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Building supply chain resilience through people: Evidence from manufacturing industry of Pakistani

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ABSTRACT

Purpose—Supply chain resilience research has explained how structures, inventories and technologies help firms withstand disruption, but has said little about the people who carry out the response. Drawing on the microfoundations of dynamic capabilities and ability–motivation–opportunity (AMO) theory, this research examines whether agility-oriented HR bundles, comprising cross-training, flexible role design and empowerment practices, build supply chain resilience through workforce adaptive performance, and whether this pathway depends on disruption exposure and industry type.

Design/methodology/approach—A cross-sectional survey of supply chain and operations managers was conducted in pharmaceutical, textile, chemical, automotive and fertilizer firms in Pakistan, a manufacturing economy exposed to repeated floods, import restrictions, currency shortages and energy shocks. Hypotheses were tested with partial least squares structural equation modelling (PLS-SEM) in SmartPLS 4, including higher-order constructs, moderated mediation and multi-group analysis.

Findings—Agility-oriented HR bundles were positively related to supply chain resilience, both directly and indirectly through workforce adaptive performance, which partially mediated the relationship. Disruption exposure strengthened the link between adaptive performance and resilience, as well as the indirect effect of HR bundles, so the people pathway to resilience was most valuable for firms facing frequent and severe disruptions.

Practical implications—The findings identify HR levers that operations and HR managers can co-design to absorb and recover from supply shocks, complementing buffers, dual sourcing and digital visibility.

Originality/value—The research offers a time-lagged test of a people-based microfoundation of supply chain resilience and specifies when that pathway matters most in a shock-prone emerging economy.

Keywords: supply chain resilience; HR flexibility; adaptive performance; AMO theory; dynamic capabilities; microfoundations; PLS-SEM; Pakistan

1 | INTRODUCTION

For manufacturers in emerging economies, disruption is no longer an exception to be planned around; it is the operating environment. Pakistani manufacturers illustrate this vividly. Within a few years they absorbed the 2022 floods, which damaged transport links and cotton supply, a prolonged foreign-exchange shortage that led to import and letter-of-credit restrictions on raw materials and spare parts in 2022–23, volatile energy prices and supply, and global shipping disruptions that lengthened lead times on imported inputs. Firms that kept plants running through these shocks did not simply hold more inventory. They resequenced production,

qualified substitute materials, moved people between lines and functions, and made fast decisions close to the problem. Each of these responses is carried out by people.

Supply chain resilience, the capability to prepare for, respond to and recover from disruptions (Ponomarov and Holcomb, 2009; Chowdhury and Quaddus, 2017), has become one of the most studied constructs in operations and supply chain management. There are a wide variety of enablers as identified in the literature: flexibility and redundancy (Sheffi and Rice 2005), visibility and collaboration (Jüttner and Maklan 2011), risk management culture and more recently digital technologies. Ambulkar, Blackhurst and Grawe (2015) demonstrated that it is the capacity of a firm to reallocate their resources during a disruption that makes them resilient. However, in most of this writing, those who rework those assets are not given the same prominence. Past research on human resource management in supply chain management (SCM) has found that the HRM dimension of SCM is under-theorised and under-measured (Hohenstein, Feisel and Hartmann, 2014). In the instances where human factors are included, they are most often included as generic "skills" or as a control variable, but not as the means by which resilience is created.

There are three reasons why this neglect makes a difference. The microfoundations of the dynamic capabilities view, upon which much resilience research is based, have been criticized for failure to specify them (Teece, 2007; Felin, Foss and Ployhart, 2015). Resilience is a dynamic capability, so it surely needs to be realized in the skills, behaviours and decisions of individuals and teams. Second, HRM research has provided very solid evidence that sets of HR practices influence the capability, motivation, and opportunity of employees, and subsequently organizational outcomes (Jiang et al., 2012). Some of these practices, notably multi-skilling, broad role design and empowerment, are explicitly about flexibility (Wright and Snell, 1998; Bhattacharya, Gibson and Doty, 2005). However, this literature has rarely looked beyond firm-level financial or operational performance to supply chain-level capabilities.

The present research addresses these gaps by answering whether agility-oriented HR bundles enhance supply chain resilience? And whether workforce adaptive performance mediate this relationship? The present reserach answer these questions with a quantitative survey of supply chain and operations managers in five Pakistani manufacturing sectors: pharmaceutical, textile, chemical, automotive and fertilizer.

The study makes two contributions. First, it specifies and tests a microfoundational mechanism for supply chain resilience, showing how HR practices that build multi-skilled, redeployable and empowered employees translate into an SC-level dynamic capability through adaptive behaviour at the unit level. Second, it extends AMO theory from employee and firm performance to supply chain resilience and identifies two boundary conditions, disruption exposure and industry type, under which the people pathway matters most.

2 | LITERATURE REVIEW AND THEORETICAL BACKGROUND

2.1 | Supply chain resilience as a dynamic capability

Supply chain resilience (SCRES) has been defined as the adaptive capability of a supply chain to prepare for unexpected events, respond to disruptions and recover from them by maintaining continuity of operations (Ponomarov and Holcomb, 2009). Building on this definition, scholars distinguish three phases. Readiness

refers to the anticipatory preparation that allows a firm to detect and brace for disruptions. Response refers to the speed and effectiveness of action once a disruption occurs. Recovery refers to the ability to restore normal, or improved, operations afterwards (Jüttner and Maklan, 2011; Chowdhury and Quaddus, 2017). We adopt this three-phase view and model SCRES as a higher-order capability formed by readiness, response and recovery.

A large stream of research interprets SCRES through the dynamic capabilities view, which explains how firms sense threats and opportunities, seize them and reconfigure their resource base (Teece, 2007). Resilience fits this logic well: it is not a stock of resources but a repeatable capacity to reconfigure resources in response to change. Ambulkar et al. (2015) showed empirically that resource reconfiguration is central to firm resilience against supply chain disruptions. The dynamic capabilities view also implies a question that the resilience literature has largely bypassed: who performs the sensing, seizing and reconfiguring?

2.2 | The microfoundations of dynamic capabilities

The microfoundations movement argues that organisational capabilities should be explained by the individuals, interactions and processes that underlie them (Felin et al., 2015). Teece (2007) himself located dynamic capabilities partly in managerial skills, routines and organisational structures. For operational capabilities such as resilience, the relevant individuals are not only senior managers but also the planners, buyers, supervisors and operators who must change what they do when inputs fail to arrive or a line stops. Their capacity to adapt is therefore a plausible microfoundation of SCRES. We capture this capacity as workforce adaptive performance: the extent to which employees in a supply chain or operations unit cope with, respond to and support changes in their work (Griffin, Neal and Parker, 2007; Pulakos et al., 2000).

Adaptive performance is distinct from task proficiency. Proficiency concerns doing well-defined work well. Adaptivity concerns adjusting effectively when the work itself changes because of new technologies, procedures, suppliers or shocks (Griffin et al., 2007). It is this second form of performance that a disruption calls for.

2.3 | AMO theory and agility-oriented HR bundles

AMO theory holds that employee performance is a function of ability, motivation and opportunity to contribute, and that HR practices influence outcomes by shaping these three components (Appelbaum et al., 2000; Jiang et al., 2012). Meta-analytic evidence shows that skill-enhancing, motivation-enhancing and opportunity-enhancing practices affect human capital and motivation, which in turn affect operational and financial outcomes (Jiang et al., 2012).

Within the broader set of high-performance work practices, the strategic HRM literature has singled out practices that build flexibility. Wright and Snell (1998) argued that firms need both fit and flexibility, and that flexibility lies in employee skills, employee behaviours and HR practices themselves. Bhattacharya et al. (2005) confirmed that these forms of HR flexibility relate to firm performance. This research builds on this work to define an agility-oriented HR bundle (AHRB) as a coherent set of three practices applied to supply chain and operations units. This includes, cross-training, which develops multi-skilled employees through rotation and training across adjacent tasks (ability). Second, flexible role design, which defines broad and

adjustable role boundaries so that staff can be redeployed when priorities change (opportunity). And finally, empowerment practices, which delegate decision authority, share operational information and invite employee voice (motivation and opportunity).

Bundling matters because these practices reinforce one another. Multi-skilled employees add little if roles are rigid, and broad roles add little if employees lack the authority to act. Following HR bundle research, we therefore treat AHRB as a higher-order construct whose dimensions jointly form the bundle.

2.4 | Integrating the perspectives

Taken together, these perspectives suggest a causal chain. AHRB is a set of resources and practices that firms can deliberately design. Through AMO mechanisms, the bundle raises the adaptive performance of employees in supply chain and operations units. Adaptive performance, in turn, is the behavioural microfoundation through which the supply chain prepares for, responds to and recovers from disruption. Contingency logic adds that the value of this behavioural capability should depend on how often adaptation is actually required, which is captured by disruption exposure, and on how much room the production technology leaves for human discretion, which differs between process and labour-intensive industries.

3 | HYPOTHESIS DEVELOPMENT

3.1 | Agility-oriented HR bundles and supply chain resilience

Resilience requires slack capability: Most research locates that slack in physical buffers, such as safety stock, spare capacity and backup suppliers (Sheffi and Rice, 2005). An HR bundle that is agile-oriented is created to produce a human equivalent. Employees who are cross-trained can fill in for each other when one is out or go to a bottleneck line or substitute material, and not have to wait for a long training period. Eliminating administrative hassle and eliminating the need to redeploy staff between functions, a planner can assist the procurement team in the event of a supplier failure or a warehouse team can reprioritise outbound loads. Empowerment practices send information and authority down through several layers to the people who are most closely involved with the problem.

All of the following practices are related to the three facets of resilience. Multi-skilled, informed staff can more easily identify early warning indicators and establish contingency routines during readiness. In response, roles are broad and authority is delegated, reducing decision and redeployment time. A flexible workforce can be scaled up rapidly during recovery and can pick up backlogs. We anticipate that the bundle will increase resilience beyond the impacts on observed adaptive behaviour, such as supporting the routines and structures from which SC managers can draw on.

H1. *Agility-oriented HR bundles are positively related to supply chain resilience.*

3.2 | HR based on mobility needs and performance adaptability of the workforce

Based on AMO theory, it is believed that HR practices have a significant impact on the performance due to their impact on the ability, motivation and opportunity of employees (Jiang et al., 2012). All three are more critical for adaptive performance. When tasks change, training a variety of skills (cross-training) extends the

range of skills available to an employee to draw on from their repertoire. Repeated exposure to different tasks increases the employee's learning ability (underlying skill) that supports adaptivity. Opportunity: flexible working opportunities provide employees with realistic scope of changing how and where they work without breaking formal expectations. Empowerment increases the sense of control, ownership, and increases the likelihood that an employee will embrace change rather than resist it. Studies of proactive and adaptive work behaviour also reveal that autonomy and role breadth are also linked to adaptivity (Griffin et al., 2007).

H2. *HR bundles with an agility focus are positively associated with workforce adaptive performance.*

3.3 | The workforce's ability to adapt to performance and adapt to supply chain resilience

In the microfoundations view, ability to reconfigure resources within a supply chain is manifested in the people who handle it (Felin et al., 2015). When there are disruptions, it is exactly when we need to be adaptive in our performance: we have new problems, new priorities, new suppliers or materials, and information is uncertain. Staff from units who adapt well to change, who are able to learn new procedures and who remain effective in stressful situations will implement contingency plans more quickly with less errors, enhancing response. Adaptability is also a factor of readiness because lessons learned are included in routines, and recovery because they can take up backlogs and get throughput back faster.

H3. *There is a positive relationship between Workforce Adaptive Performance and Supply Chain Resilience.*

3.4 | The mediating role of adaptive performance

H1 to H3 together imply that adaptive performance is a key mechanism through which HR bundles influence resilience. HR practices are designed and implemented by the firm, but their effect on a supply chain capability materialises only when employees behave differently in the face of change. This logic mirrors the HRM–performance literature, in which employee outcomes mediate the effect of HR systems on organisational results (Jiang et al., 2012). Because HR bundles may also affect resilience through structural routes, such as staffing patterns and decision rights, we expect partial, complementary mediation.

H4. *Workforce adaptive performance mediates the relationship between agility-oriented HR bundles and supply chain resilience.*

3.5 | The moderating role of disruption exposure

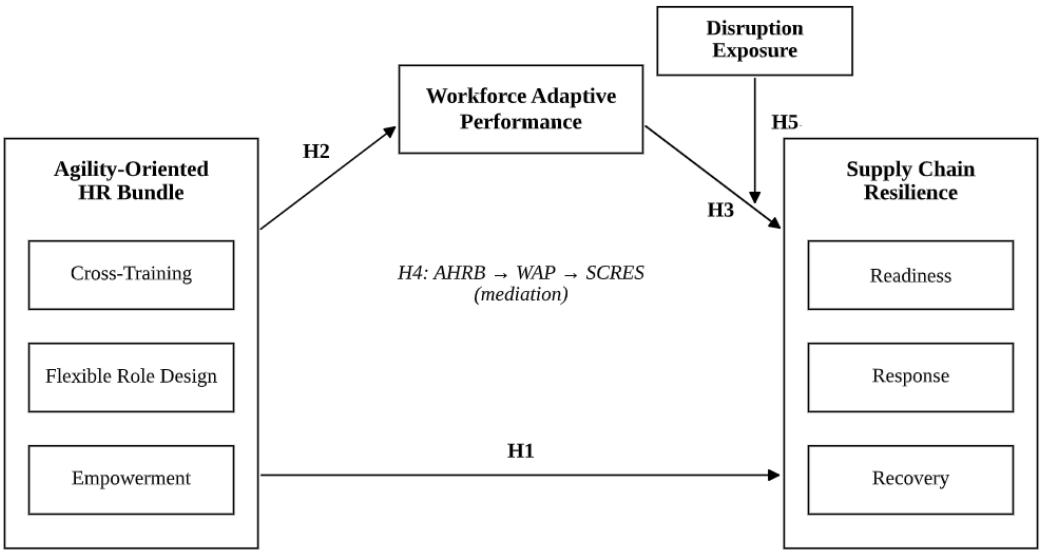
Contingency theory suggests that the value of a capability depends on the environment in which it is used. Disruption exposure refers to the frequency and severity of the supply chain disruptions a firm has recently experienced (Wagner and Bode, 2008). Where disruptions are rare, adaptive behaviour is seldom called upon, and resilience will depend more on standard procedures and buffers. Where disruptions are frequent and severe, adaptive behaviour is exercised repeatedly, and each episode tests whether employees can translate their adaptivity into supply chain outcomes. In such environments, adaptive units are also more likely to have accumulated experience and routines that make their adaptation effective. We therefore expect

the link between adaptive performance and resilience to be stronger when exposure is high, and consequently the indirect effect of HR bundles through adaptive performance to be stronger as well.

H5. *Disruption exposure moderates the relationship between workforce adaptive performance and supply chain resilience, such that the relationship is stronger when disruption exposure is high.*

Figure 1

Research framework



4 | METHODOLOGY

4.1 | Research context

Pakistan offers a suitable setting for two reasons. First, its manufacturing sector depends heavily on imported inputs, from active pharmaceutical ingredients and chemicals to automotive components and textile machinery parts, which makes supply chains vulnerable to foreign-exchange and trade shocks. Second, recent years combined natural, macroeconomic and logistics disruptions, creating meaningful variation in disruption exposure across firms. Therefore, selecting manufacturing sector to test the relationship among study variables was appropriate.

4.2 | Sample and data collection

The sampling frame combined manufacturing firms listed on the Pakistan Stock Exchange. Firms with at least 100 employees and a distinct supply chain or operations function were eligible. The unit of analysis is the supply chain or operations work unit, such as procurement, production planning, manufacturing, warehousing or logistics. Key informants were the managers or supervisors heading these units, with at least two years in their role, because they observe both the HR practices applied in their unit and the unit's contribution to managing disruptions. To limit clustering, no more than six managers per firm were surveyed.

Data were collected through a single cross-sectional survey was used and distributed through HR heads, HR officers and plant managers and officers in printed formats, with a cover letter explaining the academic purpose and assuring anonymity. To create psychological separation between predictor and criterion measures,

HR practices, disruption exposure, adaptive performance and supply chain resilience were placed in separate sections with their own introductions, and scale anchors were varied across sections (Podsakoff et al., 2012).

Of 500 questionnaires distributed, 350 questionnaires were returned. After removing incomplete and straight-lined responses, 310 usable responses remained. Non-response bias was assessed by comparing early and late respondents on all study constructs (Armstrong and Overton, 1977).

4.3 | Measures

All constructs were measured with established scales adapted to the unit referent, using seven-point Likert scales (1 = strongly disagree, 7 = strongly agree).

Agility-oriented HR bundle was modelled as a reflective–formative higher-order construct with three dimensions: cross-training (four items) and flexible role design (four items) adapted from Bhattacharya et al. (2005) and related HR flexibility measures, and empowerment practices (four items) adapted from opportunity-enhancing HR practice measures (Sun, Aryee and Law, 2007; Jiang et al., 2012).

Workforce adaptive performance was measured with six items adapted from Griffin et al. (2007) and Charbonnier-Voirin and Roussel (2012), worded so that managers rated how well employees in their unit adapt to changes in work. *Supply chain resilience* was modelled as a reflective formative higher-order construct with three dimensions, readiness, response and recovery (four items each), adapted from Chowdhury and Quaddus (2017) and Ambulkar et al. (2015). *Disruption exposure* was measured with four items adapted from Wagner and Bode (2008), capturing the frequency and severity of supply-side, logistics and demand-side disruptions over the previous 24 months.

5 | RESULTS AND ANALYSIS

5.1 | Outer loadings

Indicator reliability was checked through the outer loadings Table 1. All 34 indicators loaded on their own constructs between 0.802 (WAP5) and 0.910 (RCV1), above the recommended threshold of 0.708 (Hair et al., 2022). Each loading above 0.708 means the construct explains more than half of the indicator's variance, so every indicator shows satisfactory reliability. Bootstrapping with 1,000 subsamples showed that all loadings were significant ($p < 0.001$). No indicator was a candidate for deletion, so all items were kept for the reliability and validity assessment.

Table 1

Outer loadings

	CT	FRD	EMP	WAP	RDY	RSP	RCV	DEX
CT1	0.868							
CT2	0.881							
CT3	0.836							
CT4	0.843							
FRD1		0.850						
FRD2		0.841						
FRD3		0.865						
FRD4		0.857						
EMP1			0.892					
EMP2			0.861					
EMP3			0.848					
EMP4			0.837					
WAP1				0.809				
WAP2				0.837				
WAP3				0.840				
WAP4				0.875				
WAP5				0.802				
WAP6				0.812				
RDY1					0.861			
RDY2					0.872			
RDY3					0.833			
RDY4					0.862			
RSP1						0.864		
RSP2						0.854		
RSP3						0.884		
RSP4						0.863		
RCV1							0.910	
RCV2							0.854	
RCV3							0.890	
RCV4							0.877	
DEX1								0.845
DEX2								0.876
DEX3								0.858
DEX4								0.895

Note.CT cross-training; FRD flexible role design; EMP empowerment; AHRB agility-oriented HR bundle (HOC); WAP workforce adaptive performance; DEX disruption exposure; RDY readiness; RSP response; RCV recovery; SCRES supply chain resilience.

5.2 | Construct Reliability test

Internal consistency reliability was checked with Cronbach's alpha and composite reliability (rho_a and rho_c), and convergent validity with the average variance extracted (AVE) given in Table 2. All three measures fall within the recommended range of 0.70 to 0.95 (Hair et al., 2022). The constructs are therefore reliable, and the items are not so redundant that they inflate reliability. rho_a sits between alpha and rho_c for

every construct, as expected, because alpha is a conservative lower bound and rho_c a more liberal upper bound.

Table 2

Construct reliability

Construct	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
CT	0.879	0.884	0.917	0.735
FRD	0.875	0.879	0.915	0.728
EMP	0.882	0.886	0.919	0.739
WAP	0.909	0.910	0.930	0.688
RDY	0.878	0.881	0.917	0.735
RSP	0.889	0.891	0.923	0.750
RCV	0.906	0.910	0.934	0.780
DEX	0.894	0.939	0.925	0.755

5.3 | Discriminant validity

Discriminant validity was assessed with the Fornell–Larcker criterion and the heterotrait–monotrait ratio of correlations (HTMT). Under the Fornell–Larcker criterion (Fornell and Larcker, 1981), the square root of each construct's AVE should be larger than its correlations with every other construct. Here the square roots, shown on the diagonal, range from 0.830 (WAP) to 0.883 (RCV). All of them exceed the inter-construct correlations, the highest of which is 0.459 (EMP–WAP), so each construct shares more variance with its own indicators than with any other construct. All ratios range from 0.041 (DEX–WAP) to 0.510 (EMP–WAP), well below the conservative threshold of 0.85 (Henseler, Ringle and Sarstedt, 2015). The highest ratios fall between theoretically related constructs, namely the HR bundle dimensions and adaptive performance and the three resilience phases, but even these stay far below the cut-off. Disruption exposure is clearly distinct from all other constructs (HTMT ≤ 0.203). Together, both criteria confirm that the constructs are empirically distinct and that discriminant validity is established.

Table 3

Discriminant validity: heterotrait-monotrait ratio (HTMT)

	CT	FRD	EMP	WAP	RDY	RSP	RCV	DEX
CT								
FRD	0.458							
EMP	0.477	0.376						
WAP	0.468	0.476	0.510					
RDY	0.461	0.455	0.436	0.431				
RSP	0.269	0.310	0.378	0.484	0.469			
RCV	0.311	0.300	0.269	0.391	0.455	0.458		
DEX	0.203	0.078	0.091	0.041	0.070	0.043	0.061	

Table 4

Discriminant validity: Fornell-Larcker criterion

	CT	FRD	EMP	WAP	RDY	RSP	RCV	DEX
CT	**0.857**							
FRD	0.402	**0.853**						
EMP	0.422	0.332	**0.860**					
WAP	0.421	0.426	0.459	**0.830**				
RDY	0.407	0.402	0.386	0.387	**0.857**			
RSP	0.239	0.277	0.336	0.437	0.417	**0.866**		
RCV	0.279	0.270	0.241	0.357	0.410	0.411	**0.883**	
DEX	0.184	0.072	0.088	0.007	0.069	0.029	0.053	**0.869**

5.4 | Structural model: path coefficients

The hypothesised relationships were tested by bootstrapping with 5,000 subsamples in Table 5. All four paths were positive and significant, so H1, H2, H3 and H5 are supported. The strongest effect was that of agility-oriented HR bundles on workforce adaptive performance ($\beta = 0.569$, $t = 15.088$, $p < 0.001$), supporting H2. Firms that use cross-training, flexible role design and empowerment have markedly more adaptive workforces. HR bundles also had a significant direct effect on supply chain resilience ($\beta = 0.388$, $t = 5.762$, $p < 0.001$), supporting H1, and workforce adaptive performance in turn was significantly related to resilience ($\beta = 0.284$, $t = 4.216$, $p < 0.001$), supporting H3. The interaction term between adaptive performance and disruption exposure was positive and significant ($\beta = 0.180$, $t = 2.561$, $p = 0.010$), supporting H5. The effect of adaptive performance on resilience becomes stronger as firms face more frequent and severe disruptions. For every path the sample mean was close to the original estimate and the standard deviations were small, so the estimates were stable across bootstrap samples, and all t-values exceeded the critical value of 1.96 at the 5% significance level.

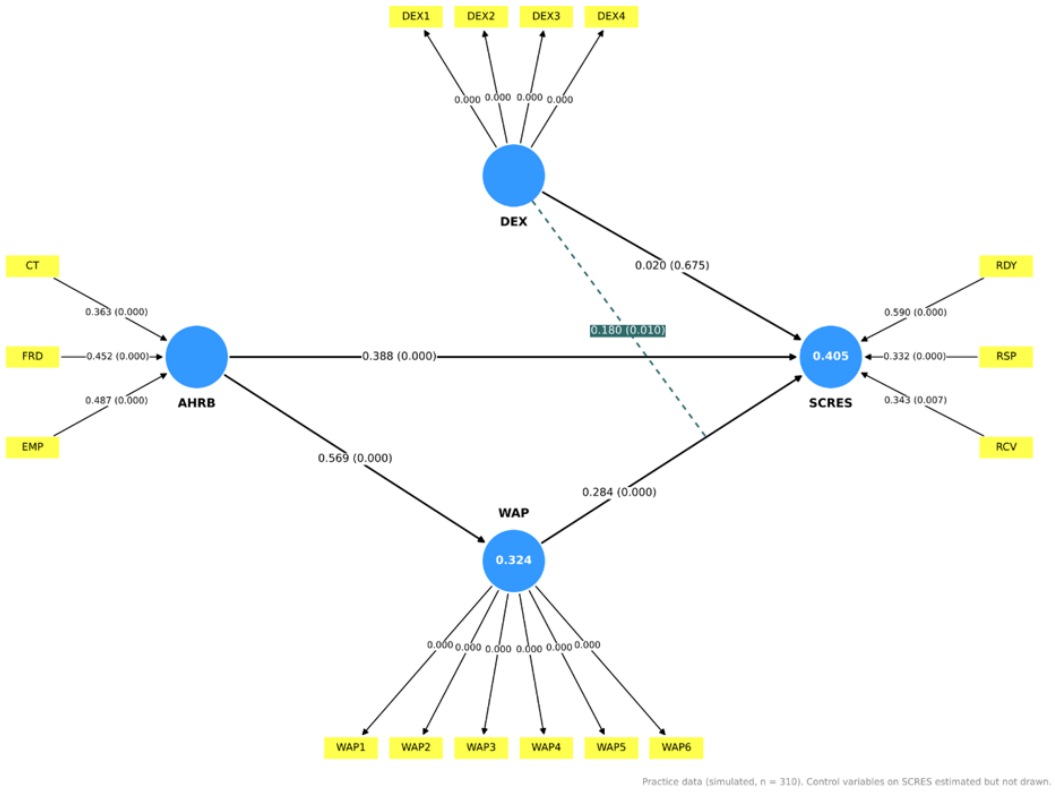
Table 5

Direct path coefficients

	Hypothesis	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
AHRB -> WAP	H2	0.569	0.572	0.038	15.088	0
AHRB -> SCRES	H1	0.388	0.386	0.067	5.762	0.000
WAP -> SCRES	H3	0.284	0.287	0.067	4.216	0.000
WAP x DEX -> SCRES	H5	0.180	0.171	0.070	2.561	0.010

Figure 2

Structural model



5.5 | Mediation and moderated mediation

The indirect effects were tested by bootstrapping (Zhao, Lynch and Chen, 2010; Nitzl, Roldán and Cepeda, 2016). The specific indirect effect of agility-oriented HR bundles on supply chain resilience through workforce adaptive performance was positive and significant ($\beta = 0.162$, $t = 3.964$, $p < 0.001$), supporting H4. Because the direct effect of HR bundles on resilience also remained significant ($\beta = 0.388$, $p < 0.001$) and both effects are positive, adaptive performance partially and complementarily mediates the relationship. It accounts for about 29% of the total effect (VAF = 0.162 / 0.550), so HR bundles strengthen resilience partly by making employees more adaptable and partly through other routes.

Table 6

Specific indirect effects (mediation, H4)

	Hypothesis	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
AHRB -> WAP -> SCRES	H4	0.162	0.164	0.041	3.964	0.000

6 | DISCUSSION

This study examined whether agility-oriented HR bundles build supply chain resilience and through what mechanism. All seven hypotheses were supported, which yields three main insights.

The direct positive effect of agility-oriented HR bundles on supply chain resilience supports the view that resilience rests on flexible, redeployable resources (Sheffi and Rice, 2005; Pettit, Fiksel and Croxton, 2010). Prior research has located this flexibility mainly in inventories, capacity and supplier networks (Ponomarov and Holcomb, 2009; Brandon-Jones et al., 2014). Findings of the research extends that logic to the workforce. Cross-trained, broadly deployable and empowered employees act as a form of human slack that firms can draw on when plans fail. The finding also confirm with the HR flexibility framework of Wright and Snell (1998) and with Bhattacharya, Gibson and Doty (2005), who linked flexibility in employee skills, behaviours and HR practices to firm performance. It adds to that work by showing that the benefit reaches beyond firm performance to a supply chain-level capability.

Further, the strong effect of HR bundles on workforce adaptive performance confirms the core prediction of AMO theory (Appelbaum et al., 2000). Practices that raise employees' ability, motivation and opportunity improve their performance, consistent with the meta-analytic evidence of Jiang et al. (2012). Cross-training, flexible roles and empowerment appear to be especially powerful for adaptivity, which matches research linking autonomy and role breadth to adaptive work behaviour (Pulakos et al., 2000; Griffin, Neal and Parker, 2007). The significant effect of adaptive performance on resilience, and its partial mediating role, give empirical support to the microfoundations view of dynamic capabilities (Teece, 2007; Felin, Foss and Ployhart, 2015). That view holds that firm-level capabilities rest on the skills and behaviours of individuals. The result also shows how the resource reconfiguration identified by Ambulkar, Blackhurst and Grawe (2015) actually happens: employees change their tasks, routines and decisions under pressure. Because the mediation is partial, HR bundles also shape resilience through routes other than observed adaptive behaviour, such as staffing structures and decision rights. This is consistent with the view that human capital resources emerge at the unit level and affect outcomes in several ways (Ployhart and Moliterno, 2011).

Disruption exposure strengthened the effect of adaptive performance on resilience and the indirect effect of HR bundles. This supports a contingency view of resilience, in which the value of a capability depends on how often it is used (Brandon-Jones et al., 2014). It also extends Wagner and Bode (2008), who treated disruption exposure mainly as a risk to performance: here, exposure also determines where people-based capabilities pay off. The stronger people pathway in labour-intensive industries than in process industries suggests that production technology sets the room for human discretion. In process industries, automated operations and validated procedures leave less scope for employees to adapt.

The findings are novel in three respects. First, few studies have empirically linked HRM to supply chain resilience; reviews describe the human side of SCM as under-researched (Hohenstein, Feisel and Hartmann, 2014). This study tests that link with a specific mechanism. Second, it brings AMO theory and the microfoundations of dynamic capabilities together in one model, showing how an HR system becomes a supply chain capability through adaptive behaviour. Third, the evidence comes from manufacturing in Pakistan, a shock-prone emerging economy that is under-represented in resilience research. It also identifies two boundary conditions, disruption exposure and industry type, that earlier work has not tested. Because the

design is cross-sectional, these relationships should be read as theory-consistent associations rather than proven causal effects.

6.1 | Theoretical implications

Resilience research has treated the capability largely as a property of network structures, buffers and information systems. By showing that adaptive performance at the unit level carries a substantial share of the effect of HR practices on resilience, this study identifies a behavioural microfoundation of a supply chain dynamic capability. The finding responds to calls to specify the individual and collective underpinnings of dynamic capabilities (Felin et al., 2015) and moves the human side of SCM from a background condition to an explanatory mechanism (Hohenstein et al., 2014). It also clarifies how resource reconfiguration (Ambulkar et al., 2015) happens in practice: reconfiguration is enacted through employees who change their tasks, routines and decisions under pressure.

Thirdly, AMO-based research has mostly linked HR systems to employee attitudes, firm productivity or financial performance (Jiang et al., 2012). Our results extend this logic to an outcome that spans organisational boundaries. The three practices in the bundle map onto ability, opportunity and motivation, and their joint effect on resilience suggests that HR systems matter not only for how well firms perform in stable conditions but also for how well their supply chains withstand shocks.

6.2 | Practical implications

For operations and supply chain managers the findings imply that workforce flexibility should be considered as a support for resilience alongside safety stock, dual sourcing, and visibility tools. A flexible workforce differs from inventory in that it is not a expense that ties up working capital, which can be a benefit in times of foreign-exchange shortages when buffers are imported at a high cost.

There are 3 actions to take for HR managers. First of all, create cross-training matrices for critical positions in the supply chain, to ensure that there are at least two people available in each of the critical tasks and rotations include the interface between procurement and planning and the interface between planning and production. Second, develop explicit role descriptions that allow for temporary transfers between roles during disruption and set this up with supervisors beforehand. Third, empower unit managers/supervisors to make decisions about disruption – like approving substitute materials within quality limits or resequencing – and provide real-time information sharing.

In an industry sector, training at sector level on disruption response and sharing of cross-training model among members firms can boost the resilience of the entire export sector at a small price.

6.3 | Limitations and directions for future research

The results are limited by several factors and indicate future research areas. First, the rating of adaptive performance was made by the unit managers and not by employees or objective measures. While the design of the instrument and the statistical control for common method bias mitigate common method concerns, further research should integrate employee self-report measures of resilience and supervisor ratings of resilience with objective measures of resilience, like time-to-recover or fill-rate recovery, following specific disruption events.

Second, firms were nested within managers. To limit the size of the sample number of respondents per firm and checked the robustness of the findings by firm-aggregated data, but to obtain more accurate cross-level estimates a fully multilevel design, with a larger sample of firms, would be required.

Thirdly, the research took place in one country. The generalisability of the model and institutional context could be examined in other emerging and developed economies, for example, Bangladesh, Vietnam or Türkiye, through replications.

Finally, other mechanisms and boundary conditions, including empowering leadership, team psychological safety, digital technologies as complementary or alternative to humans' adaptability, and working practices of suppliers in terms of network-level resilience, could be explored in future research.

7 | CONCLUSION

Supply chains are resilient when the people who run them can adapt. Using cross sectional data from Pakistani manufacturers, this study shows that agility-oriented HR bundles, combining cross-training, flexible role design and empowerment, strengthen supply chain resilience directly and through workforce adaptive performance, and that this people pathway matters most under high disruption exposure and in labour-intensive industries. For firms facing repeated shocks, investing in adaptable people is not a soft complement to physical buffers but a core part of resilience strategy.

REFERENCES

Ambulkar, S., Blackhurst, J. and Grawe, S. (2015), "Firm's resilience to supply chain disruptions: Scale development and empirical examination", *Journal of Operations Management*, Vol. 33–34, pp. 111–122.

Appelbaum, E., Bailey, T., Berg, P. and Kalleberg, A.L. (2000), Manufacturing Advantage: Why High-Performance Work Systems Pay Off, Cornell University Press, Ithaca, NY.

Armstrong, J.S. and Overton, T.S. (1977), "Estimating nonresponse bias in mail surveys", *Journal of Marketing Research*, Vol. 14 No. 3, pp. 396–402.

Bhattacharya, M., Gibson, D.E. and Doty, D.H. (2005), "The effects of flexibility in employee skills, employee behaviors, and human resource practices on firm performance", *Journal of Management*, Vol. 31 No. 4, pp. 622–640.

Brandon-Jones, E., Squire, B., Autry, C.W. and Petersen, K.J. (2014), "A contingent resource-based perspective of supply chain resilience and robustness", Journal of Supply Chain Management, Vol. 50 No. 3, pp. 55–73.

Charbonnier-Voirin, A. and Roussel, P. (2012), "Adaptive performance: A new scale to measure individual performance in organizations", *Canadian Journal of Administrative Sciences*, Vol. 29 No. 3, pp. 280–293.

Chowdhury, M.M.H. and Quaddus, M. (2017), "Supply chain resilience: Conceptualization and scale development using dynamic capability theory", *International Journal of Production Economics*, Vol. 188, pp. 185–204.

Felin, T., Foss, N.J. and Ployhart, R.E. (2015), "The microfoundations movement in strategy and organization theory", *Academy of Management Annals*, Vol. 9 No. 1, pp. 575–632.

Griffin, M.A., Neal, A. and Parker, S.K. (2007), "A new model of work role performance: Positive behavior in uncertain and interdependent contexts", *Academy of Management Journal*, Vol. 50 No. 2, pp. 327–347.

Hair, J.F., Hult, G.T.M., Ringle, C.M. and Sarstedt, M. (2022), *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*, 3rd ed., Sage, Thousand Oaks, CA.

Henseler, J., Ringle, C.M. and Sarstedt, M. (2016), "Testing measurement invariance of composites using partial least squares", *International Marketing Review*, Vol. 33 No. 3, pp. 405–431.

Hohenstein, N.-O., Feisel, E. and Hartmann, E. (2014), "Human resource management issues in supply chain management research: A systematic literature review from 1998 to 2014", *International Journal of Physical Distribution & Logistics Management*, Vol. 44 No. 6, pp. 434–463.

Jiang, K., Lepak, D.P., Hu, J. and Baer, J.C. (2012), "How does human resource management influence

organizational outcomes? A meta-analytic investigation of mediating mechanisms", *Academy of Management Journal*, Vol. 55 No. 6, pp. 1264–1294.

Jüttner, U. and Maklan, S. (2011), "Supply chain resilience in the global financial crisis: An empirical study", *Supply Chain Management: An International Journal*, Vol. 16 No. 4, pp. 246–259.

Kock, N. (2015), "Common method bias in PLS-SEM: A full collinearity assessment approach", *International Journal of e-Collaboration*, Vol. 11 No. 4, pp. 1–10.

Kock, N. and Hadaya, P. (2018), "Minimum sample size estimation in PLS-SEM: The inverse square root and gamma-exponential methods", *Information Systems Journal*, Vol. 28 No. 1, pp. 227–261.

Nitzl, C., Roldán, J.L. and Cepeda, G. (2016), "Mediation analysis in partial least squares path modeling", *Industrial Management & Data Systems*, Vol. 116 No. 9, pp. 1849–1864.

Pettit, T.J., Fiksel, J. and Croxton, K.L. (2010), "Ensuring supply chain resilience: Development of a conceptual framework", Journal of Business Logistics, Vol. 31 No. 1, pp. 1–21.

Ployhart, R.E. and Moliterno, T.P. (2011), "Emergence of the human capital resource: A multilevel model", Academy of Management Review, Vol. 36 No. 1, pp. 127–150.

Podsakoff, P.M., MacKenzie, S.B. and Podsakoff, N.P. (2012), "Sources of method bias in social science research and recommendations on how to control it", *Annual Review of Psychology*, Vol. 63, pp. 539–569.

Ponomarov, S.Y. and Holcomb, M.C. (2009), "Understanding the concept of supply chain resilience", *The International Journal of Logistics Management*, Vol. 20 No. 1, pp. 124–143.

Pulakos, E.D., Arad, S., Donovan, M.A. and Plamondon, K.E. (2000), "Adaptability in the workplace: Development of a taxonomy of adaptive performance", *Journal of Applied Psychology*, Vol. 85 No. 4, pp. 612–624.

Sarstedt, M., Hair, J.F., Cheah, J.-H., Becker, J.-M. and Ringle, C.M. (2019), "How to specify, estimate, and validate higher-order constructs in PLS-SEM", *Australasian Marketing Journal*, Vol. 27 No. 3, pp. 197–211.

Sheffi, Y. and Rice, J.B. (2005), "A supply chain view of the resilient enterprise", *MIT Sloan Management Review*, Vol. 47 No. 1, pp. 41–48.

Shmueli, G., Sarstedt, M., Hair, J.F., Cheah, J.-H., Ting, H., Vaithilingam, S. and Ringle, C.M. (2019), "Predictive model assessment in PLS-SEM: Guidelines for using PLSpredict", *European Journal of Marketing*, Vol. 53 No. 11, pp. 2322–2347.

Sun, L.-Y., Aryee, S. and Law, K.S. (2007), "High-performance human resource practices, citizenship behavior, and organizational performance: A relational perspective", *Academy of Management Journal*, Vol. 50 No. 3, pp. 558–577.

Teece, D.J. (2007), "Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance", *Strategic Management Journal*, Vol. 28 No. 13, pp. 1319–1350.

Wagner, S.M. and Bode, C. (2008), "An empirical examination of supply chain performance along several dimensions of risk", *Journal of Business Logistics*, Vol. 29 No. 1, pp. 307–325.

Wright, P.M. and Snell, S.A. (1998), "Toward a unifying framework for exploring fit and flexibility in strategic human resource management", *Academy of Management Review*, Vol. 23 No. 4, pp. 756–772.

Zhao, X., Lynch, J.G. and Chen, Q. (2010), "Reconsidering Baron and Kenny: Myths and truths about mediation analysis", *Journal of Consumer Research*, Vol. 37 No. 2, pp. 197–206.