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Securing Patient Safety: Revealing the Necessary Levels of Intrinsic Motivation, Discipline, and Risk Management through NCA

Abstract

This study investigates how human and organizational factors shape Patient Safety Culture in healthcare settings. Specifically, we evaluate the direct and indirect structural relationships between intrinsic motivation, preventive discipline, and evidence-based risk management, while identifying the minimum necessary baseline levels (bottlenecks) required to sustain a resilient safety culture. We conducted a quantitative, descriptive-verificative study surveying 86 hospital employees at a facility in Bandung City, Indonesia. We collected primary data using validated questionnaires covering Intrinsic Motivation, Preventive Discipline, Risk Management, and Patient Safety Culture. To analyze the data, we integrated Path Analysis—to evaluate structural direct and indirect effects—with Necessary Condition Analysis (NCA) to uncover non-linear necessity logic and operational bottlenecks. Path analysis reveals that intrinsic motivation exerts a 41.2% total effect on evidence-based risk management (23.0% direct effect and 17.7% indirect effect mediated by preventive discipline), while risk management subsequently drives 83.4% of patient safety culture (epsilon = 0.194). Furthermore, NCA results establish that Preventive Discipline ($d = 0.499$, $p < 0.001$), Risk Management ($d = 0.447$, $p < 0.001$), and Intrinsic Motivation ($d = 0.420$, $p < 0.001$) all function as strong necessary conditions. Without satisfying the baseline thresholds of each variable, high patient safety culture cannot exist. Hospital administrators must pursue a dual managerial approach: utilize motivation and risk management as proactive levers to elevate safety culture while rigorously enforcing baseline preventive discipline. Relying on advanced risk systems alone is insufficient if individual motivation or discipline drops below critical necessity thresholds. This research bridges a critical methodological gap by combining traditional sufficiency-based structural modeling (Path Analysis) with necessity-based evaluation (NCA) in healthcare safety literature, offering explicit quantitative thresholds for patient safety conditions rather than relying solely on average linear relationships.

Keywords: *Patient Safety Culture, Necessary Condition Analysis (NCA), Path Analysis, Intrinsic Motivation, Risk Management, Preventive Discipline.*

Introduction

Patient safety culture serves as the foundational backbone for high-performing healthcare delivery, driving clinical excellence and safeguarding patients from preventable adverse events. A robust safety culture aligns leadership practices with frontline behaviors, empowering nurse managers to champion quality care while systematically mitigating organizational risks (Lee et al., 2023). Furthermore, a positive organizational safety climate actively fosters nurses' patient safety knowledge and intrinsic motivation, which directly translates into reliable, proactive safety behaviors during daily patient care routines (Seo & Lee, 2022). By embedding safety values into institutional routines and large-scale implementation programs, hospitals transform abstract policy mandates into shared accountability, continuous learning, and resilient healthcare systems (Caldas et al., 2022).

Modern healthcare institutions face a persistent challenge in maintaining high patient safety standards while grappling with escalating systemic operational pressures. Recent evidence shows that severe organizational bottlenecks—including widespread healthcare worker burnout, high turnover intentions, and workplace violence—directly erode patient safety culture and degrade quality of care across various care settings (Kim et al., 2023; Etezad et al., 2023; Yount et al., 2022). Although traditional safety interventions focus on rigid clinical protocols and compliance, frontline health professionals often operate under excessive operational responsibility without adequate behavioral support, leading to widespread stress and safety compromises (Etezad et al., 2023). This problem underscores the critical need for comprehensive framework adjustments that combine structural safety mechanisms with

supportive workplace environments to protect both healthcare staff and patients (Kilcullen et al., 2022).

To resolve these systemic failures, healthcare management must embrace a dual approach that integrates clinical safety protocols with an active leadership strategy. Buja et al. (2022) emphasize that a robust governance framework establishes essential clinical safety protocols, incident reporting mechanisms, and data-driven risk management strategies to prevent recurring clinical errors. However, structural protocols alone cannot guarantee safety without strong operational drive; Huang et al. (2024) demonstrate that proactive leadership directly shapes the organizational safety climate by actively supporting staff, addressing hazard reports, and modeling safety behaviors. Complementing this, Granel-Giménez et al. (2022) reveal that a supportive patient safety culture transforms paper-based procedures into daily clinical practice by encouraging open communication and teamwork. Ultimately, hospital leaders cultivate a resilient culture where staff actively execute safety protocols, ensuring comprehensive patient care and long-term organizational safety. Without establishing these elements as essential baseline conditions, hospitals risk creating operational bottlenecks where even well-designed safety systems fail to improve patient safety culture (Kilcullen et al., 2022)

Maintaining a robust patient safety culture remains a critical challenge for healthcare institutions worldwide, as systemic failures in safety directly escalate healthcare worker burnout, workplace violence, and employee turnover intentions (Al-Surimi et al., 2022; Kim et al., 2023; Zhao et al., 2024). Traditional frameworks emphasize that effective leadership and structured risk management drive continuous safety improvements (Huang et al., 2024; Ying & Allaqtta, 2025). However, organizational safety relies equally on human

factors—specifically staff members' intrinsic motivation and preventive discipline. Drawing parallels from safety-critical industries such as aviation, organizations achieve operational reliability only when individual behavioral commitment intersects with rigorous risk mitigation practices (Stosic et al., 2023). Because healthcare work environments frequently induce motivational shifts and chronic fatigue (Xu et al., 2023), identifying the fundamental drivers that sustain patient safety culture becomes an urgent operational priority for hospital management.

Despite extensive literature exploring these relationships, existing studies rely almost exclusively on additive, sufficiency-based statistical methods such as Linear Regression, Path Analysis, or Structural Equation Modeling (SEM). These linear approaches explain how variables increase safety culture on average, but they fail to determine the critical threshold levels—the mandatory baseline conditions—that must exist to prevent safety failures. A hospital may implement state-of-the-art risk management protocols, yet a severe deficit in intrinsic motivation or preventive discipline can act as a single bottleneck that collapses the entire safety culture. To bridge this methodological gap, our study utilizes Necessary Condition Analysis (NCA) alongside traditional structural evaluations to uncover the precise necessary levels and bottleneck conditions of intrinsic motivation, preventive discipline, and risk management required to secure specific performance benchmarks in patient safety culture.

Research Method

To examine the relationship between the study variables, we employed a quantitative research design with a descriptive and verificative approach. This design allowed us to paint an accurate

picture of employee perceptions while simultaneously testing hypothesis-driven relationships among the targeted constructs. We conducted the research at a hospital in Bandung City to assess how intrinsic motivation, preventive discipline, and risk management shape the overall patient safety culture within a healthcare facility.

Our research participants comprised 86 hospital employees who provided primary data through structured questionnaires. We evaluated four key variables based on established theoretical frameworks: Intrinsic Motivation, defined as engaging in an activity for its inherent satisfaction (Ryan & Deci, 2017); Preventive Discipline, conceptualized as proactive behavior by healthcare personnel to prevent errors before they occur through self-awareness, adherence to safety procedures, and safe work practices (WHO; OSHA); Risk Management, defined as a managerial approach that emphasizes the use of the best available scientific evidence to inform organizational decision-making (Barends, Rousseau, & Briner, 2014); and Patient Safety Culture, operationalized as the shared values, beliefs, and behaviors among healthcare staff and management that prioritize patient safety across all clinical and non-clinical services (AHRQ, 2019).

For the quantitative data analysis, we utilized Path Analysis to evaluate the direct and indirect structural relationships among the research variables. Following the path estimation, we conducted Necessary Condition Analysis (NCA) to identify critical bottlenecks among the predictor variables. This dual analytical approach enabled us to pinpoint the essential baseline conditions required for maintaining high safety standards, allowing us to formulate precise, actionable managerial implications for hospital administration.

Results and Discussion

We assess the psychometric properties of our research instrument using validity and reliability tests based on empirical data collected from 86 hospital employees. We evaluate four core variables—Intrinsic Motivation, Preventive Discipline, Risk Management, and Patient Safety Culture—across 15 distinct measurement items (Inst1 to Inst15) to ensure that the instrument accurately and consistently measures the targeted constructs.

Table 1. validity and reliability Test

	Intrinsic Motivation		Preventive Discipline		Risk Management		Patient Safety Culture	
	Correl	CA	Correl	CA	Correl	CA	Correl	CA
Inst1	0,367		0,542		0,328		0,497	
Inst2	0,468		0,579		0,420		0,329	
Inst3	0,456		0,331		0,449		0,508	
Inst4	0,454		0,458		0,492		0,337	
Inst5	0,383		0,519		0,415		0,440	
Inst6	0,459		0,641		0,454		0,425	
Inst7	0,356		0,345		0,406		0,425	
Inst8	0,348	0,813	0,375	0,843	0,381	0,811	0,324	0,792
Inst9	0,451		0,483		0,363		0,345	
Inst10	0,559		0,420		0,391		0,467	
Inst11	0,466		0,584		0,480		0,357	
Inst12	0,399		0,419		0,490		0,405	
Inst13	0,362		0,476		0,549		0,472	
Inst14	0,483		0,456		0,341		0,321	
Inst15	0,376		0,396		0,525		0,345	

To determine item validity, we examine the correlation coefficients between individual item scores and their respective total construct scores. Our analysis demonstrates that all correlation values across Intrinsic Motivation (ranging from 0.348 to 0.559), Preventive Discipline (ranging from 0.331 to 0.641), Risk Management (ranging from 0.328 to 0.549), and Patient Safety Culture (ranging from 0.324 to 0.497) exceed the standard minimum threshold of 0.30. These robust correlation coefficients confirm that

every item possesses adequate construct validity, meaning each question validly contributes to measuring its intended variable without conceptual overlap or ambiguity.

Our path analysis reveals that intrinsic motivation exerts a powerful influence on evidence-based risk management, generating a direct effect of 23.0% (R2 = 0.230) alongside an indirect effect of 17.7% (R2 = 0.177) mediated through preventive discipline. Combined, intrinsic motivation yields a substantial total effect of 41.2% (R2 = 0.412) on evidence-based risk management. Notably, intrinsic motivation acts as a dominant primary driver because its direct contribution outweighs its indirect pathway through preventive discipline, highlighting that healthcare professionals' inherent satisfaction and internal drive directly foster evidence-based risk oversight even before structural discipline takes effect. In the subsequent structural stage, the model demonstrates that evidence-based risk management heavily influences patient safety culture, accounting for a remarkable direct effect of 83.4% (0.834, R2 = 0.834). This overwhelming effect underscores that structured, evidence-grounded managerial decisions serve as the primary catalyst for embedding safety values into daily clinical and non-clinical routines. Meanwhile, unexamined external factors—represented by an epsilon residual value of 0.194 (19.4%)—exert a relatively minor influence on patient safety culture, affirming the comprehensive explanatory strength of our structural model.

These findings align with Munuera et al. (2023), who observe that intrinsic motivation inherently drives decision-making autonomy and risk handling depending on environmental controllability. Furthermore, as Xu et al. (2022) highlight, fostering intrinsic motivation significantly improves organizational quality of work life and proactive employee engagement, which in turn

strengthens structural compliance and proactive workplace behavior. This strong relationship confirms that structured, evidence-grounded managerial decisions serve as the primary engine for embedding safety values into clinical and operational routines.

Yeboah et al., (2025) highligh how internal safety motivation actively drives employee compliance and proactive hazard mitigation. By reinforcing this internal drive through preventive self-discipline, healthcare staff continuously execute structured risk reduction strategies in their daily operations (Ying & Allaqtta, 2025). Subsequently, evidence-based risk management directly drives 83.4% of patient safety culture with a minimal error variance (epsilon = 0.194), demonstrating that rigorous risk management and supportive leadership frameworks actively shape organizational safety culture rather than leaving it to chance (Wijaya, 2024).

The higher direct effect highlights that healthcare workers' internal satisfaction and autonomous drive directly encourage them to adopt scientific risk management practices even before structural discipline takes effect. This dynamic aligns with Zhao et al. (2024), who establish that work motivation serves as an indispensable bridge in transforming positive organizational conditions into responsible employee conduct and reduced turnover in primary healthcare settings. Furthermore, as Xu et al. (2023) observe regarding the evolution of job motivation over time, sustaining intrinsic drive is paramount for preventing burnout and maintaining long-term engagement in high-demand work environments. Ultimately, establishing such a sound safety environment yields broader organizational benefits, as Al-Surimi et al. (2022) prove that a strong patient safety culture directly enhances job satisfaction and reduces

healthcare personnel's intention to leave, solidifying long-term institutional stability.

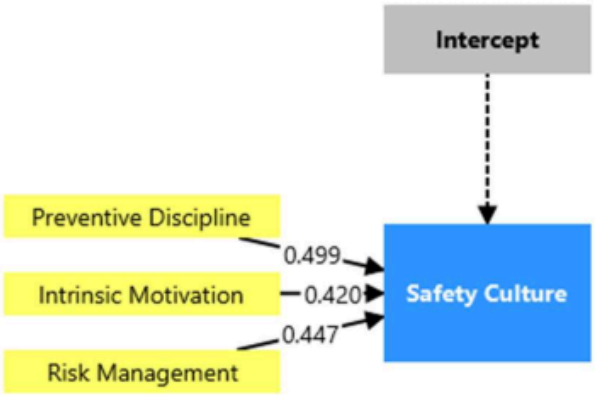

Figure1. Necessary Condition Analysis (NCA Analysis)

Table 2. Effect Size

	Original effect size	95.0%	CE-FDH	CR-FDH	Permutation p value	Decision
Preventive Discipline	0.499	0.258	0.499	0.458	0.000	Strong Necessity Conditions
Intrinsic Motivation	0.420	0.210	0.420	0.380	0.000	Strong Necessity Conditions
Risk Management	0.447	0.217	0.447	0.408	0.000	Strong Necessity Conditions

The Necessary Condition Analysis (NCA) reveals that all three predictors act as critical bottlenecks for Patient Safety Culture, as evidenced by their substantial effect sizes (d) and highly significant permutation p-values ($p < 0.001$). Under Dul's (2016) classification, any effect size exceeding 0.3 represents a large effect, meaning these factors represent Strong Necessity Conditions rather than minor contributors. Specifically, Preventive Discipline establishes the most stringent constraint on the outcome, yielding a remarkable ceiling effect size of 0.499 (CE-FDH) and 0.458 (CR-FDH). This indicates that

hospitals cannot foster a mature safety culture if they allow preventive discipline to drop below critical thresholds. Similarly, Risk Management and Intrinsic Motivation impose massive operational boundaries, generating effect sizes of 0.447 and 0.420 (CE-FDH), respectively. The permutation tests confirm that these constraints do not occur by chance ($p = 0.000$). Consequently, the data demonstrates a strict ceiling regime: deficiencies in any single factor—whether it is management's risk protocols, staff's inner drive, or preventive discipline—will single-handedly cap and limit the ultimate success of the Patient Safety Culture.

Table 3. Bottleneck Value

	Bottleneck CE-FDH			Bottleneck CR-FDH		
Safety Culture (Y)	Preventive Discipline	Intrinsic Motivation	Risk Management	Preventive Discipline	Intrinsic Motivation	Risk Management
0	21.240	NN	NN	NN	NN	NN
10	24.898	26.450	27.660	18.920	NN	25.778
20	28.556	27.770	28.240	22.757	23.283	29.388
30	32.214	30.480	29.270	26.595	26.783	32.998
40	35.872	30.480	31.980	30.433	30.283	36.608
50	39.530	32.390	32.190	34.271	33.783	40.218
60	43.188	37.290	35.290	38.109	37.284	43.828
70	46.846	38.970	36.880	41.947	40.784	47.438
80	50.504	38.970	39.940	45.784	44.284	51.048
90	54.162	51.790	46.500	49.622	47.785	54.658
100	57.820	54.040	56.500	53.460	51.285	58.268

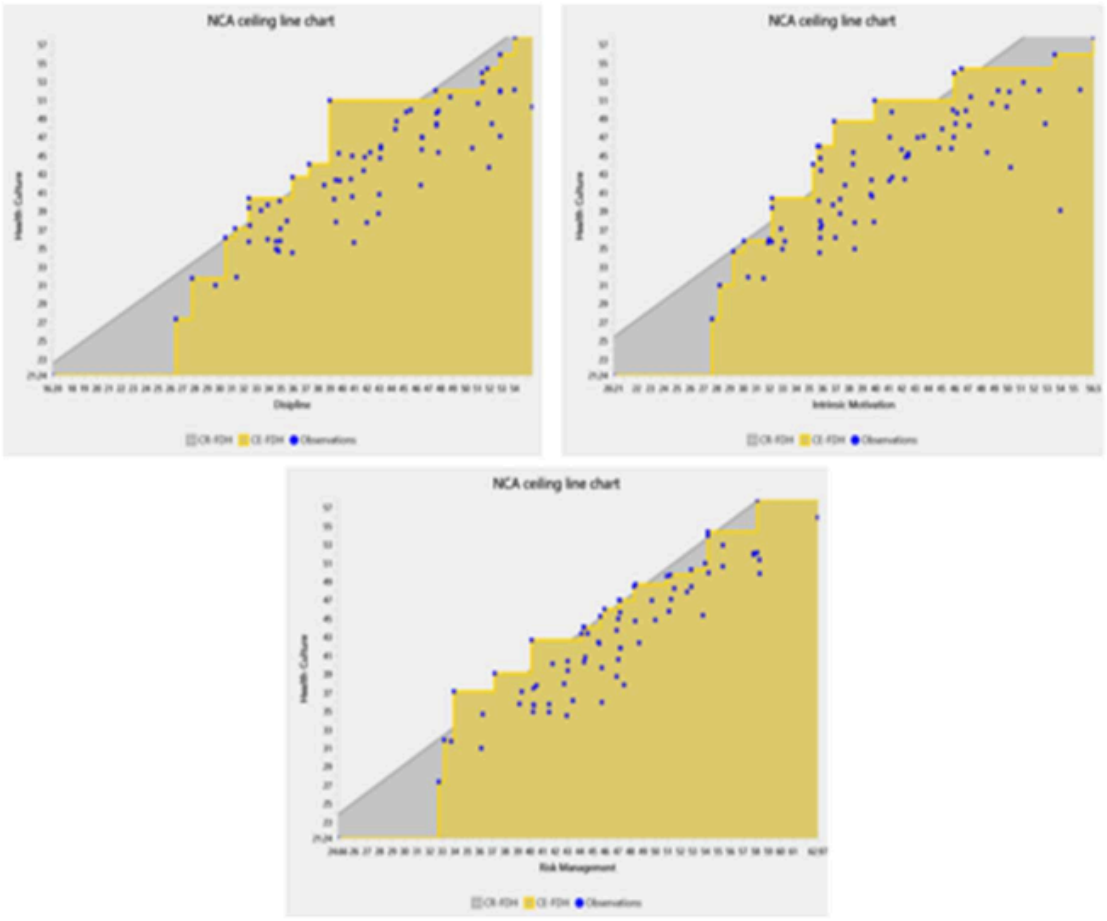

Figure 3. NCA Plot Graph

Table 4. Bottleneck Percentage

	Bottleneck CE-FDH			Bottleneck CR-FDH		
Safety Culture (Y)	Preventive Discipline	Intrinsic Motivation	Risk Management	Preventive Discipline	Intrinsic Motivation	Risk Management
0	NN	NN	NN	NN	NN	NN
10	25.7	20.5	21.0	6.1	NN	2.8
20	29.1	22.1	22.2	16.0	7.5	12.2
30	36.1	25.0	24.2	25.8	17.2	21.6
40	36.1	32.4	24.2	35.6	26.8	31.0
50	40.9	33.0	40.4	45.5	36.4	40.4
60	53.5	41.6	50.8	55.3	46.1	49.8
70	57.8	45.9	58.5	65.1	55.7	59.2
80	57.8	54.4	76.5	74.9	65.3	68.6
90	90.6	72.4	77.1	84.8	75.0	78.0
100	96.3	100.0	87.4	94.6	84.6	87.4

The bottleneck table dynamically quantifies the exact minimum thresholds that hospitals must meet across all three predictors to achieve incremental levels of Patient Safety Culture (Y). The notation "NN" (Not Necessary) signifies that low-level targets of safety culture (Y 0%) do not demand these conditions. However, as the target for Patient Safety Culture rises, the operational constraints become progressively restrictive. The data demonstrates that Preventive Discipline consistently enforces the earliest and most demanding bottleneck. To achieve even a modest 30% level of Safety Culture, hospitals must secure a minimum Preventive Discipline level of 25.8%. This operational requirement rapidly escalates; securing a high-performing Safety Culture (80%) demands that the hospital achieves at least 74.9% in Preventive Discipline. Simultaneously, Risk Management acts as a powerful structural ceiling. While it requires a low threshold of 12.2% for a 20% Safety Culture, it sharply rises in urgency at the upper tiers. To achieve a 70% to 80% level of Safety Culture, Risk Management must reach a minimum threshold of 59.2% and 68.6%, respectively. Interestingly, Intrinsic Motivation allows for slightly more flexibility in the lower to middle tiers, but still demands absolute fulfillment at the peak. For instance, achieving a 50% Safety Culture requires an Intrinsic Motivation level of 36.4%. However, to maximize the Patient Safety Culture to its absolute peak (100%), hospitals must push Intrinsic Motivation to a high threshold of 84.6%, alongside 94.6% in Preventive Discipline and 87.4% in Risk Management. This bottleneck profile confirms a strict law of non-compensation: a hospital cannot compensate for a deficit in staff discipline or risk protocols by simply boosting motivation. If any single factor falls below these identified active thresholds, it will single-handedly stall the progression of the Patient Safety Culture.

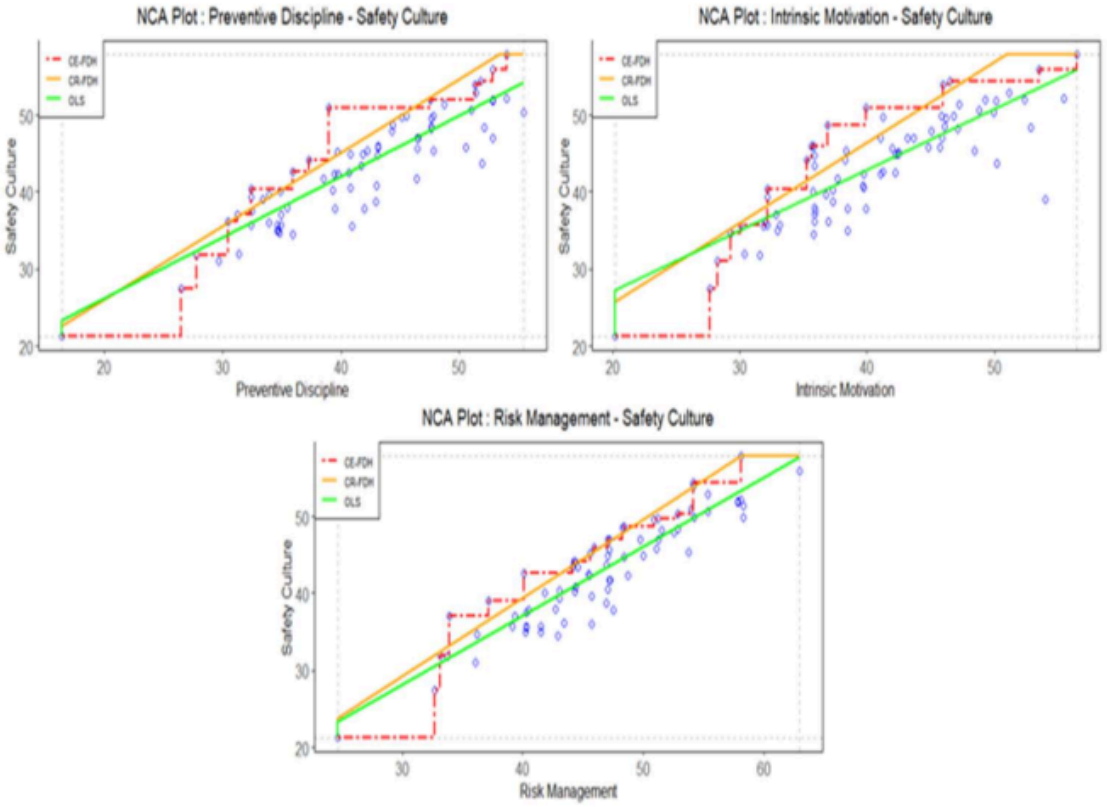

Figure 4. NCA Parameters

By integrating Path Analysis with Necessary Condition Analysis (NCA), our study provides a dual perspective on how human and organizational factors drive Patient Safety Culture. Path analysis demonstrates that intrinsic motivation exerts a 41.2% total effect on evidence-based risk management (23.0% direct effect and 17.7% indirect effect mediated by preventive discipline), while risk management subsequently exerts a dominant direct effect of 83.4% on patient safety culture (epsilon = 0.194). Complementing these linear effects, our NCA results reveal that Preventive Discipline ($d = 0.499$, $p < 0.001$), Risk Management ($d = 0.447$, $p < 0.001$), and Intrinsic Motivation ($d = 0.420$, $p < 0.001$) all represent strong necessary conditions. Together, these findings prove that while risk management and motivation act as primary drivers for elevating safety culture (sufficiency logic), maintaining minimum baseline

thresholds across all three variables is absolutely mandatory (necessity logic); failing to meet any single threshold creates an unyielding bottleneck that suppresses the entire safety culture regardless of other investments.

From a practical perspective, hospital administrators must adopt a two-pronged strategy: leverage intrinsic motivation and risk management as operational levers to actively build safety culture, while simultaneously monitoring minimum performance levels in discipline to prevent bottleneck failures.

Conclusion

Our empirical investigation confirms that Preventive Discipline Intrinsic Motivation all function as strong necessary conditions for establishing a robust Patient Safety Culture. Through Necessary Condition Analysis (NCA), we demonstrate that high patient safety culture cannot exist without minimum baseline thresholds in each of these three foundational elements. While Path Analysis highlights the direct and indirect influence of intrinsic motivation and risk management, the NCA findings establish that failing to maintain any one of these three constructs creates an impassable bottleneck that suppresses the entire safety culture, regardless of how well other organizational systems perform. Practically, hospital administrators must not rely solely on structural policies; they must actively safeguard intrinsic motivation, enforce proactive preventive discipline, and embed evidence-based risk management to secure mandatory baseline safety standards.

Despite these vital contributions, our study has certain limitations that pave the way for future research. Because we gathered data from a small sample of employees within a single hospital in Bandung City, our findings may carry context-specific

nuances that limit immediate generalization across all healthcare settings or geographic regions. Furthermore, the cross-sectional nature of our survey data captures employee perceptions at a single point in time, limiting our ability to track long-term behavioral shifts. To address these boundaries, future studies should extend this necessary-condition framework by employing multi-center longitudinal designs across diverse healthcare organizations. Subsequent research could also integrate additional operational factors—such as leadership styles, digital healthcare infrastructure, and work-life balance—to uncover further necessary baseline conditions for sustaining excellence in patient safety culture.

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