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CAPABILITIES, VULNERABILITY, AND RESILIENCE IN PUBLIC SECTOR SUPPLY CHAINS: EVIDENCE FROM GHANA UNDER CONDITIONS OF TURBULENCE

This study examines the role of capabilities and vulnerability in shaping resilience within public sector supply chains in Ghana during periods of turbulence. Using a mixed-methods approach, the study combines semi-structured interviews with public sector actors and quantitative analysis based on 350 survey responses. The findings indicate that workforce capacity and system vulnerability are significant predictors of resilience, while governance and coordination, procurement flexibility, supplier diversity, logistics and inventory management, and information systems do not exert independent effects. Qualitative data suggested that resilience was more a function of leadership judgement, co-ordination and adaptive responses than of formal structures. The findings demonstrate the impact of human competencies and institutional conditions on resilience of public sector supply chains. The findings indicate a need for greater investment in workforce development, adaptive governance and organisational learning to build resilience and sustainability in the face of future shocks.

Keywords: *Public sector supply chains, resilience, vulnerability, workforce capacity, capability-based perspective, procurement, Ghana.*

Formulation of the problem. Public sector supply chains play an integral role in the delivery of essential goods and services, particularly during periods of disruption. Recent shocks, including the COVID-19 pandemic, fiscal constraints, and disruptions to global supply networks, have exposed weaknesses in public procurement, logistics, and institutional coordination systems [1]. These events have demonstrated that supply chain resilience depends not only on the ability of public institutions to maintain operations during disruption, but also on their capacity to adjust to rapidly changing conditions. This challenge is particularly pronounced in the public sector, where procurement and supply chain activities are governed by formal rules and procedures that can constrain flexibility and timely decision-making during crises.

The growing attention to public sector supply chain resilience has also encouraged reforms centred on formal institutional structures, compliance mechanisms, and technological systems. Such reforms can improve transparency, efficiency, and information availability, but their contribution to resilience depends partly on the capacity of institutions to implement and use them effectively. Evidence indicates that limited technical capacity, institutional fragmentation, and weak coordination can constrain the effectiveness of digital systems and procurement reforms in Ghana and other contexts [2; 3; 4]. Consequently, supply chain resilience is influenced by more than formal regulations and technological infrastructure. It also depends on organisational capacity, managerial judgement, coordination, and the ability of public institutions to adjust their actions when established procedures are insufficient to address emerging disruptions.

Vulnerability represents a further dimension of public sector supply chain resilience. Disruptions can expose weaknesses in procurement structures, supplier networks, information systems, and institutional coordination, while also creating opportunities for organisational learning and adaptation. Recent research distinguishes between stability-based resilience, which emphasises the capacity to withstand and recover from disturbances, and adaptation-based resilience, which involves adjustment, reorganisation, and transformation in response to changing conditions [4]. This distinction is particularly relevant to public sector supply chains because institutions must manage both established risks and emerging forms of disruption. The ability to recover from a disruption is necessary for maintaining service continuity, while the capacity to learn and adapt can determine whether vulnerabilities are reduced over time.

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Despite increasing scholarly attention to public sector resilience, empirical evidence on the interaction between organisational capabilities, vulnerability, and resilience remains limited in the Ghanaian context. Existing studies emphasise coordination, governance, digitalisation, and procurement reform, but provide less evidence on how institutional, operational, and informational capabilities interact with supply chain vulnerability to shape resilience outcomes under disruptive conditions. This limitation suggests the need for a more integrated assessment of the factors through which public sector supply chains develop and sustain resilience.

Against this background, the present study examines the institutional, operational, and informational capabilities that influence resilience in public sector supply chains in Ghana, while also assessing the effect of supply chain vulnerability on resilience outcomes. The study extends the existing literature in three respects. First, it moves beyond structural and compliance-based explanations by examining the role of organisational capabilities and human judgement in responding to disruption. Second, it brings institutional, operational, and informational capabilities together within a unified capability-oriented framework for analysing public sector supply chain resilience. Third, it provides empirical evidence from Ghana through a mixed-methods approach that combines qualitative insights with quantitative analysis. The findings provide an empirical basis for understanding how public institutions respond to supply chain disruptions and offer evidence that can inform procurement, coordination, digitalisation, and institutional reform aimed at strengthening resilience in Ghana's public sector supply chains.

Analysis of recent research and publications. Recent research on public sector supply chain resilience has moved beyond a narrow emphasis on recovery after disruption towards a broader view that includes anticipation, adaptation, learning, and sustained performance under uncertain conditions. Scala and Lindsay found that agility, collaboration, flexibility, and redundancy supported continuity in public-sector healthcare supply chains during COVID-19, while also emphasising the importance of coordination across supply networks [11]. Norrman and Eriksson Ahre similarly showed that resilience depends on governance and risk-management arrangements that can be adjusted to changing operating conditions [12]. In public healthcare supply chains, Mogere, Kwendo and Fozia associated resilience with the capacity to cope with environmental disturbances while maintaining service delivery [13]. These studies indicate that resilience involves both immediate response and longer-term adaptation.

Governance and organisational learning have also received attention. Chen, Li and Linderman showed that learning from previous disruptions can strengthen the capacity to prevent, absorb and recover from subsequent disturbances [14]. Grohmann et al. demonstrated that governance and trust can improve coordination and cooperation among supply chain actors [15]. These findings suggest that resilience is shaped by institutional arrangements and accumulated organisational experience. At the same time, rigid procedures may restrict timely responses when disruptions require decisions beyond established routines. A capability-based perspective has therefore gained prominence. Cabrera et al. linked vulnerability, adaptability and resilience in defence-sector supply chains and argued that identifying vulnerabilities can reveal areas where adaptive capacity requires strengthening [16]. Mishra, Singh and Subramanian similarly identified coordination, collaboration, flexibility and organisational preparedness as important elements of effective disruption management during COVID-19 [17]. Jiang et al. also emphasised governance, coordination and organisational preparedness as institutional conditions that support resilience [18]. These studies indicate that leadership and institutional coordination provide a foundation for other resilience capabilities. Operational capabilities are equally relevant because disruptions often affect procurement, sourcing, logistics, inventory and distribution simultaneously. Katsaliaki, Galetsi and Kumar identified flexibility, collaboration, redundancy and preparedness as important mechanisms for responding to major disruptions [19]. Gaudenzi, Pellegrino and Confente further showed that resilience can emerge from combinations of absorptive, responsive and restorative capabilities [20]. The evidence therefore suggests that resilience is not generated by a single operational mechanism but through the combination of capabilities that allow organisations to maintain essential functions while adjusting supply arrangements.

Recent studies increasingly recognise that institutional, operational and informational capabilities interact rather than operate in isolation. Laguir, Stekelorum and Elbaz emphasised managerial decision-making, learning and organisational adaptation in translating available resources into effective resilience outcomes [24]. This suggests that the presence of individual capabilities may not be sufficient unless organisations can combine and mobilise them effectively during disruption. Vulnerability is similarly being treated as part of the resilience process. Cabrera et al. showed that vulnerability can reveal structural weaknesses requiring adaptive responses [16], while Mishra et al. demonstrated that disruption can expose weaknesses in sourcing, logistics and planning while encouraging alternative arrangements and more flexible practices [17]. Existing studies provide useful evidence on governance, coordination, digitalisation and operational flexibility, but limited empirical evidence explains how these capabilities jointly influence resilience and how vulnerability relates to resilience outcomes in Ghanaian public sector supply chains [28; 29; 30]. The present study addresses this gap by examining institutional, operational and informational capabilities together with supply chain vulnerability within a unified framework, with resilience understood as the capacity to cope with disruption, adapt to changing conditions and maintain continuity of essential functions.

Purpose of the Article. The purpose of this article is to examine how institutional, operational, and informational

capabilities, together with system vulnerability, influence resilience in public sector supply chains in Ghana during periods of turbulence, with particular attention to the capacity of public institutions to cope with, adapt to, and recover from disruptions.

Materials and Methods. The study employed a mixed-methods approach to examine the factors associated with resilience in Ghanaian public sector supply chains under turbulent conditions. The study population comprised public sector organisations involved in supply chain activities, including procurement departments, public health supply chain units, regulatory agencies, ministries, and local government authorities. Participants included procurement officers, logistics personnel, supply chain managers, regulators, and policy officials with relevant experience. For the qualitative component, 20 participants were purposively selected and interviewed until thematic saturation was reached. The quantitative component comprised survey data from 350 respondents. Data were collected through semi-structured interviews and a structured questionnaire covering governance and coordination, procurement flexibility, supplier diversity, logistics and inventory capacity, information systems, workforce capacity, system vulnerability, and resilience. Qualitative data were analysed thematically through coding, categorisation, and identification of key themes. Quantitative data were analysed using descriptive statistics, Pearson correlation, and multiple regression to estimate the relationships between the explanatory variables and supply chain resilience. Diagnostic tests were conducted to assess the reliability of the regression estimates, including multicollinearity and autocorrelation. The integration of both forms of evidence provided a broader assessment of the factors associated with resilience. The study complied with established ethical requirements. Ethical approval was obtained before data collection, informed consent was obtained from all participants, participation was voluntary, and confidentiality was maintained through the use of identification codes. The data were used solely for research purposes.

Presentation of the main research material. The qualitative findings indicate that leadership and coordination were important to maintaining supply chain continuity during periods of turbulence. Respondents consistently emphasised the ability of leaders to make timely decisions, communicate effectively, and adjust their actions when information was incomplete. One respondent stated that "what kept the system moving was not the manual but the people who were bold enough to make decisions when information was incomplete" (Respondent 1), while another observed that "when leadership hesitated, the whole chain slowed down" (Respondent 3). These accounts suggest that organisational responsiveness depended substantially on managerial judgement and the capacity to act under uncertainty. The finding is consistent with research that views resilience as involving timely decision-making, adaptation, and continued functionality rather than simple recovery after disruption [11; 12; 13].

Inter-agency collaboration also emerged as an important source of resilience. Respondents reported that institutions with established relationships and trust-based networks coordinated more effectively than those relying exclusively on formal communication channels. One participant explained that "the agencies that had worked together before the turbulence responded better because they already trusted each other's information" (Respondent 6). Weak collaboration, by contrast, resulted in delays and fragmented responses. The findings therefore suggest that trust, coordination, and shared priorities strengthen the ability of public institutions to maintain continuity during disruption. This observation supports evidence that governance, organisational learning, and inter-organisational relationships contribute to supply chain resilience [14; 15].

Procurement responsiveness varied across institutions and was influenced by procedural flexibility and staff confidence. Although emergency procurement provisions existed, some officers were reluctant to apply them because of concerns about compliance and audit scrutiny. One respondent explained that "some rules allowed expedited procurement, but officers were afraid to use them because of audit concerns" (Respondent 11). Institutions with stronger leadership support and greater familiarity with emergency procedures responded more quickly. This finding indicates that the existence of flexible procurement rules does not necessarily translate into practical responsiveness. Personnel must also have the confidence and institutional support required to use those provisions appropriately. The finding is consistent with research identifying flexibility, preparedness, and organisational capability as important components of resilience [17; 19; 20].

Inventory and distribution systems also experienced substantial pressure during periods of disruption. Respondents reported shortages, distribution delays, and limited capacity to accommodate sudden increases in demand. One participant noted that "our stock levels were planned for normal operations, so when demand doubled, there was no buffer" (Respondent 9). Although distribution systems generally functioned under normal conditions, their capacity to absorb large-scale disruptions was limited. This suggests that resilience requires operational arrangements capable of absorbing changes in demand rather than systems designed only for stable conditions. The finding is consistent with studies that associate resilience with flexibility, redundancy, and the capacity to reconfigure operational arrangements when established supply channels become unreliable [19; 20; 29].

The qualitative evidence further indicates that information-sharing challenges were associated more with institutional and behavioural constraints than with the absence of digital technologies. Although digital platforms were available, their effectiveness was constrained by fragmented records, limited technical skills, and low levels of trust. One respondent observed that "digital tools were underused because many officers were not confident with them" (Respondent

13), while another noted that "data sharing worked when individuals trusted each other" (Respondent 13). These findings suggest that digital infrastructure alone does not guarantee effective information capability. Its contribution to resilience depends on user competence, organisational readiness, information integration, and trust among participating institutions. This interpretation agrees with research showing that digital integration, information availability, and analytical capability can strengthen supply chain visibility and responsiveness when supported by appropriate organisational conditions [21; 22; 23].

The findings also indicate that public sector supply chains remained operational during periods of turbulence through individual initiative, experience, and improvisation. Respondents repeatedly described situations in which individuals compensated for weaknesses in formal systems. One senior officer stated that "the system did not collapse because individuals stepped in where the system was weak" (Respondent 11). Another respondent observed that "coping is not the same as resilience; coping means surviving the moment" (Respondent 13). These accounts suggest that public institutions demonstrated an ability to cope with immediate disruptions, although resilience remained uneven and was often dependent on workforce capability and local adaptive responses. This distinction is consistent with the growing view of resilience as a broader process involving coping, adaptation, learning, and recovery [16; 17; 29].

The quantitative analysis provides further evidence on the factors associated with public sector supply chain resilience. Table 1 presents the overall regression model.

The model produced $R = 0.439$ and $R^2 = 0.193$, indicating that the explanatory variables jointly account for approximately 19.3% of the variance in public sector supply chain resilience. The overall regression model was statistically significant, $F(7, 342) = 11.70$, $p < .001$. Thus, the explanatory variables collectively provide a statistically significant explanation of variation in resilience, although a substantial proportion of the variance remains attributable to factors outside the estimated model.

Table 2 presents the estimated effects of governance and coordination, procurement flexibility, supplier diversity, logistics and inventory capacity, information systems and digital capacity, workforce capacity, and system vulnerability on resilience.

Workforce capacity was a positive and statistically significant predictor of resilience ($\beta = 0.182$, $t = 3.65$, $p < .001$). This quantitative result reinforces the qualitative evidence that experience, confidence, and adaptability enabled personnel to maintain operations during disruption. It suggests that resilience depends substantially on the capacity of personnel to interpret procedures, exercise judgement, and respond to changing conditions. This is consistent with the capability-based literature, which places organisational preparedness and adaptive capacity at the centre of resilience [16; 17].

System vulnerability also showed a positive and statistically significant coefficient ($\beta = 0.344$, $t = 7.79$, $p < .001$). The finding requires careful interpretation. It does not imply that vulnerability itself improves resilience. Rather, institutions that experience procedural bottlenecks, resource constraints, or supplier dependence may develop stronger coping mechanisms, greater awareness of continuity requirements, or adaptive practices in response to repeated exposure to disruption. Vulnerability may therefore act as an indicator of areas where adaptive capacity has been developed or where institutions have been compelled to strengthen their response mechanisms [16; 17].

The remaining predictors were not statistically significant. Governance and coordination recorded $\beta = -0.030$ ($p = .667$), procurement flexibility $\beta = 0.005$ ($p = .954$), supplier diversity $\beta = -0.033$ ($p = .776$), and logistics and inventory capacity $\beta = 0.150$ ($p = .176$). Information systems and digital capacity produced a negative coefficient of $\beta = -0.121$ ($p = .078$), which does not reach the 5% significance level. These results do not

Table 1

Model fit measures

Model	R	R^2	F	df1	df2	p
1	0.439	0.193	11.70	7	342	< .001

Note: Model estimated using a sample of N = 350.

Source: author computation using Jamovi

Table 2

Regression coefficients for public sector supply chain resilience

Predictor	Estimate (β)	SE	t	p
Governance and coordination	-0.030	0.0695	-0.430	.667
Procurement flexibility	0.005	0.0791	0.058	.954
Supplier diversity	-0.033	0.1156	-0.285	.776
Logistics and inventory capacity	0.150	0.1109	1.355	.176
Information systems and digital capacity	-0.121	0.0684	-1.765	.078
Workforce capacity	0.182	0.0499	3.650	< .001
System vulnerability	0.344	0.0442	7.791	< .001

Source: author computation using Jamovi

necessarily indicate that these capabilities are unimportant. Rather, their effects may depend on complementary organisational conditions. The qualitative findings support this interpretation, particularly in relation to procurement and information systems, where formal arrangements existed but their effectiveness depended on staff confidence, technical competence, institutional support, and trust. This pattern is consistent with evidence that resilience capabilities often operate through combinations of institutional, operational, and informational resources rather than as isolated mechanisms [17; 20; 21].

The Durbin-Watson test was used to assess the independence of the regression residuals. The result is presented in Table 3.

The Durbin-Watson statistic was 2.20, with a p-value of .058. The result does not indicate statistically significant autocorrelation at the 5% level. The residual independence assumption was therefore considered satisfactory for the estimated regression model.

Multicollinearity among the explanatory variables was assessed using variance inflation factor and tolerance statistics. The results are presented in Table 4.

The VIF values ranged from 1.05 to 3.52, while tolerance values ranged from 0.284 to 0.952. The results indicate that the explanatory variables did not exhibit problematic multicollinearity. The regression estimates can therefore be interpreted without evidence of substantial overlap among the explanatory variables.

Both the qualitative and quantitative findings indicate that resilience in Ghanaian public sector supply chains depends on more than formal procedures or physical resources. Leadership, inter-agency trust, workforce capability, operational flexibility, information use, and organisational adaptation all emerged as relevant dimensions of the resilience process. The significant effect of workforce capacity is particularly consistent across the qualitative and quantitative evidence, suggesting that human capability provides an important foundation for maintaining operations during disruption. At the same time, the positive association between system vulnerability and resilience points to the possibility that repeated exposure to weaknesses encourages institutions to develop coping and adaptive responses [29; 21; 22].

The findings also indicate that formal capabilities may be insufficient when they are not supported by the organisational conditions required for their effective use. Procurement flexibility was constrained by concerns about audit scrutiny, while digital systems were limited by fragmented information, technical skill gaps, and trust-related barriers. The absence of significant independent effects for governance and coordination, procurement flexibility, supplier diversity, logistics and inventory capacity, and information systems should therefore not be interpreted as evidence that these capabilities are irrelevant. Rather, their contribution may depend on how they interact with workforce capability, leadership, organisational preparedness, and other conditions within the supply chain environment. Overall, the evidence supports an understanding of public sector supply chain resilience as a process of coping, adaptation, learning, and continuity in which organisational capabilities and vulnerability interact.

Table 3

Durbin-Watson test for autocorrelation

Test	DW Statistic	p
Durbin-Watson	2.20	.058

Source: author computation using Jamovi

Table 4

Collinearity statistics

Predictor	VIF	Tolerance
Governance and coordination	2.35	0.425
Procurement flexibility	3.21	0.312
Supplier diversity	3.52	0.284
Logistics and inventory capacity	3.26	0.307
Information systems and digital capacity	1.67	0.597
Workforce capacity	1.37	0.729
System vulnerability	1.05	0.952

Source: author computation using Jamovi

Conclusions. The study examined organisational capabilities and system vulnerability as determinants of resilience in Ghana's public sector supply chains. The findings show that workforce capacity and system vulnerability significantly influenced resilience, while other capabilities had no significant independent effects. The results suggest that stronger resilience requires greater emphasis on workforce development, adaptive governance, coordination, and organisational learning.

The study focused on Ghanaian public sector supply chains, which limits the generalisability of the findings to other contexts. The qualitative findings were based on participants' experiences and perceptions and may therefore reflect some degree of subjectivity. The quantitative model explained 19.3% of the variation in resilience, indicating that other factors were not captured. The cross-sectional design also limits the assessment of how resilience develops over time. Future studies could use longitudinal data to examine changes in capabilities, vulnerability, and resilience.

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МОЖЛИВОСТІ, ВРАЗЛИВІСТЬ ТА СТІЙКІСТЬ У ЛАНЦЮГАХ ПОСТАЧАННЯ ДЕРЖАВНОГО СЕКТОРУ: ЕМПІРИЧНІ ДАНІ З ГАНИ В УМОВАХ ТУРБУЛЕНТНОСТІ

Це дослідження має на меті визначити роль організаційних можливостей і системної вразливості у формуванні стійкості ланцюгів постачання державного сектора в Гані в умовах турбулентності. Актуальність дослідження зумовлена зростанням кількості зовнішніх і внутрішніх потрясінь, які впливають на державні закупівлі, логістику, розподіл ресурсів, міжвідомчу координацію та безперервність надання державних послуг. У дослідженні застосовано змішаний методологічний підхід, що поєднує якісне та кількісне дослідження. Якісна складова ґрунтувалася на напівструктурованих інтерв'ю з представниками державного сектора, які безпосередньо беруть участь у закупівлях, логістиці, регулюванні та управлінні ланцюгами постачання. Кількісна складова базувалася на даних опитування 350 респондентів, а взаємозв'язки між ключовими можливостями та стійкістю оцінювалися за допомогою множинного регресійного аналізу. Результати якісного аналізу показують, що підтримання безперервності ланцюгів постачання значною мірою залежало від лідерства, міжвідомчої координації, довіри, здатності персоналу приймати рішення за неповної інформації, оперативної гнучкості та використання інформаційних систем. Водночас формальні процедури, цифрові платформи та механізми контролю не завжди забезпечували належну швидкість реагування в умовах порушень. Кількісні результати показали, що спроможність робочої сили та системна вразливість мають статистично значущий позитивний зв'язок зі стійкістю ланцюгів постачання. Натомість управління та координація, гнучкість закупівель, різноманітність постачальників, логістика та управління запасами, а також інформаційні та цифрові системи не продемонстрували статистично значущих незалежних ефектів у повній регресійній моделі. Загалом результати свідчать, що стійкість державних ланцюгів постачання визначається не лише формальними правилами, процедурами чи технологічною інфраструктурою, а й здатністю установ мобілізувати людські та організаційні ресурси, адаптуватися до змін і підтримувати координацію під час порушень. Позитивний зв'язок між вразливістю та стійкістю також вказує на можливість того, що повторне зіткнення з процедурними обмеженнями, ресурсними дефіцитами та залежністю від постачальників може стимулювати навчання та розвиток адаптивних механізмів. Дослідження підкреслює необхідність посилення розвитку робочої сили, адаптивного управління, міжвідомчої співпраці, інформаційної інтеграції та організаційного навчання для підвищення здатності державних установ протистояти майбутнім потрясінням, адаптуватися до них і підтримувати безперервність надання суспільно важливих послуг.

Ключові слова: *ланцюги постачання державного сектора, стійкість ланцюгів постачання, системна вразливість, спроможність робочої сили, організаційні можливості, адаптивне управління, державні закупівлі, Гана.*

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