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In search of operational resilience: How and when improvisation matters

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Abstract

The need to improvise during supply chain disruptions to enhance operational resilience is ever more critical. Yet, managers appear to lack an understanding of how and when improvisation matters. We apply the conservation of resources theory to conceptualize how firms activate spontaneous and creative improvisation during supply chain disruptions and theorize how that relates to operational resilience in low and high supply chain disruption conditions. We test our arguments on primary data from a sample of 259 firms in Ghana. We find that creative improvisation has a positive relationship with operational resilience, and this relationship is stronger in high supply chain disruption conditions. Spontaneous improvisation, on the contrary, is unrelated to operational resilience in both low and high supply chain disruption conditions. These findings indicate that not all types of improvisation contribute to operational resilience, suggesting the need for a nuanced approach to theorizing and applying the improvisation concept in supply chains.

KEYWORDS

conservation of resources theory, decomposed and contingency model, operational resilience, organizational improvisation, supply chain disruption

INTRODUCTION

Operational resilience, defined as the capability of a firm's business operations to absorb and quickly recover from disruptions, has become of keen interest to supply chain scholars and practitioners (Essuman et al., 2022; Li et al., 2022). The McKinsey Global Institute (2020) reports that 93% of the global supply chain managers they surveyed aimed to increase operational resilience, and The Business Continuity Institute (2022) that 78% of firms have or are developing an operational resilience program. The growing need for operational resilience is evidence of the fact that firms' operations are highly vulnerable to disruption (Chen et al., 2022; Gerschberger et al., 2023; Jiang et al., 2023). One example is the significant damage to local and global supply chains caused by flooding in Thailand in 2011. That flooding halted the production systems of Toyota, Honda, and Nissan for several days, with a loss of 423,000 cars between them at a cost of about USD 8.80 billion (Haraguchi & Lall, 2015). The Russia–Ukraine conflict has also triggered production shutdowns at major automobile firms (e.g., BMW and Volkswagen) in Germany (Simchi-Levi & Haren, 2022). Additionally, the conflict has forced many multinational companies, e.g., McDonald's, Marriott, PepsiCo, and Shell, to unwind investments, close stores, and pause sales in Russia (The New York Times, 2022).

Supply chain disruption threatens business survival, but it also creates opportunity and increases the motivation for supply chain managers to improvise in order to mitigate disruption-induced operational and financial losses (Richey et al., 2021; Yan et al., 2022). Improvisation refers to the degree to which firms engage in spontaneous and creative actions to find new ways to achieve an objective (Vera & Crossan, 2005). Indeed, anecdotal evidence of improvisation in disruptive situations abounds in resource-constrained and resource-abundant contexts (e.g., Cunha et al., 2022; Latour, 2001; Lombardi et al., 2021; Luo & Malsch, 2020; Munir et al., 2022). Burberry, Louis Vuitton, LMVH, Rolls Royce, the Formula One team, and Airbus all used improvisation to manage disruptions from the Covid-19 pandemic, as did small and medium-sized firms (SMEs) in developing economies (Cunha et al., 2022; Stekelorum et al., 2022).

While improvisation is gaining traction in supply chain research and practice, some scholars caution that it is a double-edged sword, solving problems but also creating new ones (Giustiniano et al., 2016; Grøtan et al., 2008). The theoretical and empirical analysis of the resilience implications of improvisation is still limited (Munir et al., 2022; Patrucco et al., 2022). Using survey data from Pakistani manufacturers, Munir et al. (2022) find that improvisation is positively associated with supply chain resilience, although their empirical approach did not clarify how or when improvisation benefits supply chain resilience. Related empirical studies show that the benefits of improvisation are not universal, rather, they are multidimensional and contingent upon organizational circumstances (e.g., Hultman et al., 2022; Nemkova et al., 2015; Souchon et al., 2016). Hultman et al. (2022) find that the impact of the spontaneity dimension of improvisation on sales performance is negative, while that of the creativity dimension is U-shaped, and that self-efficacy and agency moderate both effects. On the contrary, Nemkova et al. (2015) show that creativity and spontaneity are positively related to export responsiveness but unrelated to customer and economic performance outcomes. We argue, therefore, that different dimensions of improvisation may have different effects on operational resilience under varying firm situations. As such, empirical knowledge of how and when different dimensions of improvisation affect operational resilience should be helpful for business executives and supply chain managers.

We apply the conservation of resources (COR) theory (Hobfoll et al., 2018) to analyze how the two core dimensions of improvisation, spontaneity, and creativity (Vera & Crossan, 2005), are related to operational resilience under varying levels of supply chain disruption. Using COR theory, we theorize that firms' innate desire to survive and thrive through investing resources and taking desperate measures to minimize resource losses or gain new resources explains why they spontaneously and creatively improvise to enhance operational resilience. We also apply the COR concept of "resource caravan passageways" and propose that supply chain disruptions are essential environmental conditions that allow firms to harness their spontaneous and creative improvisation to improve operational resilience. We use a sample of firms in Ghana to answer two questions: (1) How do spontaneous and creative improvisation relate to operational resilience? (2) How does supply chain disruption moderate the relationships between spontaneous and creative improvisation and operational resilience?

We make three contributions to the resilience and improvisation literature. First, we show how breaking down the improvisation construct into its core dimensions of spontaneity and creativity can contribute to a better understanding of the link between firm improvisation and operational resilience. Second, we extend the contingency approach by clarifying the boundaries of the resilience benefits of improvisation, identifying supply chain disruption as a moderator of the link between creative improvisation and operational resilience. Finally, we use COR theory to propose an alternative theoretical lens for understanding the roles and boundaries of improvisation in building resilient supply chains and operations.

THEORETICAL BACKGROUND AND HYPOTHESIS DEVELOPMENT

Operational resilience

Supply chain scholars disagree on the definition and conceptual domain of the resilience concept (Davis-Sramek & Richey Jr, 2021; Jiang et al., 2023; Wieland & Durach, 2021). From engineering and socio-ecological perspectives, resilience can manifest in a system's ability to absorb, recover from, adapt to, or transform in response to disruptions (Davis-Sramek & Richey Jr, 2021; Hughes et al., 2022; Wieland & Durach, 2021). A growing number of supply chain scholars argue that these core manifestations of resilience should be distinguished from potential antecedents such as improvisation, buffering resources (e.g., slack), bridging resources (e.g., collaboration), visibility, agility, flexibility, preparedness, and anticipation (Chowdhury et al., 2023; Eryarsoy et al., 2022; Essuman et al., 2020; Munir et al., 2022; Scholten et al., 2019).

Extant supply chain research has analyzed resilience at the supply chain (Gu et al., 2021; Lorentz et al., 2021), firm (e.g., Ambulkar et al., 2015; Jiang et al., 2023), operations (e.g., Essuman et al., 2020; Li et al., 2022), and individual levels (Gerschberger et al., 2023; Iyengar et al., 2021). While the study of resilience at the supply chain level predominates, the concept is empirically captured from the firm perspective (e.g., Lorentz et al., 2021; Wong et al., 2020), with a particular focus on operational activities (e.g., Brandon-Jones et al., 2014; Eryarsoy et al., 2022; Jiang et al., 2023; Shin & Park, 2021; Yu et al., 2019). This study focuses on the resilience of firm operations and analyzes two core resilience manifestations: disruption absorption and recoverability (Essuman et al., 2020; Jiang et al., 2023). Disruption absorption refers to a firm's capability to maintain the structure and normal functioning of its operations during disruptions (Wieland & Wallenburg, 2012), and recoverability is the capability to restore operations to prior levels following disruptions (Brandon-Jones et al., 2014). Holling (1973) argues that a system can be "resilient" (i.e., persist in the face of disruptions) but lack "stability" (i.e., the ability to return to an equilibrium state after being exposed to a disruption). Thus, disruption absorption and recoverability are distinct components of operational resilience (Essuman et al., 2020; Simchi-Levi et al., 2018).

Some scholars argue that the disruption absorption and recoverability aspects of resilience, compared with adaptive and transformative resilience, are limiting, as they assume that firms and supply chains are static systems (Tukamuhabwa et al., 2015; Wieland & Durach, 2021). While firms and supply chains are complex adaptive systems with adaptive and transformative resilience properties (Tukamuhabwa et al., 2015; Wieland & Durach, 2021), such resilience elements have a long-term focus (Richey et al., 2021), and their manifestations tend to distort the structure, configuration, and domain of current operations (Essuman et al., 2020; Wieland & Durach, 2021). Therefore, considering that firms search for stability (Bode et al., 2011), firms also demonstrate resilience in the areas of disruption absorption and recoverability (Brandon-Jones et al., 2014; Simchi-Levi et al., 2018). When disruptions occur, a firm's first-order or temporal response, where possible, might be to achieve these resilience aspects in order to safeguard how market value is created and delivered (Essuman et al., 2020; Wieland & Durach, 2021).

Improvisation

Improvisation is a widely applied concept, manifesting itself in settings as diverse as crisis management and jazz musical expression (Cunha et al., 2022; Hadida et al., 2015; Hutchins, 1991; Vera & Crossan, 2005). There was a lot of improvisation during the Covid-19 outbreak when individuals, firms, organizations, and societies had to improvise to cope with pandemic-induced disruptions (Cunha et al., 2022; Munir et al., 2022). The wide application of improvisation has led scholars to use multiple definitions, tapping into intuition, action orientation, knowledge, novelty, spontaneity, and flexibility to conceptualize the concept (Hadida et al., 2015; Vera & Crossan, 2004). In analyzing this stream of literature, Vera and Crossan (2004) apply the notion of theater improvisation characterized by "letting go" and "making do" to identify spontaneity and creativity as two fundamental constituents of improvisation. They define improvisation as "the spontaneous and creative process of attempting to achieve an objective in a new way" (Vera & Crossan, 2004, p. 733). Spontaneous improvisation is a spur of the moment reaction to a situation, creative improvisation aims to develop something new and relevant to solve a problem (Vera & Crossan, 2004). Improvisation is, therefore, a high-order construct, with spontaneity and creativity constituting its underlying components (Magni et al., 2013; Vera & Crossan, 2004).

Improvisation studies have focused on different levels of analysis, some examining improvisation at the individual level (Hultman et al., 2022), others at the team level (Magni et al., 2013), and still others at the firm level (Munir et al., 2022). How the construct is operationalized also differs, with some studies treating improvisation as a unidimensional construct (Banin et al., 2016; Magni et al., 2013; Munir et al., 2022), and others as a multiple one (Hultman et al., 2022; Nemkova et al., 2015). In this study, we analyze improvisation at the firm level by focusing on its two basic components:

spontaneity and creativity (Vera & Crossan, 2004). We define spontaneous improvisation as the extent to which firms extemporaneously respond to unexpected events, and creative improvisation as the extent to which they try new approaches to address issues (Magni et al., 2013; Vera & Crossan, 2004).

Supply chain disruption

Supply chain disruption connotes "...unplanned and unanticipated events that disrupt the normal flow of goods and materials within a supply chain" (Craighead et al., 2007, p. 132). Such events have various sources, including but not limited to natural disasters, wars and political turmoil, pandemics, volatility in macroeconomic conditions, cyberattacks, changes in supply and demand, infrastructure breakdown, power outages, strike actions, and employee turnover (Ali et al., 2023; Chowdhury et al., 2023; Kovach et al., 2023; Pellegrino et al., 2023; Wong et al., 2020). While the sources of supply chain disruption are numerous, previous studies have captured several disruption triggers under different conceptual labels. For example, supply chain disruption has been classified as supply-side disruption (e.g., supplier inability to deliver products), infrastructure disruption (e.g., breakdown of production line, information network, transportation infrastructure), and catastrophic disruption (e.g., natural disasters, wars; Wong et al., 2020), or classified as idiosyncratic disruptions (i.e., specific to a firm or its supply chain) versus covariate disruptions (i.e., those that affect multiple firms or supply chains, e.g., catastrophic disruption) (Iyengar et al., 2021). To obtain relevant variations in data, we focus on idiosyncratic supply chain disruptions and operationalize the construct as the extent to which unplanned events directly interrupt the normal flow of goods, materials, information, and services within a supply chain.

Conservation of resources theory

We use COR theory to develop a conceptual model of how and when spontaneous and creative improvisation affect operational resilience (Figure 1). Earlier works using COR theory have chosen individuals as the unit of analysis (Hobfoll, 1989), but more recent applications have considered how organizations and communities enact resilience responses to stressful conditions (e.g., disasters) (Hobfoll et al., 2018; Zamani et al., 2006). The theory's basic tenet that "individuals (and groups) strive to obtain, retain, foster, and protect those things they centrally value" (Hobfoll et al., 2018, p. 4) is predicated upon four core principles: (1) *primacy of loss principle*: resource loss is disproportionately more salient than resource gain; (2) *resource investment principle*: resource investment is necessary to protect against resource loss, recover from losses, and gain resources; (3) *gain paradox principle*: resource gain increases in salience in the context of resource loss; and (4) *desperation principle*: when resources are overstretched or exhausted, people adopt a defensive strategy to preserve remaining resources or utilize an exploratory strategy to search for alternative means to survive (Hobfoll et al., 2018).

Adopting a COR theory perspective, we see firms as having an innate desire to be resilient: to survive and thrive (Altay & Pal, 2023; Duensing et al., 2023; Hobfoll et al., 2018). Our reasoning is in keeping with information processing theory and the resource dependence logic in the supply chain literature that suggests that firms seek to minimize uncertainty, strive for stability and continuity, and accordingly, deploy bridging and buffering strategies to achieve resilience (Bode et al., 2011; Jiang et al., 2023; Manhart et al., 2020; Wong et al., 2020). A COR theory explanation of the resilience-building behavior of firms presupposes that an organization may experience socio-economic stress when there is an actual or a potential disruption to its

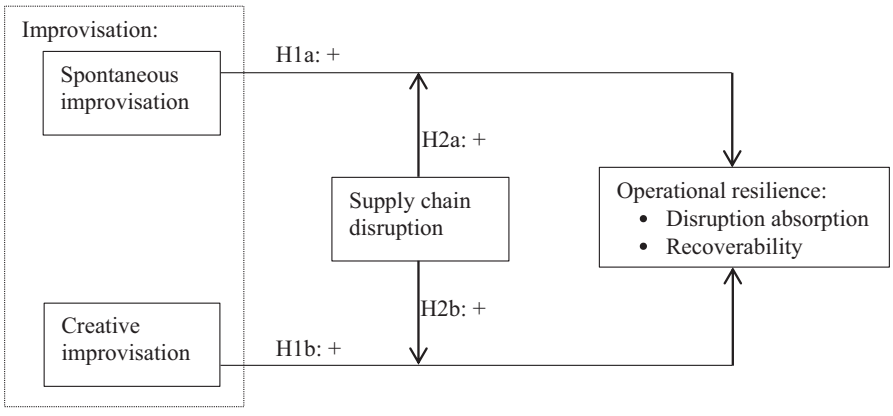

FIGURE 1 Conceptual model.

livelihood (i.e., operations) (Halbesleben et al., 2014; Hobfoll, 1989). Extant literature specifies that supply chain disruptions cause losses in output, revenue, and reputation (Ateş et al., 2022; Haraguchi & Lall, 2015).

The desperation principle of the COR theory indicates that firms are likely to engage in defensive or exploratory behaviors during supply chain disruptions in order to safeguard or adapt how they currently earn a living (Halbesleben et al., 2014; Hobfoll et al., 2018). Evidence shows that spontaneous and creative improvisation is defensive and exploratory behaviors that firms manifest during supply chain disruptions (e.g., Cunha et al., 2022; Latour, 2001; Lombardi et al., 2021; Munir et al., 2022). COR theory argues that "individuals and organizations who lack resources are more vulnerable to resource loss and less capable of resource gain" (Hobfoll et al., 2018, p. 4). Spontaneous and creative improvisation allows firms to acquire a more centrally valued resource (e.g., operational resilience) (Halbesleben et al., 2014; Hobfoll, 1989; Souchon et al., 2016). Therefore, the COR theory resource investment principle, in combination with the desperation principle, suggests that firms would be inclined to channel improvisational efforts into building operational resilience (Hobfoll et al., 2018).

Consistent with contingency theory (see, e.g., Brandon-Jones et al., 2014), the COR theory notion of resource caravan passageways explains how certain environmental factors may moderate the effectiveness of improvisation (Halbesleben et al., 2014; Hobfoll et al., 2018). Specifically, the resource caravan passageways concept contends that environmental factors can either foster or limit resource creation and sustenance (Hobfoll et al., 2018). A firm can possess valuable resources but not use—or fully exploit—them unless the situation demands it (Halbesleben et al., 2014). More specifically, though improvisation has an inherent utility for resilience-building, its value can become degraded when not necessitated by environmental conditions (Halbesleben et al., 2014). This argument is consistent with Vera and Crossan (2005) assertion that effective improvisational processes require the right environment.

We propose supply chain disruption as a resource caravan passageway to explain the efficacy of improvisation as a determinant of operational resilience. We contend that low levels of supply chain disruption signal less of a threat to resource loss and offer little opportunity for firms to evaluate the effectiveness of their response to disruption (Bode et al., 2011). By contrast, high levels of supply chain disruption provoke significant fear of resource loss but also allow firms to build the relevant disruption management knowledge and capacity (Ambulkar et al., 2015; Bode et al., 2011) necessary for reducing errors associated with improvisation (Vera & Crossan, 2005; Yan et al., 2022). Therefore, we argue that high levels of supply chain disruption enable firms to improvise more effectively and thereby enhance operational resilience (Ambulkar et al., 2015).

Improvisational responses and operational resilience

Disruption of a firm's operations can have an immediate impact, and a delayed response can aggravate the situation further (Haraguchi & Lall, 2015), suggesting that the disruption absorption and recoverability facets of operational resilience can benefit from spontaneity and creativity. Firms differ in their ability to engage in spontaneous and creative improvisation (Baker et al., 2003). Scholars contend that a higher level of these aspects of improvisation may help a firm successfully manage unexpected events (Magni et al., 2013; Vera & Crossan, 2005). Thus, improvisation can drive operational resilience as it increases the speed and flexibility with which a firm can attend to disruptions (Grøtan et al., 2008; Lombardi et al., 2021).

According to COR theory (Hobfoll et al., 2018), therefore, firms will be strongly motivated to act on the spur of the moment to regain stability and restore normal operations (Vera & Crossan, 2005). Spontaneity and creativity are important resources in attempting to minimize, by whatever means available, the impact of a disruption and to recover from operational losses, thereby increasing time-to-survive while reducing time-to-recover (Hobfoll et al., 2018). Disruptions are unpredictable, and their propagations can create new situations in which planned responses may not work (Andersson et al., 2019). By exercising creative improvisation, firms can rapidly devise and implement new solutions to contain and bounce back from disruptions (Andersson et al., 2019; Lombardi et al., 2021).

Case studies and anecdotal evidence support the notion that improvisation contributes to operational resilience (see, e.g., Andersson et al., 2019; Lombardi et al., 2021; Luo & Malsch, 2020; Munir et al., 2022) and show that firms differ in their ability to engage in improvisation (Baker et al., 2003). For example, when a fire at a Philips semiconductor plant contaminated millions of chips, Ericsson and Nokia experienced severe supply disruptions. Ericsson struggled to absorb and recover from that disruption, but Nokia showed operational resilience by quickly exploring alternative sources of chips, redesigning some phone models, and speeding-up projects to boost production (Latour, 2001). Pertti Korhonen, Nokia's top troubleshooter, summed up the difference simply, "...a crisis is the moment when you improvise" (Latour, 2001). Accordingly,

H1a. Spontaneous improvisation has positive relationships with disruption absorption and recoverability dimensions of operational resilience.

H1b. Creative improvisation has positive relationships with disruption absorption and recoverability dimensions of operational resilience.

Supply chain disruption as a boundary condition

Strategy and organizational studies show that organizational contingencies moderate the benefits of improvisation. Such contingencies include, for example, resource availability (Banin et al., 2016), self-efficacy (Hultman et al., 2022), experimental culture, real-time information and communication, and expertise (Vera & Crossan, 2005), as well as uncertainty and complexity-inducing factors such as market dynamism (Souchon et al., 2016) and spatial dispersion (Magni et al., 2013). Following the COR resource caravan passageways concept (Hobfoll et al., 2018), we further propose that the ability to leverage improvisational responses for resilience is not uniform across firms; and even if this were not true, their efficacy is likely to vary due to differences in their exposure to supply chain disruptions (Luo & Malsch, 2020; Vera & Crossan, 2005).

We argue that supply chain disruption may complement improvisation to improve operational resilience. High supply chain disruption creates an environment that legitimizes and helps firms master successful improvisation. A firm that has little or no experience with supply chain disruptions may find it difficult to decide on the form and strength of a response (Bode et al., 2011). A high level of supply chain disruption expands disruption-specific knowledge capacity, augmenting the ability to analyze, interpret, and respond to disruptive events effectively (Bode et al., 2011). Thus, the upside of supply chain disruptions is that they facilitate successful spontaneous and creative responses, thus enhancing operational resilience.

In addition, as experience with supply chain disruptions improves a firm's understanding of the effectiveness of its responses (Bode et al., 2011), it increases its confidence, making it more likely that it will exploit improvisation fully and carefully (Hultman et al., 2022; Souchon et al., 2016). On the contrary, when supply chain disruption is low, firms lack the relevant knowledge and ability to enable them to improvise effectively (Vera & Crossan, 2005). Importantly, spontaneity and creativity can create imperfect or haphazard solutions, thus increasing these improvisation behaviors when there is low supply chain disruption can weaken their contributions to operational resilience (Vera & Crossan, 2005). In line with these arguments,

H2a. Supply chain disruption moderates the relationships between spontaneous improvisation and disruption absorption and recoverability dimensions of operational resilience. The relationships are positive and stronger at high levels of supply chain disruption than at low levels.

H2b. Supply chain disruption moderates the relationships between creative improvisation and disruption absorption and recoverability dimensions of operational resilience. The relationships are positive and stronger at high levels of supply chain disruption than at low levels.

METHODOLOGY

Research design

Past research on supply chain resilience has been based primarily on cross-sectional survey data (e.g., Ali et al., 2023; Iyengar et al., 2021; Munir et al., 2022; Queiroz et al., 2022). Following examples from such studies, we collected cross-sectional survey data to test our hypotheses. We sampled Ghanaian SMEs (Table 1). Ghana is a developing country where it is difficult to obtain objective secondary data for the variables of interest (Kull et al., 2018). While cross-sectional data restrict our ability to make causal inferences, Rindfleisch et al. (2008) argue that such data can be used to test explanatory models grounded in relevant theories. We expect improvisation to have a relationship with operational resilience for two reasons. Firstly, although it takes time for the adaptability and transformability dimensions of resilience to become evident, the disruption absorption and recoverability dimensions of operational resilience can be observed during the disruption phase (Daghar et al., 2022; Essuman et al., 2020; Richey et al., 2021; Wieland & Durach, 2021). Secondly, while disruptions tend to immediately impact operations (Haraguchi & Lall, 2015), rapid and creative disruption responses can increase time-to-survive while reducing time-to-recover (Richey et al., 2021). In this sense, cross-sectional data can capture the link between these two constructs (Rindfleisch et al., 2008).

TABLE 1 Demographic characteristics of firms and respondents.

Variable	Category	Frequency	Percentage
Firm industry	Manufacturing	70	27.0
	Service	189	73.0
Respondent's position	CEO	32	12.4
	Managing director	31	12.0
	General manager	55	21.2
	Operations manager	62	23.9
	Other middle-level managerial positions	79	30.5

Variable	Mean	SD
Firm age (in years)	15.60	10.39
Firm size (i.e., number of full-time employees)	40.50	60.59
Respondents' years in current position	7.13	5.58
Respondent competence[a]:		
1. Knowledge about items in the questionnaire	5.79	1.03
2. Confidence in responses to items in the questionnaire	5.81	0.96
3. Confidence in the extent to which answers reflect the firm's situation	5.99	0.84

[a]Scale: 1 = strongly disagree; 7 = strongly agree.

Measure development

We followed the measurement guidelines in MacKenzie et al. (2011) to generate and validate suitable indicators for the constructs. Before administering our questionnaire, we asked three supply chain and strategy scholars to review the constructs' operational definitions and indicators. Based on their comments, we dropped indicators with poor face validity and revised items they found to be ambiguous. We pretested our questionnaire by administering it to 30 senior executives (e.g., CEOs, operations managers, and supply chain managers) taking part in an Executive MBA program. Upon analyzing the pilot study data and follow-up interview responses from the respondents, we found no major concerns with the questionnaire. Table 2 shows the final list of indicators, their scales, and their psychometric properties.

Substantive variables

Dependent variables

Our dependent variables are the two dimensions of operational resilience, disruption absorption, and recoverability. In measuring these constructs, we asked respondents to consider the disruptive events that interrupted their firms' operations. We used six reflective indicators adapted from Wieland and Wallenburg (2012) and Brandon-Jones et al. (2014) to measure disruption absorption. Recoverability was measured with five reflective indicators adapted from Brandon-Jones et al. (2014), with additional insights from Buyl et al. (2019).

Independent variables

The independent variables comprise the spontaneity and creativity dimensions of improvisation. We adapted three and four reflective indicators from Vera and Crossan (2005) to measure these constructs, respectively.

Moderating variable

We used nine formative indicators to measure supply chain disruption. We drew insights from previous research (e.g., Ambulkar et al., 2015) and field interviews to generate the indicators. The indicators tap different unplanned events that can interrupt supply chain flows and operations.

Control variables

To minimize alternative explanations, we controlled for factors that may covary with our dependent and independent variables (Bernerth & Aguinis, 2016). Literature suggests that firm characteristics and industry factors affect improvisation and resilience (Hadida et al., 2015; Pettit et al., 2019). We, therefore, controlled for *disruption orientation* (Yu et al., 2019), *firm size* (Pettit et al., 2019), *firm age*, and *firm industry* (Manhart et al., 2020; Pettit et al., 2019).

TABLE 2 Measures and results of validity assessment.

Construct, measures, congeneric reliability (ρ_C), and average variance extracted (AVE)	Mean	SD	S	K	Loading (*t*-value)	VIF
Spontaneous improvisation[a] *($\rho_C = 0.88$, AVE = 0.71)*						
Our company deals with unanticipated events on the spot	4.69	1.80	−0.48	−0.75	0.75 (Fixed)	–
Our employees think on their feet when carrying out actions	5.24	1.54	−1.03	0.41	0.85 (13.75)	–
Our company responds in the moment to unexpected problems	4.87	1.48	−0.89	0.30	0.92 (14.24)	–
Creative improvisation[a] *($\rho_C = 0.85$, AVE = 0.65)*						
Our company tries new approaches to problems	5.52	1.20	−0.74	0.33	0.76 (Fixed)	–
Our company identifies opportunities for new work processes	5.46	1.15	−0.85	0.87	0.90 (13.38)	–
Our company takes risks in terms of producing new ideas in carrying out its operations	5.34	1.35	−1.23	1.56	0.75 (11.90)	–
Our employees demonstrate originality in their work[c]	5.58	1.05	−0.91	1.75	–	–
Operational resilience: Disruption absorption[a] *($\rho_C = 0.92$, AVE = 0.66). For the past 3 years, whenever disruptive events occur*						
Our company is able to carry out its regular functions	5.36	1.43	−1.00	0.85	0.83 (Fixed)	–
Our company grants us much time to consider a reasonable response	5.40	1.31	−0.92	0.61	0.71 (12.74)	–
Our company is able to carry out its functions despite some damage done to it	5.37	1.22	−1.06	1.51	0.83 (16.03)	–
Without much deviation, we are able to meet normal operational and market needs	5.32	1.24	−0.84	0.87	0.87 (17.00)	–
Without adaptations being necessary, our company performs well over a wide variety of possible scenarios	5.25	1.27	−0.96	1.12	0.85 (16.43)	–
Our company's operations retain the same stable situation as it had before disruptions occur for a long time	5.10	1.24	−0.90	1.38	0.79 (14.72)	–
Operational resilience: Recoverability[a] *($\rho_C = 0.96$; AVE = 0.81). Over the past 3 years, whenever our operations breakdown due to a disruptive event*						
It does not take long for us to restore normal operation	4.83	1.72	−0.69	−0.41	0.89 (Fixed)	–
Our company reliably recovers to its normal operating state	5.07	1.50	−0.76	0.02	0.88 (20.96)	–
Our company easily recovers to its normal operating state	4.90	1.53	−0.77	−0.07	0.91 (22.72)	–
Our company effectively restores operations to normal quickly	4.81	1.50	−0.72	0.04	0.92 (22.72)	–
We are able to resume operations within the shortest possible time	4.85	1.51	−0.83	0.29	0.92 (22.62)	–
Disruption orientation[a] *($\rho_C = 0.85$; AVE = 0.58)*						
We always feel the need to be alert to possible disruptive events	5.46	1.29	−1.22	2.09	0.77 (Fixed)	–
Previously unplanned disruptions show us where we can help improve our company's operations	5.46	1.17	−1.00	1.75	0.82 (12.92)	–

TABLE 2 (Continued)

Construct, measures, congeneric reliability (ρ_C), and average variance extracted (AVE)	Mean	SD	S	K	Loading (*t*-value)	VIF
We think a lot about how threatening events could have been avoided	5.40	1.24	−1.05	1.37	0.75 (11.06)	–
After an unplanned operational disruption has occurred, our management lead in analyzing it thoroughly	5.40	1.19	−1.26	2.46	0.71 (10.38)	–
Supply chain disruption[b]. *Unexpectedly*						
Some of our employees leave their posts (i.e., quit their job)	3.40	1.86	0.50	−0.76	–	1.493
Some of our suppliers fail to make deliveries	3.11	1.67	0.19	−1.19	–	1.587
We experience vehicular breakdowns	2.87	1.58	0.52	−0.66	–	1.548
We experience service/product failure	2.72	1.52	0.56	−0.71	–	1.542
We run out of cash for running day-to-day operations	2.74	1.58	0.67	−0.44	–	1.512
We experience machine/technology downtime/failure	3.19	1.58	0.35	−0.74	–	1.381
We experience a shortage of raw materials	2.83	1.56	0.47	−0.79	–	1.698
We experience power cuts	3.33	1.80	0.41	−0.86	–	1.252
Some of our service providers fail to honor their promises	3.09	1.52	0.19	−0.98	–	1.627

Note: All indicators were rated on a seven-point scale ranging from strongly disagree (=1) to strongly agree (=7).

Abbreviations: K, Kurtosis; S, Skewness; VIF, variance inflation factor.

[a]Measured with reflective indicators.

[b]Measured formative indicators.

[c]Dropped due to poor loading.

Disruption orientation

Disruption orientation is an important proactive resilience strategy, enabling firms to prepare for disruptions (Ambulkar et al., 2015; Liu & Wei, 2022). Disruption orientation reflects a firm's general awareness and consciousness of, concerns about, attitude toward, and recognition of the opportunity to learn from disruptions (Bode et al., 2011). Disruption orientation can facilitate rapid detection and avoidance of, and quick recovery from, disruptions (Yu et al., 2019). We measured this construct with four items adapted from Ambulkar et al. (2015) and Bode et al. (2011).

Firm size

The link between firm size and resilience is unclear. Small firms have a simple organizational structure and so are perhaps more flexible, facilitating a swifter response to disruptions. However, they may also have limited financial resources, fewer managerial competencies, and little control over their environment. Therefore, small firms may find it difficult to absorb and recover from disruptions (Lai et al., 2016). By contrast, large firms may be able to build slack to cushion operations against disruptions, but at the same time, the greater complexity of their operations is a potential vulnerability (Blackhurst et al., 2011). We operationalized firm size as the natural log of the number of full-time employees (Wong et al., 2020).

Firm age refers to the number of years a firm has been operating. Older firms can leverage experience to access external resources when faced with disruptions. We operationalized firm age as the natural log of the number of years of operation (Wong et al., 2020).

Firm industry type

Scholars speculate that vulnerability to disruptions and the ability to manage them may differ across industries (Dittfeld et al., 2022; Manhart et al., 2020; Pettit et al., 2019). Manufacturing firms are more likely to have greater absorbed slack resources (e.g., excess inventory) that can cushion operations during disruptions (Dittfeld et al., 2022). Differences in demand and supply requirements and operational setups for service and manufacturing firms may be associated with varying degrees of process interdependency and complexity, and hence there might be differences in the ability to effectively improvise during disruptions (Manhart et al., 2020). We, therefore, used a dummy variable equal to one for service firms and zero for manufacturing firms.

Sample and data collection

Supply chain disruptions have become common worldwide (Nikookar et al., 2021; Simchi-Levi & Haren, 2022), particularly in developing economies where firms face considerable resource constraints and have operational vulnerabilities (Cunha et al., 2022). Our primary data come from firms in Ghana. As in other sub-Saharan African countries, Ghanaian firms experience power cuts, transport network breakdowns, technology and communication failures, and skill shortages (Essuman et al., 2022), as well as volatile market conditions, banking and credit market crises, exchange rate fluctuations, and natural disasters such as floods and fires (Essuman et al., 2020).

We were unable to obtain a comprehensive and accurate database of firms in Ghana, and the context of our study required us to administer an in-person questionnaire to gather data (Essuman et al., 2022). To that end, we constructed a sample of firms based on the following criteria. First, we considered manufacturing and service firms operating in a commercial/industrial location within Ghana (i.e., Greater Accra and Kumasi Metropolis). Second, we targeted firms that had been in business for at least 3 years and employed between five and 500 full-time workers. Third, we considered from that pool firms with managers having substantial experience, knowledgeable of the issues under investigation, sufficiently literate to complete the survey instrument, and willing to participate in the study (Yu et al., 2019).

We analyze resilience at the firm, and not at the network level, and because our sample comprises SMEs, we asked a single key informant per firm (e.g., CEO, general manager, supply chain and operations manager) to complete the questionnaire (Flynn et al., 2018; Kull et al., 2018). Previous supply chain resilience research has also used survey data from single informants (e.g., Munir et al., 2022; Wong et al., 2020; Yu et al., 2019). We administered 750 questionnaires between May 2018 and September 2018 using a team of trained fieldworkers working directly under our supervision. We obtained a total of 284 completed questionnaires, of which 25 were discarded as they were incomplete, leaving 259 valid responses (i.e., a 34.5% effective response rate). The demographic characteristics of the firms and key informants are provided in Table 1. On average, the firms that participated in the study had approximately 41 full-time employees (with a standard deviation of approximately 61), so the firms in our sample are SMEs.

Consistent with past operations and supply chain resilience studies (Munir et al., 2022; Wong et al., 2020), we asked top managers and relevant senior-level managers (e.g., CEO, managing director, general manager, operations manager, and other middle-level managers) to answer the survey. Our key informants had slightly more than 7 years of senior management experience. Additionally, we adapted three items from Boso et al. (2013) to assess informant competence on a seven-point Likert scale: 1 = strongly disagree; 7 = strongly agree. The results (see Table 1) suggest that the respondents had the competence to answer our questions.

Our sample size and response rate compare favorably with those reported in previous supply chain resilience studies (e.g., Munir et al., 2022; Wong et al., 2020; Yu et al., 2019). Bagozzi and Yi (2012) suggest that testing measurement models using confirmatory factor analysis, as we do, requires at least 200 observations. Further analysis using G*Power software reveals that a sample size of 259 is suitable for testing our hypotheses. Following the recommendation of Faul et al. (2009), we used an effect size of 0.15, alpha equal to 0.05, and power (1-β) equal to 0.95 as the input for nine predictors in our moderated regression model. The analysis returned a minimum sample of 166 as appropriate for estimating the model.

To assess nonresponse bias, we first compared the key demographic characteristics of our sample with those of the target population (Wagner & Kemmerling, 2010). We found that the size and age of the firms in our sample are similar to those reported in an earlier country-wide business establishment survey conducted by the Ghana Statistical Service (2016). Furthermore, the demographic characteristics of early respondents (i.e., questionnaires received back within 14 working days: $n = 162$) are not statistically different from those of later ones (i.e., questionnaires received within the next 14 working days: $n = 97$). The difference in mean firm size was 7.09 ($t = 0.91$, $p = .36$) and that in firm age was 1.41 ($t = 1.06$, $p = .29$; Wagner & Kemmerling, 2010).

DATA ANALYSIS AND RESULTS

Missing value analysis and normality assessment

As indicated earlier, we dropped questionnaires containing many missing values. Using the Missing Value Analysis function in SPSS, we found that missing values were less than 1%. We used an expectation maximization estimator to replace them (Hair et al., 2019). We also assessed whether the data for the indicators were normally distributed (Fawcett et al., 2014). The results show the data do not violate normality assumptions: Skewness ranges from |0.19| to |1.26|, and Kurtosis from |0.02| to |2.46| (Kline, 2011).

Measurement model assessment

We used Mplus 7.4 to analyze our reflective measurement model. We specifically used covariance-based confirmatory factor analysis (CB-CFA) and maximum likelihood estimation method to assess the reliability and validity of the reflective indicators (Bagozzi & Yi, 2012). CB-CFA is suitable for analyzing theoretically specified reflective measurement models and accounts for measurement errors (Bagozzi & Yi, 2012). To concurrently assess the psychometric properties of the indicators, we estimated a multi-factor CB-CFA model that includes all the indicators.

Our six-factor model shows a good fit (Model 1): Chi-square (χ^2) = 300.70, degree of freedom (DF) = 199, normed χ^2 = 1.51, root mean square error of approximation (RMSEA) = 0.04, Tucker and Lewis index (TLI) = 0.97, comparative fit index (CFI) = 0.98, standardized root mean square residual (SRMR) = 0.04 (Bagozzi & Yi, 2012; Hair et al., 2019). However, an inspection of the results revealed that one of the indicators for creative improvisation ("our employees demonstrate originality in their work") has a weak loading (0.63) so we re-estimated the model without it. The revised model (Model 2) shows a good fit: χ^2 = 277.00, DF = 179, normed χ^2 = 1.55, RMSEA = 0.05, TLI = 0.97, CFI = 0.98, SRMR = 0.04 (Hair et al., 2019). We tested the hypotheses using indicators in both Model 1 and Model 2 and found the results consistent. Accordingly, we report Model 2 results.

Table 2 shows all factor loadings are above 0.70 and significant at 1%, thus demonstrating unidimensionality and convergent validity. In addition, the results show that congeneric reliability and average variance extracted (AVE) are above 0.80 and 0.50, respectively (Hair et al., 2019). In line with Voorhees et al. (2016) recommendation, we used the AVE-shared variance (AVE-SV) comparison and the heterotrait–monotrait (HTMT) ratio of correlations to assess discriminant validity. As shown in Table 3, all AVE values are greater than the shared variances between the constructs. Again, the highest HTMT ratio is 0.59, far below the cut-off value of 0.85, demonstrating the discriminant validity of the indicators (Voorhees et al., 2016). Accordingly, we averaged the respective measurement items to create composite scores to capture the constructs (Bode et al., 2011).

The indicators of the supply chain disruption construct represent distinct types of unplanned events that may cause supply chain disruptions (Jarvis et al., 2003). We created a formative index for supply chain disruption as the unweighted linear sum of the indicators after investigating whether they suffer from multicollinearity (Bode et al., 2011). The highest variance inflation factor was 1.698, indicating that multicollinearity is not a concern (Bode et al., 2011).

Structural model analysis and hypothesis testing

Table 4 shows the descriptive statistics and the correlations for the study's variables. We used moderated regression analysis to test the hypotheses. We further used Hayes' PROCESS and the Johnson-Neyman technique to explore and visualize the magnitude and direction of the moderating effects (Hayes, 2018). Following Aguinis et al. (2017) recommendations, we evaluated the hypotheses by estimating regression models that include the independent, moderating, interaction, and control variables. H1a and H1b represent the main effect paths of the conceptual model. We mean-centered both the independent and moderating variables before creating the interaction terms using a multiplication approach (Aguinis et al., 2017). As reported in Table 5, we conducted two sets of moderated regression analyses. The dependent variable in the first models (Model 1a-c) is disruption absorption and that in the second models (Model 2a-c) is recoverability. In both cases, we estimated three models: the first includes the interaction between supply chain

TABLE 3 Results of discriminant validity assessment.

Variables	Spontaneous improvisation	Creative improvisation	Disruption absorption	Recoverability	Disruption orientation
Spontaneous improvisation	*0.71*	0.11	0.04	0.04	0.00
Creative improvisation	0.39	*0.65*	0.15	0.17	0.08
Disruption absorption	0.23	0.44	*0.66*	0.31	0.03
Recoverability	0.21	0.46	0.59	*0.81*	0.04
Disruption orientation	0.02	0.34	0.19	0.23	*0.58*

Note: HTMT, average variance extracted, and shared variance values are reported below, on, and above the principal diagonal, respectively.

TABLE 4 Descriptive statistics and correlations.

Variable		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1)	Disruption orientation									
(2)	Spontaneous improvisation	−0.02								
(3)	Creative improvisation	0.29**	0.33**							
(4)	Disruption absorption	0.16**	0.20**	0.39**						
(5)	Recoverability	0.20**	0.19**	0.41**	0.57**					
(6)	Supply chain disruption	−0.02	0.00	−0.02	−0.10	−0.12				
(7)	Firm size (log)	0.14*	0.22**	0.26**	0.23**	0.27**	−0.06			
(8)	Firm age (log)	0.02	0.26**	0.03	0.09	0.14*	−0.07	0.55**		
(9)	Service firms (1/0)	−0.02	−0.03	−0.02	−0.01	−0.07	−0.06	−0.11	−0.06	
Mean		5.43	4.93	5.44	5.30	4.89	27.27	3.09	2.55	0.73
Standard deviation		1.01	1.44	1.08	1.09	1.43	9.33	1.01	0.64	0.44

*$p < .05$ (2-tailed). **$p < .01$ (2-tailed).

disruption and spontaneous improvisation, the second the interaction between supply chain disruption and creative improvisation, and the third includes both interaction terms.

Contrary to our prediction in H1a, results show that spontaneous improvisation is not related to disruption absorption (Model 1c: $\beta = 0.07$, $p = .16$) and recoverability (Model 2c: $\beta = 0.05$, $p = .40$). However, in all cases, the results support H1b, which predicts that creative improvisation is positively related to disruption absorption (Model 1c: $\beta = 0.29$, $p < .01$) and recoverability (Model 2c: $\beta = 0.44$, $p < .01$). Furthermore, the results indicate that the interaction between spontaneous improvisation and supply chain disruption does not significantly relate to disruption absorption (Model 1a: $\beta = 0.00$, $p = .70$) or recoverability (Model 2a: $\beta = 0.01$, $p = .11$). Additional analysis using the Johnson-Neyman technique reveals that the relationships between spontaneous improvisation and disruption absorption and recoverability do not significantly change in direction or magnitude at different levels of supply chain disruption. Therefore, H2a is rejected.

The results show, however, that the interaction between creative improvisation and supply chain disruption is positively related to disruption absorption (Model 1b: $\beta = 0.02$, $p < .01$) and recoverability (Model 2b: $\beta = 0.02$, $p = .03$). Moreover, as detailed in Table 6, the results from the Johnson-Neyman analysis reveal that the greater supply chain disruption, the stronger the links between creative improvisation and disruption absorption and recoverability, lending support for H2b. Figure 2 plots differences in the magnitude of these relationships at low, moderate, and high levels of supply chain disruptions.

Additional analyses

Because the effect of improvisation may be nonlinear (Hultman et al., 2022), we estimated regression models that include the quadratic terms of spontaneous and creative improvisation (Lind & Mehlum, 2010) (Table 7). The results indicate that spontaneous improvisation does not have significant curvilinear associations with disruption absorption and recoverability. However, the results show that the main effect of creative improvisation is positively related to disruption absorption (Model 1b: $\beta = 0.20$, $p = .01$), while the quadratic term is negatively related to it (Model 1b: $\beta = -0.09$, $p = .01$). The quadratic term of creative improvisation does not significantly relate to recoverability. Following Lind and Mehlum (2010) guidelines and using their *utest* add-on in Stata, we formally tested whether the relationship between creative improvisation

TABLE 5 Results of moderated regression analyses.

	Dependent variable: operational resilience																
	Disruption absorption									Recoverability							
	Model 1a			Model 1b			Model 1c			Model 2a			Model 2b			Model 2c		
Independent variables	***β***	**SE**	***p***	***β***	**SE**	***p***	***β***	**SE**	***p***	***β***	**SE**	***p***	***β***	**SE**	***p***	***β***	**SE**	***p***
Spontaneous improvisation (SI)	0.06	0.05	.20	0.07	0.05	.16	0.07	0.05	.16	0.05	0.06	.44	0.05	0.06	.43	0.05	0.06	.40
Creative improvisation (CI)	0.31	0.07	<.01	0.30	0.07	<.01	0.29	0.07	<.01	0.45	0.09	<.01	0.43	0.09	<.01	0.44	0.09	<.01
Supply chain disruption (SCD)	−0.01	0.01	.11	−0.01	0.01	.03	−0.01	0.01	.03	−0.02	0.01	.05	−0.02	0.01	.02	−0.02	0.01	.02
SI×SCD	0.00	0.00	.70				0.00	0.01	.73	0.01	0.01	.11				0.01	0.01	.26
CI×SCD				0.02	0.01	<.01	0.02	0.01	<.01				0.02	0.01	.03	0.02	0.01	.08
Disruption orientation	0.06	0.07	.35	0.05	0.06	.41	0.05	0.06	.41	0.12	0.08	.14	0.11	0.08	.17	0.12	0.08	.17
Firm size	0.15	0.08	.06	0.15	0.08	.04	0.15	0.08	.04	0.18	0.10	.07	0.19	0.10	.06	0.19	0.10	.06
Firm age	−0.04	0.12	.71	−0.03	0.12	.80	−0.03	0.12	.78	0.09	0.16	.55	0.09	0.15	.54	0.10	0.16	.51
Industry	0.01	0.14	.95	−0.03	0.14	.81	−0.03	0.14	.84	−0.18	0.18	.32	−0.19	0.18	.29	−0.21	0.18	.25
Constant	2.91	0.51	<.01	4.31	0.49	<.01	4.65	0.45	<.01	1.11	0.66	.09	3.36	0.64	<.01	3.58	0.58	<.01
R^2	18.50%			21.17%			21.21%			22.63%			23.22%			23.60%		
F	7.09			8.40			7.45			9.14			9.45			8.55		
p	<.01			<.01			<.01			<.01			<.01			<.01		

Abbreviations: *β*, unstandardized regression coefficient; SE, standard error.

TABLE 6 Moderating effects of supply chain disruption on the link between creative improvisation and operational resilience (Johnson-Neyman technique).

Dependent variable = disruption absorption				Dependent variable = recoverability			
Levels of supply chain disruption	*β*	SE	*p*	Levels of supply chain disruption	*β*	SE	*p*
9.00	−0.06	0.14	.66	9.00	0.09	0.19	.62
11.35	−0.02	0.13	.89	11.35	0.14	0.17	.42
13.70	0.03	0.12	.81	13.70	0.18	0.15	.23
16.05	0.07	0.10	.47	16.05	0.22	0.14	.10
18.40	0.12	0.09	.19	17.39	0.25	0.13	.05
20.56	0.16	0.08	.05	18.40	0.27	0.12	.03
20.75	0.17	0.08	.04	20.75	0.31	0.11	<.01
23.10	0.21	0.07	<.01	23.10	0.35	0.10	<.01
25.45	0.26	0.07	<.01	25.45	0.40	0.09	<.01
27.80	0.31	0.07	<.01	27.80	0.44	0.09	<.01
30.15	0.35	0.07	<.01	30.15	0.49	0.09	<.01
32.50	0.40	0.07	<.01	32.50	0.53	0.09	<.01
34.85	0.44	0.08	<.01	34.85	0.57	0.10	<.01
37.20	0.49	0.09	<.01	37.20	0.62	0.12	<.01
39.55	0.54	0.10	<.01	39.55	0.66	0.13	<.01
41.90	0.58	0.11	<.01	41.90	0.70	0.15	<.01
44.25	0.63	0.13	<.01	44.25	0.75	0.16	<.01
46.60	0.67	0.14	<.01	46.60	0.79	0.18	<.01
48.95	0.72	0.15	<.01	48.95	0.83	0.20	<.01
51.30	0.77	0.17	<.01	51.30	0.88	0.22	<.01
53.65	0.81	0.18	<.01	53.65	0.92	0.24	<.01
56.00	0.86	0.20	<.01	56.00	0.96	0.26	<.01

Abbreviations: *β*, unstandardized regression coefficient; SE, standard error.

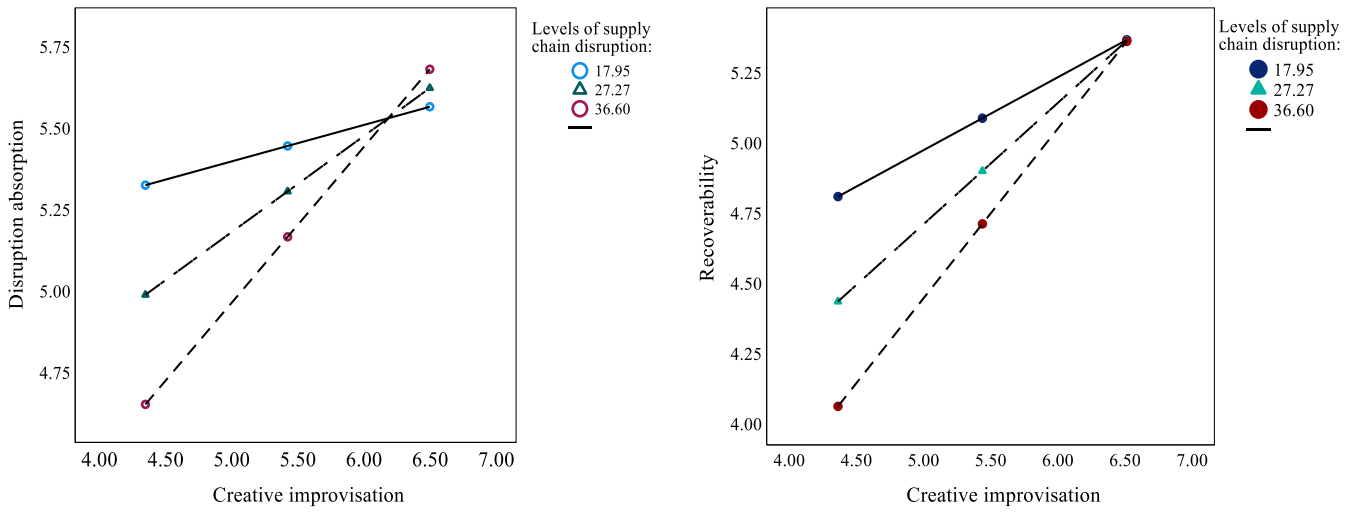

FIGURE 2 Moderating effects of supply chain disruption. Values of supply chain disruption are −1 standard deviation, mean, and +1 standard deviation, respectively.

and disruption absorption has an inverted U-shape. As shown in Table 7 and Figure 3, results show that the turning point of the relationship is close to the high end of the creative improvisation scale and that the slope at the low end of the relationship is positive and significant ($\beta = 0.88$, $p < .01$). However, the slope at the high end of

TABLE 7 Results of curvilinear analyses.

Independent variables	Dependent variable: operational resilience																
	Disruption absorption									Recoverability							
	Model 1a			Model 1b			Model 1c			Model 2a			Model 2b			Model 2c		
	β	SE	*p*	*β*	SE	*p*	*β*	SE	*p*	*β*	SE	*p*	*β*	SE	*p*	*β*	SE	*p*
Spontaneous improvisation (SI)	0.27	0.23	.25	0.06	0.05	.24	0.09	0.24	.70	0.04	0.30	.90	0.04	0.06	.49	0.03	0.32	.92
Creative improvisation (CI)	0.32	0.07	<.01	0.20	0.08	.01	0.21	0.08	.01	0.45	0.09	<.01	0.45	0.10	<.01	0.44	0.11	<.01
SI^2	−0.03	0.03	.36				−0.01	0.03	.87	0.00	0.04	.99				0.00	0.04	.97
CI^2				−0.09	0.04	.01	−0.09	0.04	.02				−0.00	0.05	.95	−0.00	0.05	.94
Supply chain disruption	−0.01	0.01	.10	−0.01	0.01	.14	−0.01	0.01	.14	−0.02	0.01	.07	−0.02	0.01	.07	−0.02	0.01	.07
Disruption orientation	0.06	0.07	.34	0.05	0.06	.45	0.05	0.07	.44	0.12	0.08	.15	0.12	0.08	.15	0.12	0.08	.15
Firm size	0.14	0.08	.07	0.15	0.08	.06	0.15	0.08	.06	0.18	0.10	.07	0.18	0.10	.07	0.18	0.10	.07
Firm age	−0.04	0.12	.72	−0.06	0.12	.64	−0.06	0.12	.65	0.08	0.16	.62	0.08	0.16	.62	0.08	0.16	.62
Industry	0.02	0.14	.91	0.05	0.14	.71	0.05	0.14	.72	−0.15	0.18	.43	−0.14	0.18	.43	−0.14	0.18	.44
Constant	5.57	0.88	<.01	5.06	0.50	<.01	5.18	0.89	<.01	4.00	1.14	<.01	4.03	0.65	<.01	3.99	1.17	<.01
R^2	18.7%			20.4%			20.4%			21.8%			21.8%			21.8%		
F	7.20			8.01			7.10			8.73			8.73			7.73		
p	<.01			<.01			<.01			<.01			<.01			<.01		
Lind and Mehlum (2010)'s test:																		
Slope at X_l: −3.77[a]				0.88 [<.01]														
Slope at X_h: 1.56[a]				−0.08 [.32]														
Appropriate *U* test				0.45[.33]														
Extremum point				1.13														
95% confidence interval, Fieller method				[.17, 8.08]														

Abbreviations: *β*, unstandardized regression coefficient; SE, standard error; *p*-values are in the square brackets.

[a]Mean-centered low (X_l) and high (X_h) values of creative improvisation, respectively.

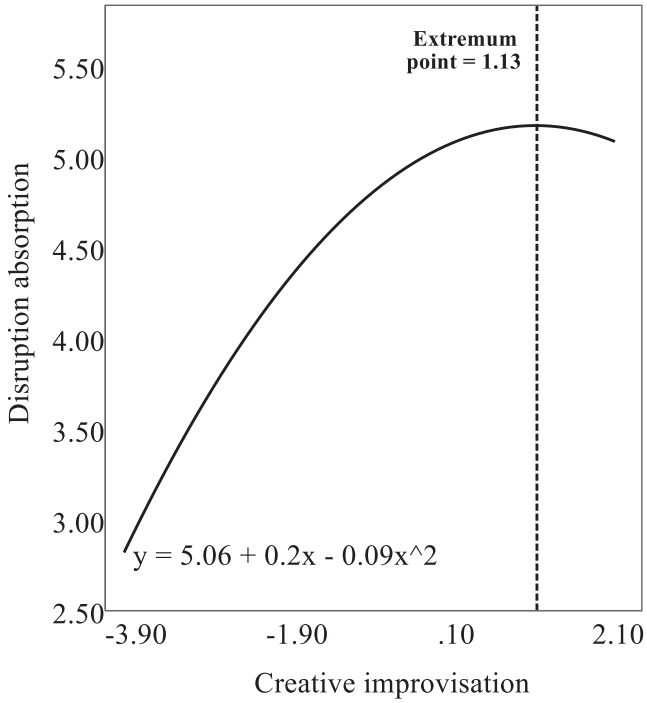

FIGURE 3 Nonlinear relationship between creative improvisation and disruption absorption. *x* represents the mean-centered values of creative improvisation.

the relationship is negative and insignificant (−0.08, $p = .32$). These additional results provide insufficient evidence for an inverted U-shaped relationship between creative improvisation and disruption absorption (Haans et al., 2016; Lind & Mehlum, 2010). We further followed Haans et al. (2016) guidelines to explore whether supply chain disruption moderates the quadratic terms of spontaneous and creative improvisation. However, none of these interactions were statistically significant.

DISCUSSION

The theoretical and empirical literature on the relationship between improvisation and resilience remains underdeveloped and has mostly focused on case studies (e.g., Cunha et al., 2022; Giustiniano et al., 2016; Lombardi et al., 2021). Supply chain resilience research on improvisation (Munir et al., 2022) ignores some of the critical concerns of the improvisation literature: improvisation is not inherently good or bad (Vera & Crossan, 2005) because not all aspects of improvisation achieve their intended outcomes (Giustiniano et al., 2016). We address these deficiencies. Specifically, we investigate how spontaneous and creative improvisation can help attain operational resilience under differing supply chain disruption conditions. Our results partly support COR theory but also reveal important nuances, as discussed below.

Contributions and implications for supply chain scholarship

Based on the resource investment and desperation principles of COR theory, we theorized that spontaneous and creative improvisation can have a positive impact on operational resilience. Our regression results, however, indicate that only creative improvisation has a significant and positive relationship with operational resilience. These results extend Munir et al. (2022) study by showing that creative improvisation may contribute more to resilience than spontaneous improvisation. More broadly, our results reinforce evidence from other studies that spontaneous improvisation and creative improvisation have different performance consequences (Hughes et al., 2019; Hultman et al., 2022; Nemkova et al., 2015), clarifying Giustiniano et al. (2016) contention that not all aspects of improvisation help resilience.

In addition, as illustrated in Figure 3, the results show that the relationship between creative improvisation and disruption absorption is positive when creative improvisation is below the average level. However, the relationship weakens when creative improvisation exceeds the average level. On the contrary, creative improvisation has a linear positive association with recoverability (Table 7). These results imply that creative improvisation contributes differently to different dimensions of resilience, corroborating previous evidence that suggests that creativity has complex effects (e.g., Nemkova et al., 2015). Unlike recoverability, disruption absorption focuses more on maintaining normal functioning (Essuman et al., 2020), while extreme creative improvisation can introduce more significant changes to existing operations. Creative improvisation provides novel solutions, while spontaneous improvisation provides speedy responses (Hughes et al., 2019; Vera & Crossan, 2005). In disruptive circumstances, time is a valuable resource (Vera & Crossan, 2005). Spontaneous improvisation allows firms to make timely decisions regarding how to contain disruptions and recover from them (Hughes et al., 2019; Souchon et al., 2016). However, an on-time response to disruptions does not guarantee success (Giustiniano et al., 2016; Souchon et al., 2016). The appropriateness of the response is as crucial as the time taken to implement it (Giustiniano et al., 2016). Extant literature suggests that spontaneous responses are prone to mistakes (Barrett, 1998; Hughes et al., 2019). This dark side of spontaneous improvisation may cancel out its contribution to operational resilience (Giustiniano et al., 2016).

In contrast to previous research, which ignores the role of organizational contingencies in the relationship between improvisation and resilience (Munir et al., 2022), our theorization and results show that supply chain

disruption is an important boundary condition. As depicted in Figure 2, our results reveal that creative improvisation is more helpful to operational resilience when supply chain disruption is high. This supports the findings of studies that suggests that the benefits of creative improvisation are context-dependent (Hultman et al., 2022; Nemkova et al., 2015; Vera & Crossan, 2005). However, contrary to H2a, we find that the relationship between spontaneous improvisation and operational resilience is not affected by supply chain disruption.

Based on the COR theory notion of resource caravan passageways (Halbesleben et al., 2014; Hobfoll et al., 2018), we have argued that the bright side of supply chain disruption, i.e., urgency to act and disruption-specific knowledge, can facilitate successful spontaneous and creative improvisation (Yan et al., 2022). While disruption-specific knowledge (Bode et al., 2011) may not always be relevant to new disruptions (Ambulkar et al., 2015), it can reduce the drawbacks of spontaneous improvisation (Hughes et al., 2019). Unlike creative improvisation, spontaneous improvisation results in fewer options being considered (Hughes et al., 2019). Therefore, experience with disruption may be insufficient to achieve operational resilience (Ambulkar et al., 2015). Moreover, given the urgency of finding solutions to disruptions, the mistakes inherent in spontaneous improvisation can be more significant (Hughes et al., 2019). We speculate that this is why supply chain disruption positively moderates the relationship between creative improvisation and operational resilience but not that between spontaneous improvisation and operational resilience.

Our application of COR theory extends existing theoretical perspectives on improvisation and resilience in supply chain contexts. Supply chain complexities, disruptions, and uncertainties (Ateş et al., 2022), along with the cognitive limitations of managers, restrict the ability to make optimal decisions. The improvisation literature has argued that such bounded rationality explains the emergence and benefits of improvisation (Banin et al., 2016; Hultman et al., 2022; Nemkova et al., 2015). Supply chain scholars have used varied theoretical lenses, including information processing theory (e.g., Bode et al., 2011; Wong et al., 2020), resource dependence (e.g., Bode et al., 2011; Jiang et al., 2023; Manhart et al., 2020), and the attention-based view (Essuman et al., 2022) to explain why managers strive to reduce uncertainty and achieve organizational resilience. We apply COR theory to explain how the saliency of the threat of resource loss caused by disruptions, in conjunction with a firm's innate desire to survive through resource investment and desperate actions, explains the link between firm improvisation and operational resilience. Accordingly, we expand the boundaries of COR theory by showing that it can be applied to firm-level phenomena (Hobfoll et al., 2018).

Implications for SMEs and supply chain managers

SMEs in developing countries can be confronted with severe operational difficulties triggered by hostile environmental conditions, such as institutional voids, volatile markets, resource scarcity, and weak supply chain infrastructure (Essuman et al., 2022; Hultman et al., 2022; Munir et al., 2022). Therefore, SME owners and supply chain managers in such countries may consider improvisation to be a default solution to disruption (Cunha et al., 2022), but they also must be aware that not all types of improvisation may prove beneficial to operational resilience. Our results suggest that, compared with spontaneous improvisation, a moderate degree of creative improvisation may be more helpful for building resilient operations, particularly when a firm enacts this type of improvisation in a more disruptive supply chain environment.

Evidence from previous studies offers guidelines for SME owners and supply chain managers engaging in creative improvisation (e.g., Hodgkinson et al., 2016; Hughes et al., 2018; Vera & Crossan, 2005). Creative employees, including top managers and team members, are the cornerstone of successful improvisation, making it imperative that there be a supportive social atmosphere that reduces fear of failure and fosters creativity. In such a workplace, ambiguity is tolerated and autonomy granted. In a setting like Ghana, where uncertainty avoidance is high, SME owners should make a deliberate effort to integrate creative thinking and action into an organizational culture by encouraging experimentation and risk-taking. They should invest in training to develop employees' cognitive abilities and readiness to take risks. Since experience is associated with successful improvisation, experienced employees should be encouraged to improvise. Finally, firms should celebrate experimentation by rewarding individuals and teams that engage in creative improvisation.

Strengths, limitations, and directions for future research

Improvisation has a long history across several fields and many contexts (Vera & Crossan, 2004) but is surprisingly underexplored in operations and supply chain management (Richey et al., 2021). One recent area of interest is the role of improvisation in supply chain disruption management and resilience-building (Munir et al., 2022; Patrucco et al., 2022), although the theoretical and empirical

foundations are still at the nascent stage. We contribute to this literature by advancing the understanding of the determinants of resilient operations and supply chains. We use COR theory to develop and test a model of how and when improvisation is associated with operational resilience using a sample of SMEs in Ghana.

Taken together, this research suggests that the link between firm improvisation and operational resilience is contingent upon three conditions: (1) improvisation type (i.e., spontaneity versus creativity); (2) operational resilience type (i.e., disruption absorption versus recoverability); (3) organizational contingencies (i.e., supply chain disruption). These insights, while providing valuable directions for emerging supply chain research (Munir et al., 2022; Patrucco et al., 2022), reorient the debate on whether improvisation is good or bad for operational resilience (Giustiniano et al., 2016; Grøtan et al., 2008). We call on supply chain scholars to apply theoretical and methodological approaches and empirical data that can unravel the complexities behind the improvisation-resilience relationship at firm and supply chain levels. There are six avenues that we believe will advance the literature.

First, we see promise in investigating further improvisation at the dimensional level of the construct as we have done in the current study and others have done previously (e.g., Hultman et al., 2022; Nemkova et al., 2015). Our findings suggest that spontaneous and creative improvisation may relate differently to resilience. Specifically, unlike the linear association often examined in prior research, a nonlinear association can be expected (Hughes et al., 2019; Hultman et al., 2022). We encourage additional supply chain research couched in different contexts to theorize and test a potential curvilinear relationship between improvisation and resilience.

Second, examining the resilience effect of improvisation by treating resilience as a multidimensional construct may prove useful. In addition to disruption absorption and recoverability, future studies might analyze adaptive and transformative resilience, particularly at the supply chain level. These dimensions of resilience require changes in operations (e.g., product lines and target markets), as well as structures and systems (e.g., organizational structure and physical resources; Richey et al., 2021; Wieland & Durach, 2021). As it takes longer for firms and supply chains to achieve adaptive and transformative resilience than operational resilience (Wieland & Durach, 2021), improvisation may explain these aspects of resilience differently.

Third, our moderating results show that incorporating organizational contingencies into the analyses of the improvisation-resilience link can advance improvisation theory and practice. As we theorized, and our moderating results show, supply chain disruption is a major boundary condition for the relationship between creative improvisation and resilience. However, we only focus on idiosyncratic disruptions to operationalize this construct. Following earlier studies (e.g., Wong et al., 2020), future studies might examine the boundary condition effects of other types of supply chain disruptions: catastrophic disruption, infrastructure/operations disruption, supply-side disruptions, and customer-market disruptions. The frequency and consequences of these disruption types may vary, and so too the extent to which firms respond to them.

Fourth, it would be interesting to conduct a study that measures supply chain disruption in terms of impact and risk levels (i.e., frequency times impact) as these operationalizations of the construct may provide additional insights into the link between improvisation and resilience (Ambulkar et al., 2015; Qi et al., 2022). We encourage further research that broadens our conceptualization of supply chain disruptions as threats to businesses by exploring how differences in the interpretation of such events by supply chain managers determine which improvisation type they activate (Bode et al., 2011). In addition to supply chain disruption, future research could draw insights from past improvisation research to explore other organizational contingencies, such as resource slack (Banin et al., 2016), experimental and risk management cultures, information sharing (Vera & Crossan, 2005), and environmental dynamism (Souchon et al., 2016) and complexity (Magni et al., 2013).

Fifth, there is an unexploited opportunity to test the causal effect of improvisation on resilience. We acknowledge that there is a risk of reverse causality in our research design because firms with both low and high operational resilience might have the drive to master creative improvisation. However, we contend that a cross-sectional survey is not the best approach for empirically testing such an argument. A longitudinal research design or a natural experiment could address these concerns (Rindfleisch et al., 2008). Such a design would require (1) an analysis of resilience and its antecedents in specific disruptive situations and (2) the availability of secondary data that objectively capture the variables of interest (see Buyl et al., 2019; Li et al., 2022; Qi et al., 2022). In addition, our sample comprises SMEs in a developing country, and we could not access objective data to minimize common method bias. We implemented relevant procedural strategies to mitigate that problem but missed the chance to capture an ideal marker variable to enable us to statistically examine the degree of common method bias in the data.

Sixth, we tested our research hypotheses in a single country, which limits the generalization of our findings. We recognize that differences in institutional and

economic contexts matter in the analysis of models of resilience (Manhart et al., 2020; Pettit et al., 2019). For example, countries differ in the quality of supply chain infrastructure (e.g., technological resources and integrated transport networks), formal institutional resources (e.g., access to external funding, government support, and country's risk management infrastructure), and informal institutional resources (e.g., uncertainty avoidance culture and social capital). These country-specific variables could help or hinder the ability of a firm to manage disruptions and build resilience capabilities. Thus, the contributions of improvisation to operational resilience may differ across countries. Our sample also consists of SMEs, which are generally resource-constrained organizations. We call for future studies to test our hypotheses on data from different countries and large firms to broaden the generalizability of findings.

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