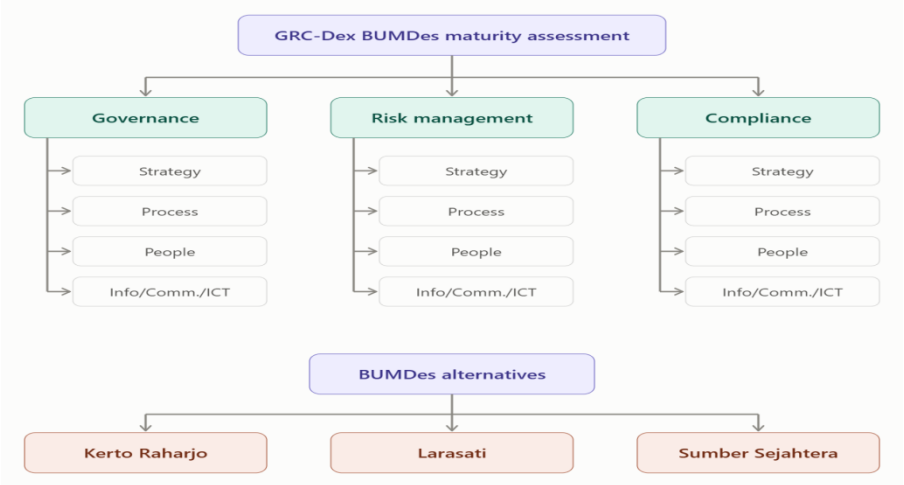

Fig. 1. GRC-Dex decision hierarchy: GRC maturity is assessed through Governance, Risk Management, and Compliance criteria, their four underlying components, and three BUMDesa alternatives.

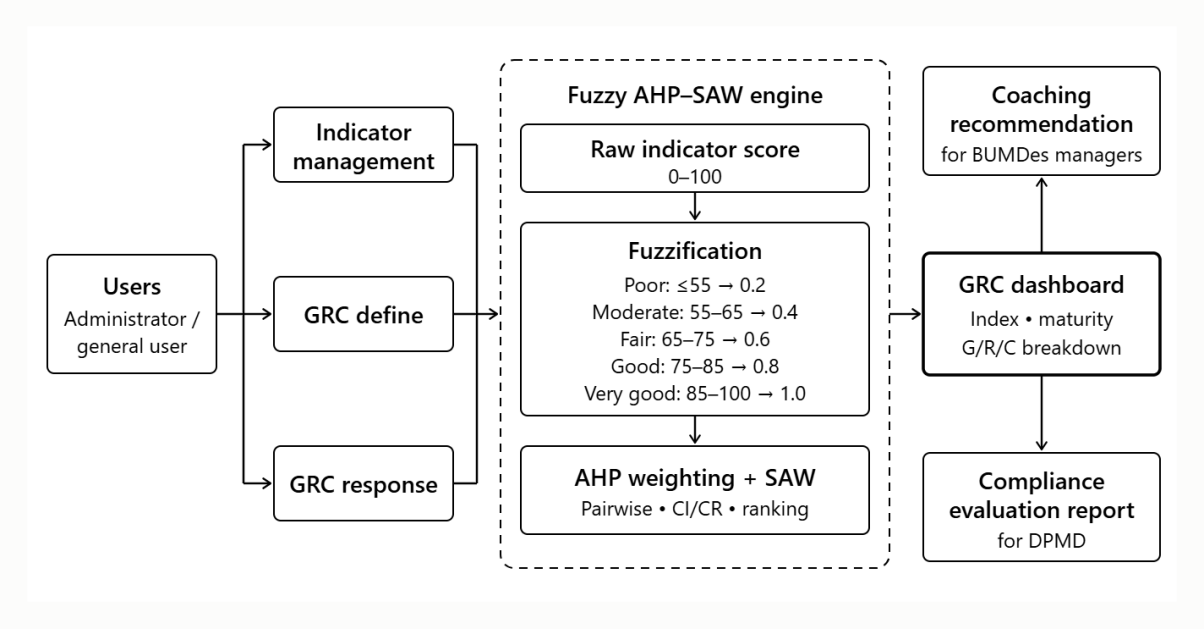

Fig. 2.Stages of GRC maturity assessment for BUMDesa

using GRC-DexEach indicator's raw score (0–100) is mapped onto a five-level fuzzy linguistic scale, as summarized in Table I. This conversion allows heterogeneous qualitative judgments to be represented consistently across all indicators before aggregation. The score-to-linguistic mapping is illustrated in Fig. 2.

Table I. Fuzzy Scale Convertion

Score Range	Linguistic Var.	Wt.
85 < x ≤ 100	Very Good (SB)	1.0
75 < x ≤ 85	Good (B)	0.8
65 < x ≤ 75	Fair (C)	0.6
55 < x ≤ 65	Moderate (S)	0.4
x ≤ 55	Poor (K)	0.2

2.2 Fuzzy AHP-SAW Procedure

After indicator-level fuzzification, GRC-Dex applies AHP at the criteria and alternative (BUMDesa) levels, with SAW computed in parallel as a cross-check. In this implementation, fuzzification is applied to the indicator scores before the AHP stage(Ayurini & Wijayati, 2025); the pairwise comparisons themselves retain Saaty's crisp 1–9 scale. The computation flow is shown in this:

1) Construct the decision hierarchy: goal (measuring BUMDesa GRC maturity), criteria (Governance, Risk, Compliance), and alternatives (the BUMDesa being assessed).

2) Build pairwise comparison matrices for the alternatives under each criterion, using Saaty's 1–9 fundamental scale of relative importance; in parallel, normalize the same fuzzified decision matrix against the maximum value per benefit attribute for SAW.

3) Normalize each AHP comparison matrix and compute the priority (eigenvector) weight for each alternative; compute the SAW weighted score Vi as the sum of criterion weight times normalized rating.

4) Compute the consistency index (CI) and consistency ratio (CR) for each AHP matrix:

$$CI = (\lambda max - n) / (n - 1), \quad CR = CI / RI$$

whereλmax is the principal eigenvalue, n is the matrix order, and RI is the random consistency index (RI = 0.58 for n = 3). A matrix is considered consistent when CR < 0.1.

5) Aggregate the weighted priority vectors across the three criteria (each criterion weighted equally at 1/3, per regulatory equivalence) to obtain the final GRC maturity score for each BUMDesa alternative, cross-validated against the SAW ranking.

2.3 System Architecture and Output Pipeline

The computational model above is implemented in the GRC-Dex web application, which provides three core modules: (1) Indicator Management, for defining and scoring GRC indicators under each criterion; (2) GRC Define, for categorizing indicators into Governance, Risk Management, and Compliance; and (3) GRC Response, for uploading respondent assessment data (CSV/XLSX) and automatically computing the GRC index using the Fuzzy AHP-SAW engine described above.(Calabrese et al., 2019) The system supports two user roles—administrator and general user(Wang et al., 2012)(, Awasthi et al., 2018).

III. METHOD: CONCEPTUAL MODEL DEVELOPMENT

3.1 Research Objectives

The proposed method was applied to three BUMDesa in East Java, Indonesia: BUMDesaKertoRaharjo, BUMDesaLarasati, and BUMDesaSumber Sejahtera. BUMDesaLarasati was selected as a benchmark case, having won the 2020 East Java Provincial BUMDesa competition and having implemented New Public Governance across three pillars: institutional and business development, financial access (in partnership with Bank Jatim), and digitalization through an online village marketplace ecosystem.

Table 2.The raw assessment scores obtained for the three criteria.

BUMDesa	G	R	C
KertoRaharjo	80	73	72
Larasati	67	72	88
Sumber Sejahtera	88	81	83

These scores serve as input to both the descriptive fuzzy classification and the AHP pairwise comparison stage described in Section III.

IV. RESULT And DISCUSSION

4.1. Pairwise Comparison Results

Pairwise comparison matrices were constructed for each criterion based on relative preference judgments derived from the raw scores in Table II. For the Governance criterion, the resulting priority vector was 0.5907 (KertoRaharjo), 0.3338 (Larasati), and 0.0755 (Sumber Sejahtera), with CI = 0.0071 and CR = 0.0122 — indicating a consistent judgment matrix (CR < 0.1). For the Risk Management criterion, the priority vector was 0.0905, 0.7030, and 0.2065 respectively, with CI = 0.0092 and CR = 0.0158. For the Compliance criterion, the priority vector was 0.6479, 0.1222, and 0.2299, with CI = 0.0018 and CR = 0.0032. All three matrices satisfy the consistency requirement, confirming the reliability of the pairwise judgments used in this study.

4.2. Final GRC Maturity Ranking

Applying equal criteria weighting (1/3 each, reflecting their equivalent regulatory standing under PP No. 11/2021), the weighted evaluation scores were aggregated as shown in Table 3.

Table3. Final GRC Index Ranking (AHP)

Criteria	Wt.	KR	LR	SS
Governance	1/3	0.197	0.111	0.025
Risk Mgmt.	1/3	0.030	0.234	0.069
Compliance	1/3	0.216	0.041	0.077
Total	1	0.443	0.386	0.171

KR = KertoRaharjo, LR = Larasati, SS = Sumber Sejahtera.

The final GRC maturity ranking was determined by aggregating the weighted scores of the three assessment criteria: Governance, Risk Management, and Compliance. In this study, equal weights of 1/3

(33.33%) were assigned to each criterion, reflecting their equivalent regulatory significance under Government Regulation No. 11 of 2021 concerning Village-Owned Enterprises (BUMDesa). The weighted evaluation results are presented in Table 3.As shown in Table 3, KertoRaharjo (KR) achieved the highest overall GRC maturity score of 0.443, followed by Larasati (LR) with 0.386, and Sumber Sejahtera (SS) with 0.171. These results indicate differences in the relative maturity of GRC implementation across the three BUMDesa.

A closer examination of the criterion-level scores reveals distinct strengths among the assessed BUM Desa. KertoRaharjo demonstrated its strongest performance in Compliance (0.216), followed by Governance (0.197), while its Risk Management score remained relatively low (0.030). This suggests that its overall GRC performance is primarily supported by regulatory compliance and governance practices, although improvements in risk management are still required.

In contrast, Larasati recorded its highest contribution in Risk Management (0.234), followed by Governance (0.111) and Compliance (0.041). This pattern indicates that risk management represents its strongest GRC dimension, whereas strengthening compliance mechanisms could further improve its overall maturity.Meanwhile, Sumber Sejahtera obtained relatively low scores across all three criteria, with Compliance (0.077) contributing the largest share, followed by Risk Management (0.069) and Governance (0.025). This result suggests that more comprehensive institutional improvements are needed to strengthen its governance structures, risk management practices, and regulatory compliance.

Overall, the ranking demonstrates that GRC maturity is not merely determined by the aggregate assessment score but also reflects the different performance profiles of each BUMDesa across the three dimensions. These findings highlight the importance of adopting a differentiated improvement strategy, in which development priorities are tailored to the specific weaknesses identified in each GRC dimension. Such an approach enables the GRC assessment framework to function not only as a measurement instrument but also as a decision-support mechanism for identifying institutional improvement priorities and strengthening the sustainability governance of BUMDesa.

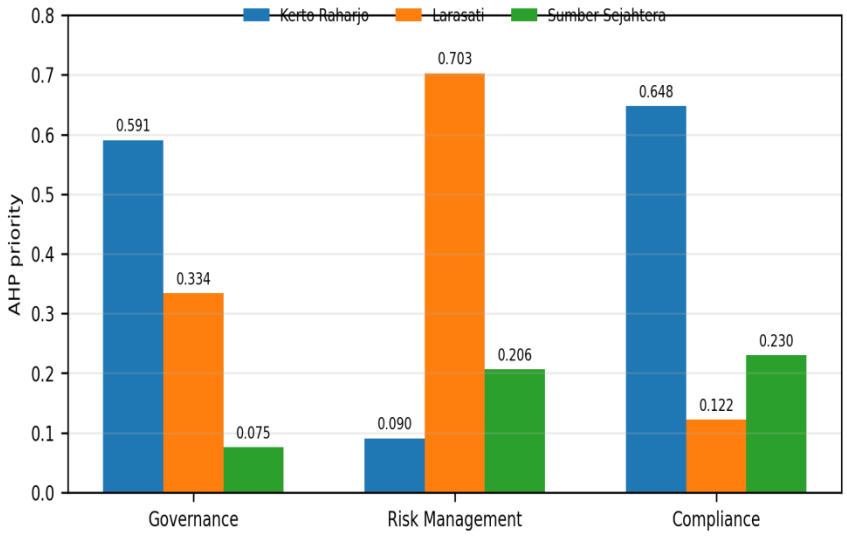

Fig. 5.AHP priority profile across the three GRC criteria for the three assessed BUMDes.

The final ranking places BUMDesaKertoRaharjo as the highest-scoring entity (0.4430), followed by Larasati (0.3863) and Sumber Sejahtera (0.1706). Notably, KertoRaharjo's strength is concentrated in Governance and Compliance rather than Risk Management, while Larasati—despite having the lowest raw Governance score—scores highest on Risk Management priority, illustrating how AHP's relative pairwise weighting can surface priority patterns that raw averages alone would not reveal.

4.3. GRC-Dex Application

The computed index and underlying instrument were operationalized in the GRC-Dex web application. Through the Indicator and GRC Define modules, assessors configure indicators under each of the three GRC

categories; through GRC Response, respondent data is uploaded and the GRC index is computed automatically(Manoharan et al., 2023). The resulting dashboard displays the normalized index score, a maturity-level gauge (Forming to Optimized), and a category-level breakdown for Governance, Risk Management, and Compliance, enabling BUMDesa managers and village governments to track maturity over time and prioritize improvement areas.

Table 4 SAW Result of BUM Desa

Alternative	SAW Score (V)	Rank
BUMDesaLarasati	0.9825	1
BUMDesaKertoRaharjo	0.9525	2
BUMDesaSumber Sejahtera	0.9076	3

To validate the consistency of the assessment results, the Simple Additive Weighting (SAW) method was applied as a complementary decision-making approach. Unlike the AHP-based ranking, which determines relative priorities through pairwise comparisons, SAW aggregates normalized performance scores across the assessment criteria to generate an overall preference value for each BUMDesa.As presented in Table 4, BUMDesaLarasati achieved the highest SAW score of **0.9825**, ranking first among the three assessed entities. This was followed by BUMDesaKertoRaharjo, with a score of **0.9525**, and BUMDesaSumber Sejahtera, with a score of **0.9076**.

These findings reveal a different ranking pattern compared with the AHP results presented in Table 3. While KertoRaharjo obtained the highest relative priority score under AHP, Larasati achieved the highest preference value under SAW(Erkut, 2020). This difference highlights the distinct analytical characteristics of the two methods. AHP captures the relative priorities generated through hierarchical pairwise comparisons, whereas SAW evaluates the aggregated performance of alternatives based on normalized criteria scores.The relatively high SAW scores across all three BUMDesa indicate that their normalized performance values are comparatively close within the assessed alternatives. However, these scores should be interpreted as relative preference values rather than absolute GRC maturity percentages.Gericke et al., (2009) the use of SAW as a complementary validation method provides an additional perspective for evaluating GRC performance and identifying differences among BUMDesa. Rather than relying on a single ranking result, integrating AHP and SAW enables a more comprehensive interpretation of assessment outcomes and supports managerial decision-making(Calabrese et al., 2019), .

Integration of Assessment Results with the Four GRC Components

This is the core part of the proposed model. Each GRC assessment result is not only followed up based on the GRC variables, but also translated into four managerial components.

Table 5. Components GRC Strategy

GRC Subject	Strategy	Process	People	Information, Communication & Technology
Governance	Establish business priorities and policies	Improve structure, SOPs, and accountability	Clarify the responsibilities of managers	Develop performance reporting and dashboards
Risk	Establish risk mitigation strategies	Develop risk control procedures	Assign risk owners	Build a risk register and risk monitoring
Compliance	Establish compliance policies	Improve procedures and legal documentation	Increase understanding of regulations	Build compliance documentation and monitoring

This is the core part of the model that proposing. Each GRC assessment result is not only addressed based on GRC variables but is also translated into four managerial components.

The central contribution of the proposed GRC integration model lies in translating assessment results into actionable managerial interventions. The model extends beyond measuring Governance, Risk Management, and Compliance performance by connecting each identified GRC dimension to four organizational management components: Strategy, Process**,** People, and Information, Communication, and Technology (ICT)(Ayurini & Wijayati, 2025).As illustrated in Table 5, this integration provides a structured mechanism for translating GRC assessment findings into specific improvement directions. Each GRC dimension is addressed through four complementary managerial perspectives, ensuring that identified weaknesses can be translated into organizational strategies, operational procedures, human resource responsibilities, and supporting information systems(Aida Makaš, 2023).

First, the Governance dimension is translated into managerial actions aimed at strengthening organizational direction and accountability. From a strategic perspective, BUMDesa is expected to establish clear business priorities and governance policies. At the process level, improvements involve organizational structures, standard operating procedures (SOPs), and accountability mechanisms. The people component emphasizes clarifying managerial roles and responsibilities, while the ICT component focuses on developing performance reporting systems and dashboards to support transparency and monitoring.

Second, the Risk Management dimension focuses on strengthening the capacity of BUMDesa to identify, assess, mitigate, and monitor business and operational risks. At the strategic level, risk mitigation strategies should be established in alignment with organizational objectives. These strategies must subsequently be translated into risk control procedures and operational mechanisms. The people component emphasizes assigning clear risk ownership to responsible managers or personnel. Meanwhile, the ICT component supports the development of risk registers and digital risk-monitoring systems to facilitate continuous risk identification and control.

Third, the Compliance dimension translates regulatory requirements into organizational policies and operational practices. Strategically, BUMDesa needs to establish compliance policies that reflect applicable laws and regulations. At the process level, this requires improving operational procedures and maintaining adequate legal and administrative documentation. The people component emphasizes increasing managerial and employee understanding of relevant regulatory requirements. Finally, ICT facilitates the development of digital compliance documentation and monitoring systems to support regulatory adherence and accountability(Nasal & Gani, 2023).The integration of these dimensions demonstrates that GRC implementation requires more than the establishment of separate governance, risk, and compliance mechanisms. Instead, effective GRC implementation depends on the alignment of strategic direction, organizational processes, human resource capabilities, and information technology(Calabrese et al., 2019).

Table 5 therefore illustrates the operational mechanism of the proposed model, in which GRC assessment findings serve as the basis for determining managerial improvement priorities across the four organizational components. This approach enables BUMDesa managers to move from assessment-based diagnosis toward structured and measurable improvement actions.Furthermore, the proposed integration creates a practical link between GRC maturity assessment and sustainability-oriented organizational development. By embedding GRC principles into strategy, processes, people, and ICT, BUMDesa can progressively strengthen institutional accountability, operational resilience, regulatory compliance, and the capacity to sustain its business activities(Ramadana et al., 2013).

4.4. Coching Recommendation for BUMDesa Manager

The effectiveness of GRC implementation depends not only on the ability to assess organizational maturity but also on how assessment findings are translated into appropriate managerial responses. In the context of BUMDesa, GRC assessment should serve as a diagnostic foundation for identifying organizational weaknesses, understanding their underlying causes, and determining corrective actions that are relevant to operational and institutional needs(Raharjo et al., 2022). Therefore, the proposed GRC-Dex model extends beyond providing maturity scores and rankings by incorporating a coaching-oriented recommendation mechanism to support managerial improvement.

This mechanism positions BUMDesa managers as key actors in interpreting assessment results and initiating organizational improvements. Rather than treating low-scoring indicators merely as evaluation findings, managers are encouraged to examine the underlying problems and formulate targeted follow-up actions(Juliman & Muslimin, 2019). This process establishes a logical sequence from GRC assessment, managerial diagnosis**, to corrective action**, ensuring that each identified weakness is addressed through a specific and actionable intervention.

To operationalize this approach, the GRC-Dex model provides coaching recommendations at the indicator level across the three GRC dimensions: Governance, Risk Management, and Compliance. Each inadequate indicator is linked to a managerial diagnosis and a recommended follow-up action, as illustrated in Table 6. The recommendations are subsequently aligned with the four managerial components—Strategy, Process, People, and Information, Communication, and Technology (ICT)—to facilitate their implementation within the organizational structure of BUMDesa.

Through this mechanism, GRC-Dex functions as an action-oriented decision-support system that facilitates continuous organizational improvement. It enables managers to move from identifying weaknesses toward implementing structured corrective actions, thereby strengthening institutional accountability, operational control, risk resilience, and regulatory compliance as essential foundations for BUMDesa sustainability.

Table 6. GRC DexAsessment and Follow up Action

GRC Dex Assessment Result	Manager's Diagnosis	Follow-up Action
GV8 – Manager accountability is inadequate	Accountability is not yet running effectively	Establish a periodic financial and performance reporting system
GV12 – Asset management is inadequate	Assets have not been properly inventoried	Create an asset register and maintenance procedures
RK9 – Business risk is not managed in an integrated manner	No business risk mapping yet	Develop a risk register and risk mitigation
RK14 – Financial recording SOP is inadequate	Weak transaction control	Establish SOPs for cash receipts and disbursements
CP2 – Business unit legality is inadequate	Legal documents are incomplete	Conduct an inventory and fulfillment of legal documents
CP12 – Environmental and social protection is inadequate	Business impact is not yet managed	Develop procedures for managing social and environmental impacts

Table 6 illustrates how the GRC-Dex assessment results are translated into managerial diagnoses and follow-up actions. Each indicator identified as inadequate is not treated as an isolated finding, but is interpreted by the manager to determine the underlying organizational problem and the corrective action required.In the Governance dimension, indicator GV8 shows that manager accountability is inadequate, which the manager diagnoses as accountability not yet running effectively. The follow-up action is to establish a periodic financial and performance reporting system. Indicator GV12 shows that asset management is inadequate, diagnosed as assets not having been properly inventoried, so the manager is advised to create an asset register and maintenance procedures.

In the Risk dimension, indicator RK9 reveals that business risk is not managed in an integrated manner, as no business risk mapping exists yet. The recommended action is to develop a risk register and risk mitigation measures. Indicator RK14 shows that the financial recording SOP is inadequate, indicating weak transaction control, which is addressed by establishing SOPs for cash receipts and disbursements.In the Compliance dimension, indicator CP2 shows that the legality of the business unit is inadequate because legal documents are incomplete. The follow-up is to conduct an inventory and fulfill the required legal documents. Indicator CP12 shows that environmental and social protection is inadequate, as the business's impact has not yet been managed, so procedures for managing social and environmental impacts need to be developed.

Overall, the table shows that the GRC-Dex functions not only as a measurement tool but also as a decision-support mechanism, since each weak indicator is linked to a concrete and actionable response. These actions can then be classified into the four managerial components (Strategy, Process, People, and Information, Communication & Technology) as described in the integration framework.

4.5. Proposed narrative for the Head of the Village Community Empowerment Office (DPMD)

GRC Dex is envisioned not merely as an instrument to measure the maturity level of Village-Owned Enterprise (BUMDesa) governance, but also as a decision-support system for the DPMD. It will enable the office to design targeted, data-driven guidance tailored to the specific needs of each BUMDesa. By integrating Governance, Risk, and Compliance (GRC), assessment results can be translated into capacity-building programs, risk mitigation strategies, compliance strengthening, and continuous monitoring and evaluation. Consequently, the DPMD can shift its approach from generalized oversight to a model of guidance based on the actual capabilities and needs of each BUMDesa(Puspitasari, 2021).

My key strategic recommendation is to position GRC Dex as a "Decision Support System for the DPMD in Sustainable Village-Owned Enterprise Development." This will add significant value to your application, as its benefits extend beyond the individual BUMDesa level to also support the governance of BUMDesa development at the local government level.The following is the feedback provided to the DPMD based on the results of the GRC assessment.

1. Institutionalization of GRC Assessment: The DPMD (Village Community Empowerment Office) promotes the use of the GRC Dex assessment as an instrument for periodically mapping the governance capabilities of Village-Owned Enterprises (BUMDesa).
2. Evidence-Based Development Policy: The DPMD utilizes assessment results as a foundation for designing development programs tailored to the specific needs of each BUMDesa.
3. Integrated GRC Capacity Building: The DPMD develops competency-enhancement programs for BUMDesa management, covering strategy, processes, human resources, and information and technology systems.
4. GRC-Based Monitoring and Evaluation: The DPMD establishes a mechanism to monitor follow-up actions based on assessment results, ensuring that recommended improvements are effectively implemented.
5. Sustainable Village Enterprise Governance: The DPMD integrates the strengthening of governance, risk management, and compliance with the economic, social, and environmental sustainability agenda of BUMDesa.

V. IMPLICATIONS

5.1. Theoretical Implications

This study contributes to the literature on sustainability governance by extending the application of Governance, Risk Management, and Compliance (GRC) from a conventional organizational control framework into an integrated sustainability-oriented assessment model for Village-Owned Enterprises (BUM Desa). The proposed GRC-Dex framework demonstrates that institutional sustainability cannot be assessed solely through financial or operational performance, but also requires an integrated evaluation of governance structures, risk management capabilities, and regulatory compliance(Mitchell, 2007).

Furthermore, this study extends the conceptualization of GRC by linking its three functional dimensions with four organizational components: Strategy, Process, People, and Information, Communication, and Technology (ICT)(Grossi & Argento, 2022). This integration provides a more comprehensive understanding of how GRC principles can be operationalized within village-level business institutions. By connecting maturity assessment with managerial diagnosis and follow-up recommendations, the study positions GRC as both an organizational evaluation framework and an action-oriented mechanism for strengthening sustainability governance.

5.2. Practical and Managerial Implications

From a managerial perspective, GRC-Dex provides a decision-support mechanism that enables BUM Desa managers to identify institutional weaknesses and establish improvement priorities based on assessment evidence(Manoharan et al., 2023). Rather than relying on general managerial judgments, managers can use indicator-level assessment results to formulate targeted interventions in governance, risk management, and compliance.

The integration of assessment results with Strategy, Process, People, and ICT also provides a practical framework for translating identified weaknesses into organizational improvements. For example, weaknesses in managerial accountability can be addressed through structured reporting systems, inadequate asset management through digital asset registers, and insufficient risk management through risk identification and mitigation procedures. Similarly, compliance weaknesses can be addressed through improved legal documentation and regulatory monitoring(Awasthi et al., 2018).

These managerial interventions are expected to strengthen operational efficiency, reduce potential financial and asset losses, improve accountability, and support more sustainable business performance. In the longer term, improved institutional capacity and risk control may enhance BUMDesa's ability to generate Village Original Income (PAD) and contribute to local economic development.

5.3. Policy Implications

The findings also provide implications for village development policymakers, particularly the Village Community Empowerment Offices (DinasPemberdayaanMasyarakatdanDesa/DPMD). GRC-Dex can serve as an evidence-based monitoring and coaching instrument to support the supervision and institutional development of BUM Desa. Instead of applying uniform development interventions, DPMD can use GRC assessment results to identify differences in institutional maturity and formulate differentiated capacity-building programs according to the specific weaknesses of each BUM Desa.

At the policy level, the proposed framework can support the integration of GRC-based assessment into broader village enterprise development programs(Frigo & Anderson, 2009). The results can inform the prioritization of managerial training, governance improvement, risk mitigation assistance, asset management strengthening, and regulatory compliance facilitation. Furthermore, aggregated assessment results can provide DPMD with a broader understanding of institutional challenges across BUM Desa, supporting more targeted resource allocation and monitoring strategies(Leda, n.d.).

Ultimately, integrating GRC-Dex into village enterprise development policies may strengthen the institutional capacity of BUM Desa as an instrument of inclusive rural economic development. This is particularly relevant to the achievement of the Village Sustainable Development Goals (SDGs), as accountable governance, effective risk management, and regulatory compliance provide essential institutional foundations for sustainable village economic activities(Badria et al., 2021).

5.4. Overall Contribution to Sustainability Governance

The broader implication of this study is that GRC-Dex introduces a shift from assessment-oriented governance toward action-oriented sustainability governance. By integrating maturity measurement, managerial diagnosis, coaching recommendations, and organizational improvement components, the proposed model establishes a practical connection between institutional evaluation and sustainability-oriented decision-making.

VI.CONCLUSION

This study developed and implemented GRC-Dex, a Fuzzy AHP-based decision support system designed to assess and strengthen the Governance, Risk Management, and Compliance (GRC) maturity of Village-Owned Enterprises (BUMDesa). Grounded in Government Regulation No. 11 of 2021 and validated through practitioner assessments, the proposed framework provides an integrated approach to evaluating institutional maturity across three fundamental GRC dimensions. The application of the model to three BUM Desa in East Java demonstrated its applicability in identifying institutional strengths, weaknesses, and relative assessment priorities, with all AHP consistency ratios meeting the acceptable threshold ($CR < 0.1$).

The findings reveal variations in GRC performance among the assessed BUMDesa, highlighting that institutional maturity is influenced by different levels of governance effectiveness, risk management capabilities, and regulatory compliance. The complementary SAW evaluation further provided an alternative perspective on the relative performance of the assessed entities. These results emphasize the importance of multidimensional assessment rather than relying on a single organizational performance indicator.

The main contribution of this study lies in extending GRC maturity assessment beyond measurement by integrating assessment findings with four managerial components: Strategy, Process, People, and Information, Communication, and Technology (ICT). Through this integration, GRC-Dex translates identified

weaknesses into managerial diagnoses and actionable coaching recommendations. Consequently, the proposed system functions not merely as a digital assessment instrument but also as an action-oriented decision-support mechanism that supports continuous organizational improvement. This approach provides a practical foundation for strengthening institutional accountability, operational resilience, asset management, and regulatory compliance within BUMDesa.

From a sustainability governance perspective, the proposed model offers opportunities to strengthen the institutional capacity of BUMDesa as village-level economic institutions. Improved governance practices, integrated risk management, and stronger compliance mechanisms are expected to support more accountable business operations, reduce potential operational and financial losses, enhance public trust, and contribute to sustainable rural economic development. Furthermore, GRC-Dex provides a potential monitoring and coaching instrument for village governments and the Village Community Empowerment Offices (DPMD) in formulating differentiated institutional development interventions aligned with the Village Sustainable Development Goals (SDGs).

Nevertheless, this study has limitations. The empirical application involved only three BUMDesa in East Java, limiting the generalizability of the findings to other institutional and regional contexts. In addition, the cross-sectional assessment captures GRC conditions at a particular point in time and does not yet demonstrate changes in organizational maturity or long-term sustainability performance. Future research should expand the assessment to a larger and more geographically diverse sample of BUMDesa, incorporate longitudinal evaluations to examine changes in GRC maturity, and further validate the model using complementary multi-criteria decision-making methods. Integration with regional government digital reporting systems and the development of automated monitoring capabilities could also enhance the scalability and institutional usefulness of GRC-Dex.

Overall, this study establishes GRC-Dex as a foundation for transforming GRC assessment from a measurement-oriented approach into an action-oriented sustainability governance mechanism. By connecting digital assessment, managerial diagnosis, and structured improvement recommendations, the model offers a pathway toward more accountable, resilient, and sustainable BUMDesa institutions.

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