From process integration to resilience: The mediating role of inter-organizational governance in Tanzania's healthcare supply chains

Jacquline Mutta[1]
Albogast Musabila[2]
Edward Makoye[3]
Bahati Ilembo[4]

[1]jcqlnmtt45@gmail.com (+255 766 062 909)
[2]akmusabila@mzumbe.ac.tz (+255 767 476 318)
[3]edwardmakoye@gmail.com (+255 714 134 260)
[4]ilembobahati@gmail.com (+255 717 037 394)

[1,2,3,4] Mzumbe University, Tanzania

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ABSTRACT

Tanzania has implemented several significant reforms to supply chain processes, including integrating the electronic Logistics Management Information System and the Prime Vendor system. However, despite such investments, healthcare continues to experience regular quarterly shortages. The effectiveness of aligning processes to improve supply chain resilience is questioned, underscoring the need to understand how process integration practices translate into preparedness, responsiveness, and recovery during disruption. Adopting a dynamic and relational capability view, this paper examines the influence of process integration on the resilience of the healthcare supply chain and the mediating role of inter-organizational governance. The study population comprises actors involved in healthcare supply chain management, including 153 public facilities from hospitals, health centers, and dispensaries located in 5 districts in Dar es Salaam, Tanzania. The study employed an explanatory sequential mixed-methods design, with data collected from 365 respondents in public healthcare facilities, including hospitals, health centers, and dispensaries, and supported by 12 key informant interviews with key healthcare supply chain institutions, such as the Medical Stores Department and the Accredited Prime Vendors. Quantitative and qualitative tools were used to collect data; quantitative data were collected through questionnaires and analyzed using Smart PLS (Partial Least Squares), while semi-structured interviews guided by thematic analysis were employed to collect qualitative insights to explain the quantitative findings. The findings show that while the dimensions of process integration significantly improve integration, they do not have a direct effect on healthcare supply chain resilience ($\beta = 0.120$, $p = 0.090$). Instead, inter-organizational governance mechanisms account for this relationship, with contractual governance exerting the strongest influence. Evidence from the interviews indicates that although integration improves visibility and coordination of activities, effective responses are driven by inter-organizational governance mechanisms that enable enforcement and the timely coordination of supply chain actors' actions. This study shows that resilience depends more on the inter-organizational governance of integrated activities, highlighting the central role of governance mechanisms in shaping process integration to enable adaptive responses in healthcare supply chains.

Keywords: Healthcare Supply Chain Resilience, Inter -Organisational Governance, Process Integration, Tanzania

I. INTRODUCTION

The goal of Universal healthcare coverage is to ensure that people can access and afford healthcare services conveniently. The healthcare supply chain (HCSC) is considered the backbone of the health system, ensuring that health commodities are delivered at the right time and in the right quantity to safeguard patients' health goals and safety (Piffari et al., 2024). However, today, HCSCs continue to operate in a volatile environment, exposed to global crises such as the pandemic, production cost pressures, and geopolitical shocks (Leite, 2023). Disruptions are threatening patient care continuity, as they reveal limited structural strength in healthcare supply chains' ability to prepare, respond, and recover. In Sub-Saharan Africa, building resilient healthcare systems remains constrained by recurring stockouts, affecting 41% of public health facilities. Failures are attributed to fragmented arrangements, weak coordination, limited visibility, and inconsistent process standardization, reflecting limited integration among supply chain actors (Okoye et al., 2024).

Despite deliberate reforms in the health sector, such as the introduction of eLMIS, prime vendors, and various integration initiatives in Tanzania, resilience capabilities remain limited, with facilities facing limited availability of health commodities, contrary to the World Health Organization [WHO]-recommended threshold of 80%.The performance gap results in an overall unstable, non-resilient healthcare system (Mathias et al., 2024). Partly, the situation is attributed to limited interoperability between digital systems, poor synchronization of interconnected processes, procurement delays, and weak coordination among supply chain actors. (Kessy et al., 2024).

Studies show that building resilience in complex supply chains, including Health systems, requires bold investments in dynamic capabilities, such as process integration that aligns and standardizes procurement activities, as well as technology alignment and system compatibility across supply chain actors. They facilitate visibility, reduce duplication, and enable faster response and recovery during disruptions (Friday et al., 2021; Teece et al., 1997). Despite such assertions, integrating processes may not always lead to resilience, as integrated systems remain exposed to delays, coordination failures, and fragmented decision-making. Research findings remain inconclusive on how process integration builds resilience, with suggestions that, without governance, integration may be insufficient to strengthen resilience in healthcare systems (WHO, 2024; Betcheva et al., 2020). According to the relational view, process integration fosters interconnectedness, creating interdependence among healthcare supply chain actors. As interdependence grows, coordination complexity also increases, creating a need for formal and informal governance mechanisms to coordinate activities, reduce opportunism, and enhance resilience (Dyer et al., 2018).

Inter-organizational governance, including contractual, relational, and institutional governance, shapes the success and failure of collaborative risk management practices by integrating processes, regulating partners' behavior, clarifying roles, improving accountability, and coordinating responses during disruptions (Tsolakis et al., 2023; Poppo & Zenger, 2002). However, despite increasing interest in how firms can handle disruptions and build resilience, there is limited research examining how process integration translates into resilience through governance arrangements, particularly in fragmented, multi-actor, complex supply chains in low- and medium-sized countries, where coordination depends on inter-organizational governance. Therefore, the study examines the relationships among process integration, inter-organizational governance, and healthcare supply chain resilience. Drawing on the Dynamic and Relational view, the study argues that inter-organizational governance enables process integration and enhances the resilience of health systems.

1.1 Research Objectives

i. To examine the influence of process integration on the resilience of the healthcare supply chain in Tanzania.
ii. To examine the mediating role of inter-organizational governance on the relationship between process integration and healthcare supply chain resilience.

II. LITERATURE REVIEW

2.1 Theoretical Review

The Dynamic Capabilities View and the Relational View Theory guide the study. Both theories explain how process integration and inter-organizational governance influence resilience in Healthcare supply chains. Dynamic capability explains how firms develop and leverage capabilities to recover from supply chain disruptions and build resilience. In contrast, the relational view asserts that coordinating inter-organizational processes and building resilience require collaborative relationships and governance mechanisms.

2.1.1 Dynamic Capability Theory

The dynamic capability view was developed from Teece's (2007) work, which emphasizes a firm's ability to rapidly adapt to an ever-changing environment by integrating, building, and reconfiguring its internal and external competencies. The theory emphasizes the firm's ability to sense, seize, and reconfigure threats in its environment to manage disruption and enhance resilience. Integration of processes through process coordination and standardization, and alignment of technology and system compatibility, enables firms to sense and neutralize challenges and reconfigure their supply chains (Kähkönen et al., 2023).

2.1.2 Relational View Theory

The relational view theory, as proposed by Dyer and Singh (1998), explains that firms generate relational rents through collaborative interorganizational relationships. The theory asserts that value is obtained from relation-specific assets, knowledge-sharing routines, complementary resources, and governance mechanisms. In healthcare supply chains, process integration increases interdependence through linking procurement activities, information flows, and coordination routines. As interdependence increases, the requirements for coordinating supply chain actors grow, as does the need for governance. Recent extensions of the relational view (Dyer et al., 2018) focus on the essence of formal governance arrangements, including contractual and institutional mechanisms, as well as on informal governance and on adaptability and coordination arrangements in complex interdependent supply chains. In the context of the healthcare supply chain, relational theory provides a foundation for understanding how integrating processes contributes to resilience through governance mechanisms.

2.2 Empirical Review

2.2.1 Process Integration and Healthcare Supply Chain Resilience

Process integration refers to aligning processes, information flows, and technologies across supply chain actors to enable coordinated operations (Chen et al., 2009). In healthcare supply chains, this alignment is reflected in process coordination, standardization, technology integration, and system compatibility (Betcheva et al., 2020). Together, they strengthen operational alignment by improving information visibility, reducing uncertainty, and enabling synchronized activities across organizations (Friday et al., 2021). Previous studies show that process integration improves resilience through process coordination, standardization, technology integration, and system compatibility. Process alignment enhances visibility, activity coordination, and workflow synchronization among supply chain actors. According to Jawab (2024), technology integration and system compatibility enhance situational awareness and response capabilities by facilitating inventory visibility and coordination among actors, enabling timely identification and mitigation of disruptions to medical supplies and service delivery. Studies reveal that process coordination is also essential for managing supply disruptions by enabling coordinated task allocation, role clarity, and aligned workflows (Gooding et al., 2022). Without effective process coordination, fragmented workflows, misaligned operational responsibilities, and unclear role allocation, supply failures and increased supply chain vulnerabilities result (Ojo, 2024; Patel et al., 2024).

Regarding process standardization, the Tanzania healthcare facility-level assessment found that non-adherence to standard operating procedures generates multiple forms of waste, including inventory imbalances, delayed responses, and medicine stockouts. Standardizing processes by aligning activities, rules, roles, and documentation enables real-time visibility, consistency, and coordinated action, enhancing both responsiveness and recovery (Sadru et al., 2023; Kessy et al., 2024). Despite studies establishing the role of process integration in enhancing supply chain resilience, empirical findings remain inconsistent, with some studies reporting that integration cannot strengthen resilience, especially in highly interdependent supply chains where coordination challenges and governance limitations persist. As firms become more integrated, the complexity of coordination and interdependence increases, underscoring the need for stronger coordination and governance (Dyer et al., 2018). Existing studies have largely focused on the direct relationship between process integration and supply chain resilience, with limited attention to inter-organizational governance through which process integration contributes to the supply chain.

2.2.2 Process Integration, Inter-Organizational Governance, and Healthcare Supply Chain Resilience

Integrated supply chains are highly interdependent, sharing aligned processes and technologies to enhance resilience. This interdependence requires contractual, relational, and institutional governance mechanisms to coordinate activities, manage relationships, and enable joint value creation among actors (Tsolakis et al., 2023; Dyer & Singh, 1998). Governance stems from shared values and aligned processes within the relationship, providing structures for decision-making, defining responsibilities, and allowing more flexible, timely responses during disruptions (Belloni et al., 2025). Prior studies, such as those by Zhou et al. (2024), demonstrate that governance mechanisms improve supply chain integration and performance outcomes. Other research by Wu et al. (2023) indicates that they facilitate coordinated responses within an interdependent supply chain. To enhance resilience, studies emphasize balancing contractual, relational, and institutional governance (Tsolakis et al., 2023). Contractual and institutional governance are formal mechanisms. Contractual governance, involving formal agreements and contractual obligations, serves as a control and coordination mechanism, supporting adaptive interaction and collaborative alignment through accountable, clear contractual measures (Lumineau, 2017). Click or tap here to enter text. while institutional governance, including regulatory oversight and guidelines, oversees supply chain operational activities and decision-making (Ryciuk, 2020). Complementing formal governance, relational governance uses trust and shared norms to coordinate inter-organizational relations and relationships among supply chain actors (Dyer & Singh, 1998). Although studies show that formal and informal governance complement each other (Cao & Lumineau, 2014; Poppo & Zenger, 2002; Dyer & Singh, 1998), in highly interconnected supply chains, Dyer et al. (2018) urge focusing primarily on contractual governance, suggesting that excessive reliance on relational governance creates relational inertia that might constrain accountability and adaptability, leading to rigidity and hampering resilience.

III METHODOLOGY

3.1 Research Design

This study employs an explanatory sequential mixed-methods design, with a quantitative phase followed by a qualitative phase. A cross-sectional survey was administered in a quantitative phase to examine the relationships among process integration, inter-organizational governance, and healthcare supply chain resilience, followed by a quantitative interview in a qualitative phase to explain the quantitative findings (Burke & Onwuegbuzie, 2004).

The study was conducted in Dar es Salaam, Tanzania, the country's central healthcare logistics hub. The region hosts key supply chain actors, including the Medical Stores Department (MSD) headquarters and zonal offices, as well as Accredited Prime Vendors, that procure, store, and distribute medicines and medical supplies to public healthcare facilities. Additionally, the region has a high concentration of hospitals, health centers, and dispensaries.

3.2 Target Population

The study population comprises actors involved in healthcare supply chain management, including 153 public facilities from hospitals, health centers, and dispensaries located in 5 districts in Dar es Salaam, Tanzania. Key supply chain organizations, including the Medical Stores Department and Accredited Prime Vendors, were also included due to their central roles in procuring and distributing healthcare commodities across facilities.

3.3 Sampling and Sampling Size

3.3.1 Sampling Approach

The study adopted a multi-stage sampling approach, grouping healthcare facilities by level of care (hospitals, health centers, and dispensaries) and subsequently by district (Kinondoni, Ubungo, Ilala, Temeke, Kigamboni). Hospitals and Health centres were included through a census, and while dispensaries were selected using proportional stratified sampling with a simple random selection within each district. Purposive sampling was used to select additional key informants, MSD, and Accredited Prime Vendors.

3.3.2 Sample size

The Cochran formula for a large population was used to determine the minimum sample size. A 95% confidence level and a 5% margin of error were adopted with a proportion of 0.5 to ensure maximum variability. A minimum of 384 respondents from public health care facilities (hospitals, health centers, and dispensaries) were yielded and included, with an additional 12 key informants from key supply chain organizations (MSD and Accredited Prime Vendors), resulting in a total planned sample of 396 respondents.

3.4 Data Collection Tools and Procedures

The study collected both quantitative and qualitative data from healthcare facilities using a structured questionnaire and semi-structured interviews with key informants from MSD and APV. A sequential approach was applied; questionnaires were distributed to selected respondents at healthcare facilities, including the facility in charge, pharmacists, and procurement staff. Before distributing the questionnaires, a pilot study was conducted with 15 respondents to refine the instrument and secure ethical approval. For qualitative data collection with key informants, interviews were held in a private setting; information was recorded with participants' consent and supplemented by field notes.

3.5 Data analysis

Quantitative analysis was conducted using Partial Least Squares Structural equation modeling (PLS-SEM) 4 (Hair & Alamer, 2022). The model quality was assessed using Cronbach's alpha and composite reliability to measure reliability, average variance extracted to examine convergent validity, and heterotraitmonotrat ratio for discriminant validity. During model quality assessment, a structural analysis using 5000-sample bootstrapping assessed the explanatory power, coefficient determination, effect sizes, and mediation effects of PI, IOG, and HSCR. Qualitative data were analyzed thematically in NVivo using Braun and Clarke's six-step procedure and integrated with quantitative findings through triangulation (Bryman, 2016).

3.6 Ethical Considerations

Ethical clearance was granted by the National Institute for Medical Research (NIMR/HQ/R.8a/Vol.IX/5129), with relevant authorities granting permission to collect data. Participants provided written informed consent, and anonymity and confidentiality were maintained.

IV. FINDINGS & DISCUSSION

4.1 Data Overview

A total of 365 valid questionnaires were collected from public healthcare facilities in Dar es Salaam, along with 12 key informant interviews. This represents 95.05% of the planned sample of hospitals and health centers, which accounted for the majority of responses. Dispensaries were less represented due to access constraints. However, overall, the sample size was sufficient for PLS-SEM analysis.

Table 1
Demographic Profile of Respondents (n=365)

Variable	Category	n	%
Age	18–34	142	38.9
	35–54	216	59.2
	54+	7	1.9
Education	Diploma	178	48.8
	Degree	157	43.0
	Master's	18	4.9
	Postgraduate	12	3.3
Facility Type	Hospitals	80	21.9
	Health Centres	189	51.8
	Dispensaries	96	26.3
Job Position	Pharmacist	142	38.9
	Medical Officer / In-charge	116	31.8
	Procurement Officer	87	23.8
	Others	20	5.5
Experience (Years)	<1 year	15	4.1
	1–3 years	111	30.4
	4–6 years	102	27.9
	7–10 years	66	18.1
	>10 years	71	19.5

4.2 Measurement Model Before Item Refinement

The section assesses the quality of measurements of the original, unpurified model before the item deletion. It includes indicator reliability (outer loadings), internal consistency reliability (Cronbach's alpha, rho_a, rho_c), convergent validity (AVE), and discriminant validity (HTMT and Fornell-Larcker).

4.2.1 Indicator Reliability

Outer loadings with the decision rule of 0.708 were used to assess indicator reliability, as it is considered a sensible minimum for reflective measurement in applied social science and management research (Hair & Alamer, 2022). The full outer loadings are shown in Table 2.

Table 2
Outer loadings before deletion

Constructs	Outer loadings	Constructs	Outer loadings
CG1 <- CG	0.723	PC5 <- PC	0.764
CG2 <- CG	0.866	PI <- PI	1.000
CG3 <- CG	0.651	PS1 <- PS	0.810
CG4 <- CG	0.714	PS2 <- PS	0.801
CG5 <- CG	0.921	PS3 <- PS	0.749
HSCR1 <- HSCR	0.834	PS4 <- PS	0.700
HSCR2 <- HSCR	0.879	PS5 <- PS	0.711
HSCR3 <- HSCR	0.709	RG1 <- RG	0.819
HSCR4 <- HSCR	0.654	RG2 <- RG	0.778
HSCR5 <- HSCR	0.818	RG3 <- RG	0.790
HSCR6 <- HSCR	0.838	RG4 <- RG	0.712
HSCR7 <- HSCR	0.662	RG5 <- RG	0.664
HSCR8 <- HSCR	0.787	SC1 <- SC	0.754
HSCR9 <- HSCR	0.873	SC2 <- SC	0.761
IG1 <- IG	0.873	SC3 <- SC	0.781
IG2 <- IG	0.770	SC4 <- SC	0.679
IG3 <- IG	0.716	SC5 <- SC	0.708
IG4 <- IG	0.841	TI1 <- TI	0.731
IG5 <- IG	0.659	TI2 <- TI	0.891
PC1 <- PC	0.781	TI3 <- TI	0.612
PC2 <- PC	0.798	TI4 <- TI	0.783
PC3 <- PC	0.708	TI5 <- TI	0.843
PC4 <- PC	0.810		

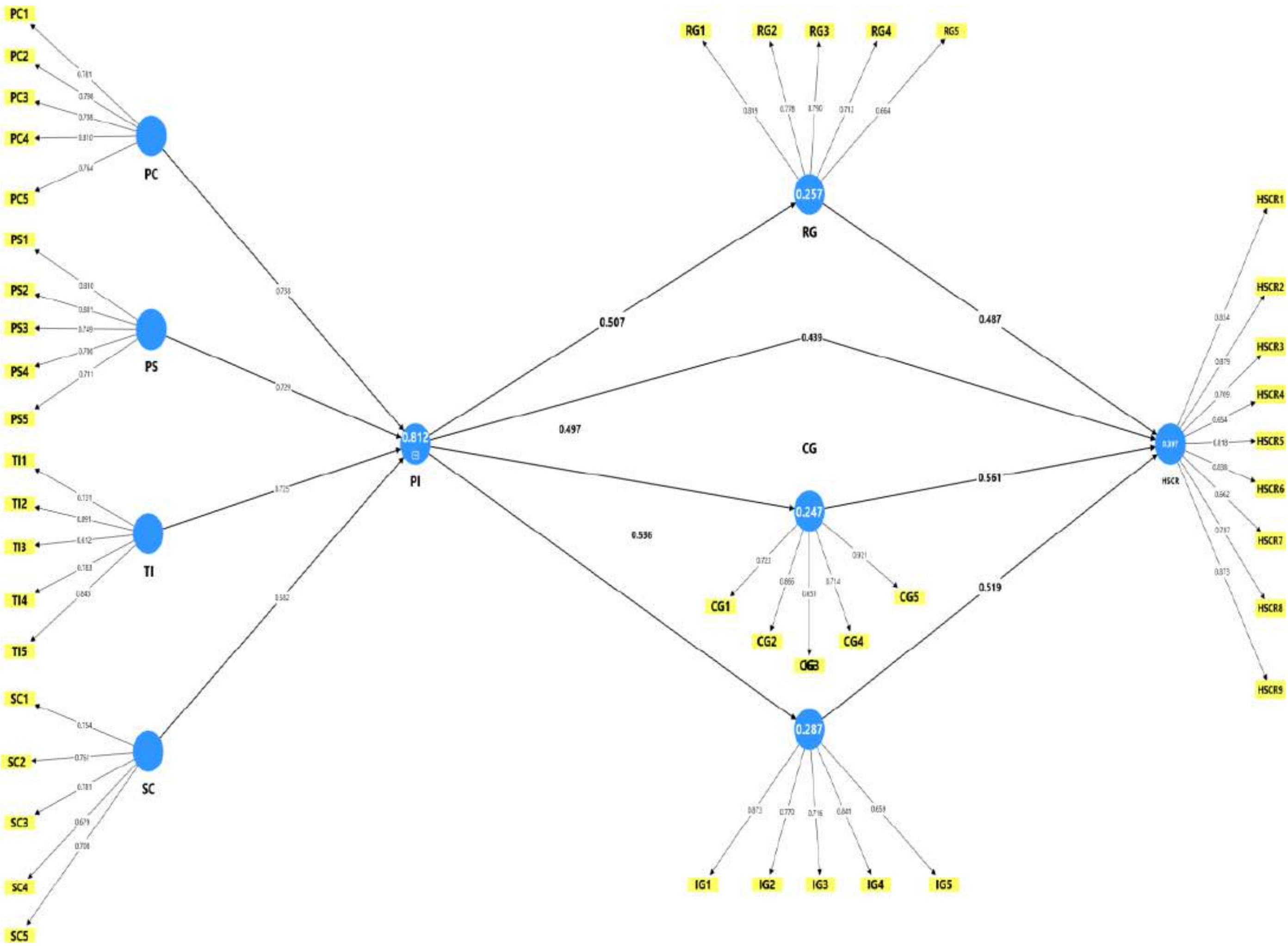

Figure 1
Outer loadings before deletion

The results show that the specific items measuring contractual governance (CG3), technology integration (TI3), institutional governance (IG5), system compatibility (SC4), and healthcare supply chain resilience (HSCR 4 & HSCR7) had loadings below the required threshold.

4.2.2 Internal Consistency Reliability

To test internal consistency reliability, the study used three key measures: Cronbach's alpha and composite reliability rho_c, both based on direct outer loadings (Hair & Alamer, 2022). The composite reliability results are presented in Table 3.

Table 3
Composite reliability

Constructs	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)
CG	0.835	0.852	0.885
HSCR	0.926	0.955	0.936
IG	0.832	0.851	0.882
PC	0.831	0.832	0.881
PS	0.811	0.812	0.869
RG	0.810	0.818	0.868
SC	0.790	0.790	0.856
TI	0.831	0.839	0.883

All constructs had Cronbach's alpha values exceeding the minimum required of 0.70. This internal consistency was further confirmed by the composite reliability estimates, which indicate that the measurement items captured their respective constructs.

4.2.3 Convergent Validity

Convergent validity, to test whether items measure related constructs, was assessed using AVEs. According to Henseler et al. (2015), an AVE threshold of 0.50 indicates that a construct accounts for more than half of the variance among its items. The results are shown in Table 4.

Table 4
AVE before deletion

Constructs	Average variance extracted (AVE)
CG	0.611
HSCR	0.621
IG	0.602
PC	0.597
PS	0.571
RG	0.569
SC	0.544
TI	0.605

All AVEs exceed the recommended threshold of 0.50, supporting convergent validity in the first model. This pattern implies that indicators measure their respective constructs and explain more than half of the variance.

4.2.4 Item Purification and Deletion Process

After pre-evaluating the measurement model, a systematic process of item purification was done to achieve statistical reliability. The item deletion process followed (Hair &Alamer, 2022). Recommended removing indicators with an outer loading less than 0.708. However, item deletion did not occur automatically; indicators with loadings between 0.400 and 0.708 were removed only if their removal significantly improved the AVE or composite reliability to acceptable levels. Furthermore, the purification process did not compromise the theoretical content validity of the constructs. Applying these criteria, seven indicators were removed as shown in Table 5.

Table 5
Summary of Deleted Items

Construct	Deleted Item	Original Loading
Contractual Governance	CG3	0.651
Healthcare Supply Chain Resilience	HSCR4	0.654
Healthcare Supply Chain Resilience	HSCR7	0.662
Institutional Governance	IG5	0.658
Relational Governance	RG5	0.663
System compatibility	SC4	0.678
Technology Integration	TI3	0.611

4.3 Evaluation of the Measurement after deletion of the Items

After removing indicators with loadings below the threshold, the purified measurement model was reassessed to confirm its reliability and validity before proceeding to structural model assessment.

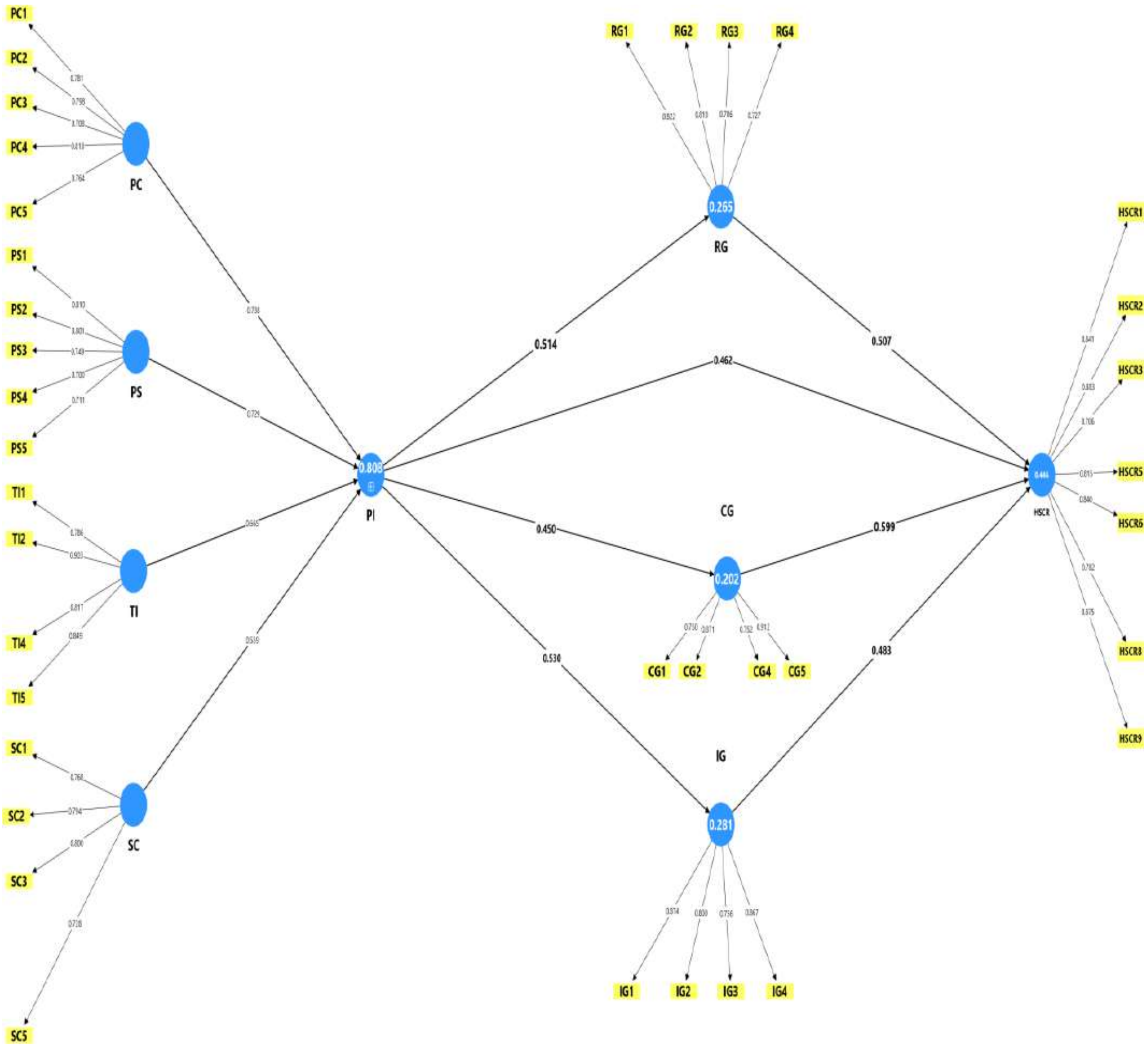

Figure 2
Measurement after Deletion of the Items

4.4 Assessment of Higher Order Constructs.

After validating the purified lower-order model, the higher- order constructs were validated. Additionally, the model combined the lower-order dimensions into two broader constructs: Unified Process Integration and Unified Governance. The analysis used a two-stage, disjoint approach, in which the latent-variable scores in the purified lower-order model served as indicators of the higher-order constructs. This method is suitable for the research because process integration and governance are both general-purpose capabilities composed of multiple related dimensions.

Table 6
Assessment of Reliability and Convergent Validity of Higher Order Constructs

Constructs	Cronbach's alpha	Composite reliability (rho_c)	Average variance extracted (AVE)
IOG	0.747	0.856	0.664
PI	0.787	0.862	0.621

Table 6 shows that both higher-order constructs demonstrated acceptable reliability and convergent validity. Inter-organizational Governance (IOG) had a Cronbach's alpha of 0.747, a composite reliability of 0.856, and an AVE of 0.664. Process Integration (PI) had a Cronbach's alpha of 0.787, a composite reliability of 0.862, and an AVE of 0.621. All values exceed the acceptable minimums of 0.70 for reliability and 0.50 for AVE, confirming adequate internal consistency and convergent validity of the higher- order constructs.

4.5 Collinearity Assessment

Collinearity was evaluated using the variance inflation factor (VIF). With a conservative threshold of 3.3, all VIFs were below the recommended cutoff, indicating no multicollinearity among predictor constructs.

Table 7
Inner model VIF

Path	VIF
CG -> HSCR	1.513
IG -> HSCR	1.647
PC -> PI	1.996
PI -> CG	1.000
PI -> HSCR	1.613
PI -> IG	1.000
PI -> RG	1.000
PS -> PI	2.267
RG -> HSCR	1.637
SC -> PI	2.066
TI -> PI	1.156

4.6 Direct effects

Table 8 shows the direct effects using a bootstrapping analysis, revealing that most direct pathways are statistically significant at the 5% level, except for two notable cases: system compatibility to process integration and process integration to healthcare supply chain resilience.

Table 8
Direct path

Direct path	Beta (β)	t-value	p-value	f²	Decision
PC -> PI	0.622	15.205	<0.001	0.389	Supported
PS -> PI	0.566	11.172	<0.001	0.285	Supported
TI -> PI	0.617	24.003	<0.001	0.820	Supported
SC -> PI	-0.053	0.899	0.369	0.002	Not supported
PI -> CG	0.450	8.403	<0.001	0.254	Supported
PI -> IG	0.530	13.137	<0.001	0.392	Supported
PI -> RG	0.514	10.896	<0.001	0.360	Supported
PI -> HSCR	0.120	1.697	0.090	0.016	Not supported
CG -> HSCR	0.386	4.626	<0.001	0.178	Supported
IG -> HSCR	0.139	2.706	0.007	0.021	Supported
RG -> HSCR	0.183	2.208	0.027	0.037	Supported

Process coordination, process standardization, and technology integration all contribute to process integration. Process coordination positively influences PI ($\beta = 0.622, p = 0.001, f^2 = 0.389$), demonstrating that well-coordinated workflows and combined execution routines significantly support integration. Similarly, process standardization is important ($\beta = 0.566, p < 0.001, f^2 = 0.285$), indicating that shared operational processes encourage cohesive performance. However, technology integration demonstrates the strongest influence ($\beta = 0.617, p = 0.001, f^2 = 0.820$), highlighting the vital role of data connectivity and digital links in healthcare supply chain integration. In contrast, system compatibility is not significant ($\beta = -0.053, p = 0.369, f^2 = 0.002$), suggesting that system compatibility alone does not necessarily enhance process integration.

Process integration is a strong predictor of inter-organizational governance. Contractual governance ($\beta = 0.450, p < 0.001, f^2 = 0.254$), institutional governance ($\beta = 0.530, p < 0.001, f^2 = 0.392$), and relational governance ($\beta = 0.514, p < 0.001, f^2 = 0.360$) All exhibit significant direct effects. This shows that more robust inter-organizational governance mechanisms support and reinforce operational process integration.

Furthermore, the direct relationship between process integration and healthcare supply chain resilience at the lower level is statistically insignificant ($\beta = 0.120, p = 0.090, f^2 = .016$). This indicates that process integration does not directly improve resilience in this context; instead, its effect is transmitted through inter-organizational governance mechanisms. Contractual governance has the strongest impact on improving healthcare supply chain resilience ($\beta = 0.386, p < 0.001, f^2 = 0.178$), followed by relational governance ($\beta = 0.183, p = 0.027, f^2 = 0.037$) and institutional governance ($\beta = 0.139, p = 0.007, f^2 = 0.021$). Practically, this finding means that integration boosts resilience when governance mechanisms turn integrated routines and activities into coordinated, enforceable actions during disruptions.

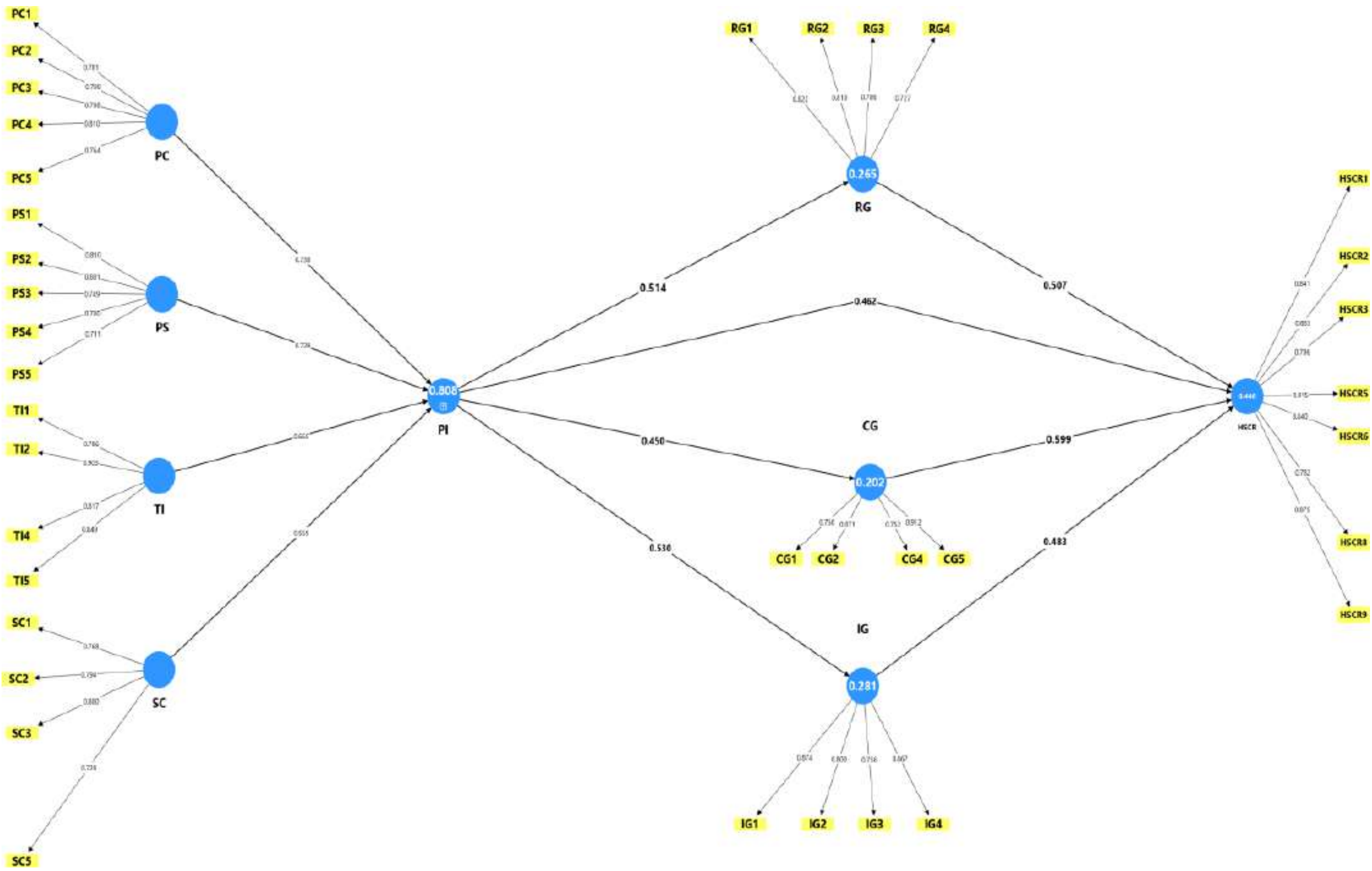

Figure 3
Structural Model and Path Coefficients

4.6.1 Assessment of Indirect Effect to determine Mediation Relationship

The mediation analysis was conducted using bootstrapped specific indirect effects to assess the mediation effect of operational process integration on healthcare supply chain resilience through governance mechanisms. This is necessary because the indirect effect is non-normally distributed, and bootstrapping must be used to make statistical inferences based on it rather than relying on normal theory(Hair et al., 2019). Table 8 summarizes the indirect effects in the original sample, along with t-statistics and p-values for each relevant mediator pathway.

The study found that the direct relationship between PI and HSCR was not significant. However, the indirect effects of PI on HSCR through governance mechanisms were positive and significant. This finding confirms full mediation, meaning that process integration enhances resilience by turning integrated activities into enforceable, coordinated, and actionable steps during disruptions.

Table 9
Specific Indirect Effects

Path	Indirect Path	β	t-value	p-value	Decision
PI -> CG -> HSCR	Process Integration to Contractual Governance to Resilience	0.174	3.449	0.001	Supported
PI -> IG -> HSCR	Process Integration to Institutional Governance to Resilience	0.074	2.634	0.008	Supported
PI -> RG -> HSCR	Process Integration to Relational Governance to Resilience	0.094	2.014	0.044	Supported

All indirect pathways are statistically significant, with contractual governance exhibiting the strongest mediation effect (β = 0.174, p = 0.001). This is followed by relational governance (β = 0.094, p = 0.044) and institutional governance (β = 0.074, p = 0.008), both of which also show significant mediation effects. Since the direct path between process integration and healthcare supply chain resilience is insignificant, but the indirect path through inter-organizational governance is significant, the structural model indicates full mediation. These findings imply that operational process integration does not directly enhance healthcare supply chain resilience; instead, its impact on resilience operates through contractual, relational, and institutional governance systems.

4.6.2 The coefficient of determination

The coefficient of determination was used to assess the explanatory power of the proposed structural model, measuring the variance in the dependent variables accounted for by the predictor variables. Table 10 presents the explanatory power and the specific values (R^2 and adjusted R^2) obtained from the analysis.

Table 10
The coefficient of determination

Construct	R^2	Adjusted R^2
Contractual governance (CG)	0.202	0.200
Relational governance (RG)	0.265	0.263
Institutional governance (IG)	0.281	0.279
Process integration (PI)	0.808	0.806
Healthcare supply chain resilience (HSCR)	0.446	0.440

The findings show moderate explanatory power, as approximately 44.6% of the variation in healthcare supply chain resilience is explained by process integration and inter-organizational governance. Healthcare supply chain resilience attained R^2 = 0.446 and adjusted R^2 = 0.440. This small difference establishes model stability and the relative importance of the predictors. Also, the model demonstrates substantial explanatory power for Process integration (0.808), while Institutional, relational, and contractual governance had moderate explanatory power of 0.281, 0.265, and 0.202, respectively.

4.7 Predictive Relevance (PLS-Predict)

Predictive relevance was assessed using PLS-predict. Positive Q2predict values show that the model has predictive relevance beyond a simple baseline.

Table 11
Q2-predict Value

Construct	Q2predict	RMSE	MAE
PI	0.803	0.447	0.379
CG	0.282	0.867	0.561
IG	0.368	0.800	0.633
RG	0.316	0.834	0.650
HSCR	0.252	0.878	0.570

All Q2 predicted values were positive. The highest was PI (0.803), which corresponds to a strong R^2 value for process integration. The predictive relevance of the HSCR was also positive (0.252), indicating that HSCR has meaningful predictive relevance.

Table 12
PLS-predict indicator-level comparison

HSCR indicator	Q2predict	PLS RMSE	LM RMSE	Diff RMSE	PLS MAE	LM MAE	Diff MAE
HSCR1	0.229	0.682	0.626	0.056	0.496	0.445	0.051
HSCR2	0.233	0.565	0.508	0.057	0.365	0.353	0.012
HSCR3	0.194	0.566	0.541	0.025	0.380	0.399	-0.019
HSCR5	0.058	0.652	0.614	0.038	0.476	0.462	0.014
HSCR6	0.170	0.761	0.671	0.091	0.532	0.488	0.045
HSCR8	0.133	0.654	0.636	0.018	0.501	0.485	0.016
HSCR9	0.133	0.622	0.597	0.025	0.421	0.423	-0.002

The model shows predictive relevance for the endogenous constructs, as all Q2predict values were above zero. Process integration PI has the highest Q2predict value (0.803), followed by institutional governance IG (0.368), relational governance RG (0.316), contractual governance CG (0.282), and Healthcare supply chain resilience HSCR (0.252). At the indicator level, HSCR indicators also produced positive Q2predict values, confirming their predictive relevance. However, when comparing the PLS-SEM model to the linear model (LM) benchmark, mixed prediction errors were observed, with several indicators showing higher PLS RMSE values than the LM benchmark. This suggests that the model demonstrates low to moderate predictive power.

4.8 Qualitative findings

To gain a deeper understanding of the quantitative results related to process integration, inter-organizational governance, and healthcare supply chain resilience, a qualitative phase was undertaken. A semi-structured interview was conducted with key informants from MSD Headquarters, the Zonal Office, and Accredited Prime Vendors. The findings are presented according to the study objectives and organized around themes emerging from the interviews.

4.8.1 Process integration and Healthcare supply chain resilience

The qualitative findings showed that process integration through connected procedures, ordering, and operational linkages improved communication, coordination of operational activities, and stock-level visibility among healthcare supply chain actors. One participant mentioned that the ordering process follows standardized procedures via a digital, interconnected communication system such as eLMIS, enabling monitoring of stock levels, identifying shortages, and ensuring coordinated follow-up of supply requests between facilities and suppliers during disruptions (KII-APV, 3rd February 2026). Additionally, one respondent noted that when MSD faces stock shortages, established, coordinated ordering and reporting procedures facilitate communication and help facilities obtain supplies from an Accredited Prime Vendor (KII-APV, 13th February 2026). This implies that technology integration, process coordination, and standardization enhance process integration among collaborative firms; however, such capability does not necessarily strengthen resilience. Interviews showed that process integration alone is not enough to improve healthcare supply chain resilience during disruptions, as even when integrated systems detect stock shortages, the response still requires approvals and compliance with the Public Procurement Act and regulations (KII-MSD Official, 2nd March 2026).

4.8.2 Process Integration, Inter-organizational Governance, and Healthcare Supply Chain Resilience

The qualitative findings highlight the importance of inter-organizational governance in shaping the relationship between process integration and healthcare supply chain resilience. While respondents confirmed that process integration improves communication, coordination of operational activities, and stock visibility among healthcare supply chain participants, they also emphasized the crucial role of contractual, relational, and institutional governance mechanisms in coordinating implementations and decisions during disruptions. This aligns with WHO (2024), Betcheva et al. (2020), and Dyer et al. (2018), who view integrated supply chains as highly interdependent and as requiring governance mechanisms to coordinate actions across integrated activities for responsiveness during disruptions. These points are supported by one participant, who mentioned that forecasting and planning activities in facilities go through the system for approvals and reviews, along with regulatory and contractual arrangements for their implementation (KII-MSD Official, 2nd March, 2026).

Additionally, supporting this, one respondent noted that while process integration allows for early detection of shortages, the emergency procurement process and the redistribution of medical items and supplies depend on framework agreements, procurement regulations, and previously established collaborative supply chain relationships (KII-MSD Official, 2nd March, 2026). This suggests that healthcare supply chain resilience depends on the effectiveness of process integration, which improves risk visibility, and governance mechanisms support implementation by coordinating action, enforcing procedures, and facilitating emergency response

4.9 Discussion

The findings indicate that process integration does not directly affect healthcare supply chain resilience, contrary to earlier research, which suggests that process integrations, such as technology integration (Jawab, 2024), process coordination (Gooding et al., 2022), and process standardization (Sadru et al., 2023), influence healthcare supply chain resilience. This study concurs with Betcheva et al. (2020) and Chen et al. (2009) that integration capabilities are essential for aligning actors' operational activities and enhancing communication and visibility along the supply chain.

The study states that, for process integration to enhance healthcare supply chain resilience, the relationship must be mediated by inter-organizational governance. This aligns with the WHO (2024), which notes that investing in integration capabilities requires a governance mechanism to manage the integrated relationship effectively, and supports Belloni et al. (2025) argument that healthcare supply chain resilience results from integrated, governed activities.

The findings show that contractual, relational, and institutional governance create a framework that translates the integrated process into responsive and recovery capabilities. The complementarity of governance mechanisms indicates that healthcare supply chain resilience relies on a well-balanced mix of formal and informal governance mechanisms (Tsolakis et al., 2023).

However, while healthcare supply chain resilience benefits from a balanced governance mechanism, the highly independent and process-interconnected nature of the public healthcare supply chain in Tanzania increases reliance on contractual governance to coordinate aligned processes, enforce compliance, and facilitate preparedness, responsiveness, and recovery during disruptions. In line with the extended relational view by Dyer et al. (2018), jointly aligned investments foster reciprocal interdependence. Hence, responsiveness in this context appears to rely more on formal contractual governance mechanisms than on informal ones to improve accountability and synchronize interconnected operations and interactions among supply chain actors.

Overall, from a theoretical perspective, the results support the relational and dynamic capability views, suggesting that healthcare supply chain resilience relies more on how well integrated processes are effectively governed than simply on the presence of process integration (Dyer et al., 2018; Teece, 2007; Ryciuk, 2020).

V.CONCLUSION & RECOMMENDATIONS

5.1 Conclusion

The findings of this study do not support the previous idea of a direct link between process integration and healthcare supply chain resilience. It shows that technology alignment, process coordination, and standardization improve the coordination of activities and interdependencies; however, increasing resilience capacity requires inter-organizational governance mechanisms to coordinate the actions of highly interdependent actors. A balanced use of contractual, relational, and institutional governance is key in shaping how responses develop within integrated processes. Nevertheless, building resilience in a highly interdependent supply chain relies heavily on contractual governance rather than relational governance, as it enforces agreements, clarifies roles, establishes accountability, and facilitates coordinated responses among actors. Although relational governance enhances integrated processes to build resilience, relying on informal relational arrangements instead of formal contractual ones may create relational inertia over time, thereby limiting adaptability and constraining resilience. Overall, the results show that healthcare supply chain resilience depends on the effective governance of process integration among supply chain actors.

5.2 Recommendations

Health supply chain actors should consistently invest in integrating processes among supply chain participants; however, greater focus should be placed on how these processes are governed to improve supply chain resilience. Effective process integration, supported by effective contractual governance and balanced with relational and institutional governance, enhances resilience by enabling preparedness, responsiveness, and recovery during disruptions.

Declaration of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

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