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COLLABORATIVE APPROACH TO FLEXIBILITY, VISIBILITY AND VELOCITY IN SUPPLY CHAINS: A MULTI-GROUP ANALYSIS

The resilience of manufacturing supply chains have garnered a wide spread interest from researchers, however, most studies focus on developed economies when investigating resilience, creating a gap in research in developing countries. This study addresses that gap by examining supplier collaboration's effect on supply chain flexibility, visibility, and velocity in an African business environment. The study also fills another literature gap by uniquely assessing the relevance of company size to this relationship. This study employed a descriptive research design, with a population of 1332 and sample of 264. The analysis was based on 219 retrieved questionnaire copies, and it was performed using percentages and a structural equation model. The study reveals that resource sharing is the most effective strategy for improving supply chain resilience, and collaboration practices are most effective for supply chain flexibility. Organisations pursuing supply chain resilience should invest more in resource-sharing and information-sharing strategies because both strategies have the most positive impacts on resilience. Additionally, managers must note that supplier collaboration may not yield similar results across all resilience performance measurements. That said, medium-scale firms must focus on information sharing to improve the supply chain flexibility.

Keywords: Supplier collaboration, disruption, supply chain resilience, flexibility, visibility, information sharing.

1. INTRODUCTION

Disruptions occur, and in some cases, nothing can stop them. The best that can be done in such instances is to reorganise and re-strategise towards recovery. Such is the level of disruption triggered by Coronavirus. Disruption has occurred if there is an impromptu halt to the production and supply chain process (Revilla, Saenz, 2017). While there are studies on mitigating the possibilities of disruption (Polyviou, Croxton, Knemeyer, 2019), studies focused on developing flexibility, visibility, and velocity (resilience) in cases where management is powerless to disruption occurrence are limited (Ivanov, Dolgui, Sokolov,

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Ivanov, 2017), and only a few consider supplier collaboration. Collaboration is a concept that fosters the interdependence of firms to harvest the synergy between/among them to satisfy the end-users. It is a concept and strategy that has been investigated for several reasons, including internationalisation (Masiero, Ogasavara, Risso, 2017), improved society (Brown, Rizzuto, Singh, 2019), organisational performance (Tajeddini, Elg, Ghauri, 2015), market share growth (Ryan, Evers, Smith, Andersson, 2018), and modern slavery (Benstead, Hendry, Stevenson, 2018); to mention a few. However, the function of supplier collaboration in a bid to achieve supply chain flexibility, visibility and velocity to gain swift ample recovery from a supply disruption has been scantily researched (Duong, Chong, 2020). The novel coronavirus was an unprecedented event, and the level of disruption experienced was massive. Thus, studies that help navigate the current conditions of the business environment are essential. This study aims to investigate the role of supplier collaboration on supply chain flexibility, visibility and velocity. This is a response to contemporary calls for more empirical studies on supply collaboration and partnerships to improve resilience, especially from developing nations (Duong, Chong, 2020; Ali, Arslan, Chowdhury, Khan, Tarba, 2022; Spieske, Gebhardt, Kopyto, Birkel, 2022). The study also addresses a salient gap in supply chain resilience literature by assessing the relevance of company size on the relationship between supplier collaboration and resilience

2. LITERATURE REVIEW

2.1. Conceptual review

Supplier Collaboration

The network of manufacturing firms is a necessity for the achievement of company objectives in today's business environment. The dependence on supply chain partners in the delivery of customer satisfaction is becoming inevitable for manufacturing, especially big firms (Zhu, Krikke, Caniels, 2016). While collaboration in its essence is all-encompassing, including suppliers, distributors and customers, the major risk of disruption for any manufacturing firm is from the supply end (Scholten, Schilder, 2015), therefore, this study focuses on the collaboration between the focal firm and suppliers. The relevance of supplier collaboration to the success of supply chain and organisational performance is a growing concern with multiple researchers focusing on this niche (Mikkola, Skjøtt-Larsen, 2006; Cousins, Lamming, Lawson, Squire, 2008; Kähkönen, Lintukangas, Ritala, Hallikas, 2017). The goal to remain competitive in a contemporary business environment has continued to lend support to supplier collaboration. Competition is beyond focal firms in contemporary business spheres, it now resides in the effectiveness and efficiency of the supply chain (Puche, Ponte, Costas, Pino, Fuente 2016), therefore, the role of supplier collaboration is invaluable to the sustained competitiveness of a firm.

Kähkönen et al. (2017) measured supplier collaboration using green ethical supply management, early supplier involvement practice, systemic purchasing approach, and inter-firm learning. Cao, Vonderembse, Zhang, and Ragu-Nathan (2010) measured collaboration using information sharing, goal congruence, joint decision-making, resources sharing, incentive alignment, collaborative communication and joint knowledge creation. Simatupang and Sridharan (2004) used information sharing, decision synchronisation, and incentive alignment. A hierarchical model employed by Kumar and Banerjee (2012) to establish the rank of collaboration practices suggested collaborative culture, joint problem--solving and performance measurement, supplier joint planning, information-sharing and

resource-sharing practices as the most relevant collaboration practices. This study adopts information sharing, joint decision-making, joint planning, and resource planning.

Supply chain resilience

The year 2020 is one that most operations and supply chain managers will not forget soon, particularly because of the level of devastating disruption that was experienced in the year. Disruptions could be intentional (e.g., strikes), accidental (e.g., fire outbreak), or natural (e.g., earthquakes), the duration it takes to recover from the disruption experienced determines its longevity, after all, experiencing disruption is a matter of time. The Business Continuity Institute (BCI) in 2011 reported that only 15% of existing manufacturing firms are yet to experience a supply chain disruption. 10 years later (2021) they reported that 87.8% of manufacturers exerienced disruption costing millions (BCI, 2021). Though there are studies that focus on disruption, post-disruption studies are still in their infancy (Kim, Hastak, 2018; Ivanov, Tsipoulanidis, Schönberger, 2019). Perhaps that is why most firms are somewhat ill-prepared to manage post-disruption in terms of recovery (Chen, Das, Ivanov, 2019). These surveys highlight the relevance of a recovery plan to supply chain disruptions.

It is often said that the bigger the firm; the bigger the supply chain, and the bigger the supply chain, the bigger the exposure to disruptions (Scheibe, Blackhurst, 2018). In other words, the nature of globalisation has fostered global supply chains for some firms, and being that big comes with the price of suffering supply chain disruptions periodically, recovery from disruption must be taken into consideration even more. Supply chain resilience can be described as how well an organisation recovers from a supply chain disruption (Golgeci, Ponomarov, 2013). The swiftness and extent of recovery from supply chain disruption is a testament to how well a supply chain is resilient. The parameters of supply chain resilience will be adopted from the study of Scholten and Schilder (2015), which are supply chain flexibility, supply chain visibility, and supply chain velocity.

Conceptual Model

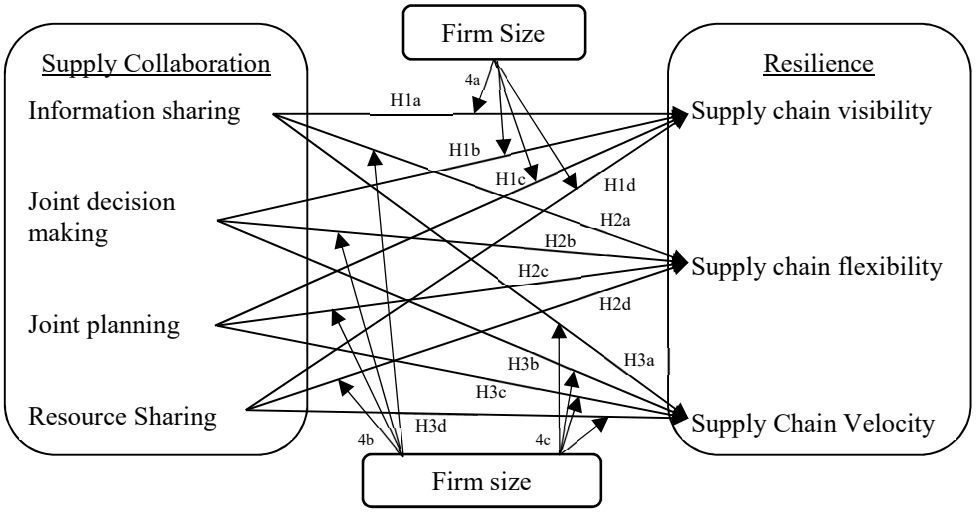

Figure 1. Conceptual model of Supplier Collaboration and Supply Chain Resilience relationship

Source: Authors, 2022.

Hypothesis Development

Golgeci and Ponomarov (2013) investigated the role of a firm's innovation in achieving supply chain resilience. While the study establishes the significance of innovation on disruption recovery, it begs the question of what role did the suppliers and distributors play to bring resilience to fruition, considering that supply chain resilience is a coordinated effort of supply chain members and not just the focal firm. As highlighted by Scholten and Schilder (2015), one firm cannot achieve supply chain resilience, it is a wrong approach to achieve resilience in manufacturing firms. Also, to emphasize the need for this study, Scholten and Schilder (2015), highlighted a need for quantitative empirical studies from developing nations to test the role of collaboration on supply chain resilience because theirs was qualitative, and based on a developed economy (Netherlands). This study answers that call by focusing on a developing economy (Nigeria).

Zhu et al. (2016) conducted a simulation on the relationship between collaboration and supply chain resilience; however, studies using data from major disruptions are needed to show how well collaboration aid the recovery process of manufacturing firms. It has also been established that studies on supply chain resilience and its parameters have been focused on the focal firm rather than the supply chain members (Manders, Caniëls, Ghijsen, 2016; Rojo, Stevenson, Montes, Perez-Arostegui, 2018), thus, reducing the relevance of the findings. It is important that empirical studies on the buyer-suppliers relationship be done with firms on the chain, rather than just focal firms. In addition to these, the literature on supply chain resilience from the Nigerian front is very limited (if any exists). Which is one of the reasons why Chowdhury and Quaddus (2017) called for more empirical studies to be carried out for the enhancement of supply chain resilience knowledge.

In addition to the need for studies on developing economies. Prior studies on supplier collaboration and resilience (Scholten, Schilder, 2015; Duong, Chong, 2020; Spieske, Gebhardt, Kopyto, Birkel, 2022) do not establish the impact of the individual practices of supplier collaboration on the exclusive dimensions of supply chain resilience, that is, flexibility, visibility and velocity. This study goes beyond assessing supplier collaboration on flexibility, visibility and velocity. It also tests the exclusive roles of information sharing, joint decision-making, joint planning and resource sharing on the dimensions of resilience. These gaps have prompted the need to empirically test the role of supplier collaboration practices on supply chain resilience. From the discussion above, this study tests the following alternative hypotheses:

H1: Supplier collaboration has a significant impact on supply chain visibility.

H2: Supplier collaboration has a significant impact on supply chain flexibility.

H3: Supplier collaboration has a significant impact on supply chain velocity.

In the literature on supplier collaboration and supply chain resilience, several studies have been conducted, both qualitative and quantitative (Scholten, Schilder, 2015; Chowdhury et al., 2019), yet, little or no research has been done to assess the possible influence of company size on the relationships. Chowdhury and Quaddus (2017) called for more extensive studies into the possible contrast in relationship to enrich the supply chain resilience literature. This study ascends to the call by enriching supply chain resilience literature in testing the possible similarities or contrast when size is specifically considered in these relationships. Supply chain resilience literature holistically lacks comparative analysis studies. More recent studies in supply chain resilience (Gu et al., 2021; Ali et al., 2022; Kazancoglu, Ozbiltekin-Pala, Mangla, Kazancoglu, Jabeen, 2022) looked into several relationships without empirically establishing the role of company size, though the

responses were from companies of different sizes. This, therefore, leads to the fourth hypothesis formulation in this study, which tests the impact of company size.

H4: The relationship between supplier collaboration and supply flexibility, visibility and velocity are significantly different among medium and big firms.

3. METHODOLOGY

In line with prior publications on supplier collaboration relevance and supply chain resilience (Kähkönen et al., 2017; Patrucco, Luzzini, Ronchi, 2017), this study adopts a descriptive research design and a cross-sectional survey approach to capture respondents' opinions on the variables under study. Data is retrieved from manufacturing firms domiciled in Lagos, Nigeria. The population of this study is made up of all the employees of eleven selected manufacturing firms in the food and beverage industry (one focal firm and ten first-tier suppliers). The first-tier suppliers chosen were the most critical suppliers of the focal firm. The staff strength of all 11 selected firms was 1332. Employing a stratified sampling procedure, the sampling was limited to the Executive (Chief Executive officer, Chief Operating Officer, President, Vice President, Managing Director) officers and decision-making staff of the production, supply chain, and operations departments of the chosen firms. Provision was made for 3 Executives and 7 staff (Directors, Deputy Directors, Managers, Assistant Managers, and 3 Supervisors) in each department. It is assumed that they are more conversant with the variables under study. The sample for the study was 264 respondents.

Table 1. Measurement Items

Supply Collaboration dimensions	
Information sharing (IS)	
IS1 My company and its supply partners exchange relevant and timely information	Cao et al. (2010)
IS2 My company and its supply partners exchange accurate and complete information	Cao et al. (2010)
IS3 My company and its supply partners exchange information on inventory levels, delivery schedules, and cost of inventory warehousing	Kumar, Banerjee (2012)
IS4 My company and its supply partners exchange information on users' feedback on products and services	Kumar, Banerjee (2012)
Joint decision making (JDM)	
JDM1 Joint decision on optimal order quantity	Simatupang, Sridharan (2004)
JDM2 Joint decision on product quality and market segmentation	Simatupang, Sridharan (2004)
JDM3 Joint decision in resolving production related problems	Simatupang, Sridharan (2004)
JDM4 Joint decision on goals, objectives, and reward for good performance	Kumar, Banerjee (2012)
Joint planning (JP)	
JP1 My company makes plan to purchase raw materials and other required goods with good quality, and maintain relationships with suppliers	Kumar, Banerjee (2012)

Table 1 (cont.). Measurement Items

Supply Collaboration dimensions	
Joint planning (JP)	
JP2 New Product Development in my company integrates suppliers into its planning	Kumar, Banerjee (2012)
JP3 My company jointly plan demand forecasts with its suppliers	Kumar, Banerjee (2012)
JP4 My company develops promotional and advertising strategies of product lines in conjunction with suppliers	Kumar, Banerjee (2012)
Resource Sharing (RS)	
RS1We have shared all required technology and machinery with our partners	Kumar, Banerjee (2012)
RS2Use cross-organisational teams frequently for process design and improvement	Cao et al., (2010)
RS3 We offer technical support to our suppliers	Cao et al., (2010)
RS4 We offer financial and non-financial resources to supply partners to enable them meet deliveries.	Cao et al., (2010)
Supply Chain Resilience dimensions	
Supply chain visibility (SCV)	
SCV1 Our supply partners have real time data to aid observation of a change in strategy	Chowdhury, Quaddus, Agarwal (2019)
SCV2 All supply partners can see updated fluctuations in stock	Brandon-Jones, Squire, Autry, Peterson (2014)
SCV3 Required investments in IT system have been made by partners along the chain for tracking goods	Mandal et al. (2016)
SCV4 We get information from various sources to understand the changing market conditions	Mandal (2017)
Supply chain flexibility (SCF)	
SCF1 Our firm has the ability to manufacture a variety of goods with minimal change in the production setup	Zhang, Vonderembse, Lim (2003)
SCF2 We have the capacity to tweak delivery time for expected inventories to manage a disruption	Mandal et al. (2016)
SCF3 Staff are well trained in handling different types of production systems and tasks	Chowdhury, Quaddus (2017)
SCF4 The suppliers react well to changes in product design while maintaining minimal losses in time or finances	Chiang, Kocabasoglu-Hillmer, Suresh (2012)
Supply chain velocity (SCVe)	
SCVe1 Our firm's supply chain practices a hands on rapid approach to deal with threats in our environment	Scholten, Schilder (2015)
SCVe2 The partners of the firms supply line understand and react swiftly to the dynamism of the business environment.	Mandal et al. (2016)
SCVe3 When opportunities for the firm come into the business space, supply chain partners quickly latch unto such and exploit it	Mandal et al. (2016)

Source: Literature review, 2022.

A questionnaire was developed using existing scales from supply chain literature. Cao et al. (2010) and Kumar and Banerjee (2012) provided measurement scales for information

sharing. Simatupang and Sridharan (2004) provided measurement scales for joint decision-making. Measurement items from Kumar and Banerjee (2012) and Cao et al. (2010) measured joint planning and resource sharing respectively. Zhang, Vonderembse, and Lim (2003), Chiang, Kocabasoglu-Hillmer, and Suresh (2012), Brandon-Jones, Squire, Autry, and Peterson (2014), Scholten and Schilder (2015), Mandal et al. (2016), and Chowdhury and Quaddus (2017) provided measurement items for supply chain flexibility, visibility and velocity. The research instrument was distributed to all 264 respondents that make up the sample. The items adapted were done because of their simplistic nature and specificity on the sub-variables of this study. The items were slightly modified for the suppliers to reflect a relationship with a customer (focal firm). It had a return rate of 82.95%, that is, 219 questionnaire copies. The data were analysed using frequencies and a structural equation model (SEM).

4. DATA ANALYSIS AND RESULTS

Table 2. Construct assessment

Construct	items	Factor loading	CFI	RFI	RMR	NFI	*p*	Cronbach α	AVE	CR
Information Sharing	IS1	.945	.977	.928	.041	.976	.021	.832	.811	.918
	IS2	.917								
	IS3	.819								
	IS4	.883								
Joint Decision Making	JDM1	.932	.988	.961	.021	.987	.110	.813	.754	.793
	JDM2	.785								
	JDM3	.929								
	JDM4	.818								
Joint Planning	JP1	.509	.997	.985	.010	.995	.050	.853	.711	.847
	JP2	.953								
	JP3	.897								
	JP4	.983								
Resource Sharing	RS1	.916	.994	.980	.033	.993	.002	.875	.875	.926
	RS2	.949								
	RS3	.988								
	RS4	.965								
Supply Chain Visibility	SCV1	.884	.913	.737	.032	.912	.030	.812	.833	.931
	SCV2	.934								
	SCV3	.951								
	SCV4	.973								
Supply Chain Flexibility	SCF1	.660	.978	.899	.025	.966	.062	.701	.797	.831
	SCF2	.680								
	SCF3	.773								
	SCF4	.689								
Supply Chain Velocity	SCVe1	.742	.908	.923	.023	.917	.097	.732	.783	.900
	SCVe2	.673								
	SCVe3	.611								

Source: Field Survey, 2022.

Measurement model

The measurement model was tested for multivariate normality, unidimensionality, reliability, multicollinearity, using factor analysis (EFA), and confirmatory factor analysis (CFA). Multivariate normality was satisfied by conducting a Mahalanobis test to reveal a Mahalanobis range of 3.618-100.830. The critical value was calculated to be 40.113, thus, eliminating 11 respondents from the survey because their Mahalanobis values were higher than the critical value. Unidimensionality was tested to examine the factor loadings of the items of the major constructs. While constraining the highest factor loading of the measurement items to 1, the loadings were good, as revealed in Table 1. The reliability assessment revealed that all constructs had values above .70 (see Table 1). Multicollinearity was assessed through the Tolerance and VIF figures of the items. The items had Tolerance values above .2 and VIF values below 5.

Table 3. Discriminant Validity

Constructs	Mean	SD	IS	JDM	JP	RS	SCV	SCF	SCVe
Information Sharing	3.86	.92	***.901***						
Joint Decision Making	3.60	.85	.762**	***.868***					
Joint Planning	3.62	.96	.654**	.826**	***.843***				
Resource Sharing	3.67	.96	.719**	.805**	.790**	***.935***			
Supply Chain Visibility	3.63	.86	.584**	.734**	.632**	.734**	***.913***		
Supply Chain Flexibility	3.86	.67	.053*	.165**	.120*	.046*	.214**	***.893***	
Supply Chain Velocity	3.59	1.05	.319**	.428**	.369**	.316**	.332**	.521**	***.885***

**/* significant at 0.01 and 0.05 respectively (2-tailed). Bold diagonal values are AVE square root values

Source: Field Survey, 2022.

Exploratory factor analysis carried out was in a bid to affirm no positive definiteness in the study data set. The factor extraction was set at 7; mirroring the study's main variables, and varimax rotation had its condition to suppress any rotation values beneath 0.3. There was a need to conduct the EFA because though measurement items were adapted, they were applied to a different and very developed business environment. The positive definiteness assumption was not violated as the determinant value was 4.360 (above 0) (Lowry, Gaskin, 2014). In addition, the Kaiser-Meyer-Olkin (KMO) value was 0.796, and Bartlett's test of sphericity (BTS) was significant at .001 (.000). KMO value above 0.5 is considered good and indicates an adequate sample size (Hair, Anderson, Tatham, Black, 1998). Confirmatory factor analysis tested both convergent and discriminant validity. The average variance extracted and composite reliability values were within the range to establish convergent validity, given that they were above 0.50 and 0.70 respectively (Dubey, Gunasekaran, Childe, Wamba, Roubaud, Foropon, 2021). The discriminant validity confirmation was established through the comparison of the squared root AVE values and the squared correlation values. Once it is established that Squared AVE values surpass the all-squared correlation values, discriminant validity is satisfied (Hair et al., 1998).

Table 4. Brief description of respondents' bio-data and distribution across firms and positions

		Frequency	Valid Percent	Cumulative %
Gender	Male	165	75.3	75.3
	Female	54	24.7	100
	Total	219	100	
Department	Production	64	29.22	29.22
	Supply chain	69	31.51	60.73
	Operations	59	26.94	87.67
	Executive	27	12.33	100
	Total	219	100	
Company Size	Medium	71	32.42	32.42
	Big	148	67.48	100
	Total	219	100	
Firm Distribution	Company A (Focal firm)	20	09.13	09.13
	Supplier 1	22	10.05	19.18
	Supplier 2	22	10.05	29.22
	Supplier 3	19	8.68	37.90
	Supplier 4	15	8.65	44.75
	Supplier 5	21	09.59	54.34
	Supplier 6	22	10.05	64.39
	Supplier 7	20	09.13	73.52
	Supplier 8	20	09.13	8265
	Supplier 9	17	07.76	90.41
	Supplier 10	21	09.59	100
	Total	219	100	

Firms	Size	E	D	DD	M	AM	S	Total
Company A (Focal Firm)	Big	3	2	2	3	1	9	20
Supplier 1	Big	3	3	3	3	1	9	22
Supplier 2	Big	3	2	2	3	3	9	22
Supplier 3	Medium	2	3	3	3	3	5	19
Supplier 4	Medium	1	2	3	3	3	3	15
Supplier 5	Big	2	3	3	3	1	9	21
Supplier 6	Big	3	3	3	3	1	9	22
Supplier 7	Medium	3	3	3	3	3	5	20
Supplier 8	Big	1	3	3	3	1	9	20
Supplier 9	Medium	3	3	3	1	3	4	17
Supplier 10	Big	3	3	2	3	1	9	21
Total Medium/Big		9/18	11/19	12/18	10/21	12/9	17/63	71/148
Total Male/Female		24/3	30/0	27/3	19/12	12/9	53/27	165/54
Total		27	30	30	31	21	80	219
Supervisor (S), Departmental Assistant Manager (AM), Departmental Manager (M), Departmental Deputy Director (DD), Directors (D), Executive (E)								

Source: Field Survey, 2022.

80 supervisors (36.53%), 21 assistant managers (9.58%), 31 managers (14.16%), 30 deputy directors (13.70%), 30 directors (13.70%), and 27 executives (12.33%) made up the respondents for the study. 71 respondents (32.42%) were from medium firms, while 148 respondents (67.48%) were from big firms. The focal firm, supplier 7 and supplier 8 had 20 respondents (9.13%) each, and 22 respondents (10.05%) each came from Suppliers 1, 2, and 6. Supplier 3 had 19 respondents (8.68%), while suppliers 4, 5, 9 and 10 had 15, 21, 17, and 21 respondents respectively, constituting 8.65%, 9.59%, 7.76%, 9.59%. All directors in this study were male employees of the production department. 27 deputy directors (90% of deputy directors) were male, while 3 deputy directors were female. These statistics support the male dominance and physicality involved in working in a manufacturing firm in Nigeria, especially in medium-scale firms; where everyone might need to get their hands dirty in labour support (occasionally) to meet up with customer demands. The data shows that 7 firms in the study were big-sized, while 4 firms were medium-sized. The big firms include the focal firm, suppliers 1, 2, 5, 6, 8 and 10. The medium-scale firms include suppliers 3, 4, 7, and 9. The analysis also shows that out of the 80 supervisors among the respondents, 63 were employees of big firms, while 17 were the medium firm staff. While on contrast, big firms had only 9 assistant managers out of the 21 assistant managers in the study. This implies that because of the multi-specialised activities in big departments, big firms focus on having more specialist supervisors than assistant managers. These specialist supervisors then serve as assistants to the manager.

Table 5. Hypotheses test result

Hypothesis	Path	Standardised Coefficient	t-values	Result
H1	SC ⟶ SCV	.245**		Supported
H1a	IS ⟶ SCV	.024*	2.451	Supported
H1b	JDM ⟶ SCV	.010^{ns}	1.582	Not Supported
H1c	JP ⟶ SCV	.101**	5.337	Supported
H1d	RS ⟶ SCV	.110**	3.156	Supported
H2	SC ⟶ SCF	.312**		Supported
H2a	IS ⟶ SCF	.060**	3.941	Supported
H2b	JDM ⟶ SCF	.008**	2.217	Supported
H2c	JP ⟶ SCF	.107*	2.174	Supported
H2d	RS ⟶ SCF	.137*	5.915	Supported
H3	SC ⟶ SCVe	.186**		Supported
H3a	IS ⟶ SCVe	.166**	3.891	Supported
H3b	JDM ⟶ SCVe	.006**	2.017	Supported
H3c	JP ⟶ SCVe	.008**	4.874	Supported
H3d	RS ⟶ SCVe	.006**	2.315	Supported

**/* significant at 0.01 and 0.05 respectively.

SC = Supplier collaboration, IS = Information sharing, JDM = Joint decision making, JP = Joint planning, RS = Resource sharing, SCV = Supply chain visibility, SCF = Supply chain flexibility, SCF = Supply chain flexibility, SCVe = Supply chain velocity.

Source: Field Survey, 2022.

The accepted thresholds for model indices are CFI ≥ 0.90, GFI ≥ 0.90, IFI ≥ 0.90, NFI ≥ 0.90, RMR ≤ 0.08, RMSEA ≤ 0.08, and x^2/df ≤ 5 (Bagozzi, Yi, 1988; Hair, Anderson,

Tatham, Black, 1998; Hair, Black, Babin, Anderson, Tatham, 2010). The model fit indices for the model (CMIN/df 2.999, NFI .995, RFI .985, IFI .997, TLI .990, CFI .997, RMSEA .081) were acceptable because they were above the threshold recommended. The result showcases the relationships among the major constructs of the study. First, the supply collaboration and supply chain visibility hypothesis test. The individual practices of supply collaboration selected for this study were information sharing, joint decision-making, joint planning, and resource sharing. They accounted for 2.4 percent, 1.0 percent (though insignificant), 10.1 percent, and11 percent respectively in the influence of supply chain visibility. In totality, the study shows that supply collaboration accounts for 24.5 percent of supply chain visibility. The study accepts that the results being positively and significant establish a significant relationship between supply collaboration and the supply chain visibility of manufacturing firms in Nigeria. Therefore, the hypothesis is retained. Secondly, the supply collaboration and supply chain flexibility hypothesis test. The individual practices of supply collaboration accounted for 6 percent, 0.8 percent, 10.6 percent, and 13.7 percent respectively in their influence on supply chain flexibility. The study shows that supply collaboration accounts for 31.2 percent of supply chain flexibility. The results were positive and significant, thereby establishing a significant relationship between supply collaboration and the flexibility of the supply chain of Nigerian manufacturing firms. Therefore, the hypothesis was retained. Lastly, the supply collaboration and supply chain velocity relationship was tested. Information sharing accounted for a 16.6 percent influence on supply chain velocity, joint decision-making accounted for a 0.6 percent influence on supply chain velocity, joint planning predicted a 7.8 percent change in supply chain velocity and resource sharing had a 0.6 percent influence on supply chain velocity. In totality, the study shows that supply collaboration is capable of influencing 18.6 percent of supply chain velocity. All tests were positive and significant, which shows that supply collaboration is significantly influencing the supply chain velocity of manufacturing firms in Nigeria. The hypothesis was retained.

To test hypothesis four, a multigroup analysis (via SEM) was conducted on the existing conceptual model for hypotheses testing. Two groups were created in the SEM to reflect the company sizes. Group 1 was Medium, while group 2 was Big. The data file was aligned to these groups by using the categorical variable Company Size. For testing the hypothesis, structural covariances as well as structural residuals were deleted from the parameter constructs revealed by the multigroup analysis. This enables the test to confine its assessment to the similarity between unconstrained values and constrained values (structural weights). In essence, the test tells us if there is a difference when company size is factored into the relationship between supplier collaboration and supplier resilience. Standardised estimates and squared multiple correlations were highlighted as needed outputs for the test. Results show that there is a significant difference (DF = 18, CMIN 94.23, p = .000) between the models when company size is considered.

This result prompted a more in-depth analysis to reveal the relationship between supplier collaboration practices and supply resilience dimensions. To do this, the parameter constraints for exclusive relationships (e.g., between information sharing and supply chain flexibility) were retained, while all others were deleted from the parameter constraints list to capture specific relationships tested. For medium firms, the findings reveal that on the relationships between all supplier collaboration practices and flexibility, all relationships were insignificant except information sharing. Supplier collaboration practices and

visibility proved insignificant across all relationships. This was also the case with supplier collaboration and velocity.

The reverse was found in the relationships between supplier collaboration practices and flexibility, visibility, and velocity among big firms. The results show that supplier collaboration practices all had significant relationships with flexibility, visibility and velocity. The findings of the multigroup analysis prompt the acceptance of H4 which states that the relationship between supplier collaboration and supply flexibility, visibility and velocity are significantly different among medium and big firms.

5. DISCUSSION OF FINDING

The study revealed that supply collaboration had positive and significant effects on supply chain disruption recovery. Supply collaboration was measured by information sharing, joint decision-making, joint planning, and resource sharing. The first hypothesis tested supply collaboration and supply chain visibility, and the result was significantly positive. This is in line with the findings of Scholten and Schilder (2015), and Botes et al. (2017) who found significant relationships between supplier collaboration and visibility. The second hypothesis tested supplier collaboration and supply chain flexibility. The finding revealed that supplier collaboration is a reliable predictor of supply chain flexibility. This finding aligns with other studies, such as Scholten and Schilder (2015), and Gu et al. (2021) where collaboration efforts lead to improvement in supply chain flexibility; among other things. The final hypothesis of this study was to test the effect of supplier collaboration on supply chain velocity. The final hypothesis equally had positive significant results, aligning with studies like Botes et al. (2017) and Chen et al. (2019) who opined that supplier collaboration was a great way forward for firms who pursue supply chain resilience.

The findings of the study also present an interesting angle to research in supply chain disruption recovery and resilience, as it presents the individual effect of supplier collaboration constructs on resilience, which is lacking in prior research, such as Scholten and Schilder (2015) and Botes et al. (2017). Prior studies did not empirically establish which constructs deserved the most investment to yield the best results in the supply chain resilience quest. The study reveals that among all constructs used in measuring supplier collaboration, the most influential construct was resource sharing, with a 25.3 percent effect on supply chain disruption recovery holistically. The next influential constructs were information sharing (25 percent), joint planning (21.6 percent), and joint decision making having the least effect on supply chain disruption recovery with 2.4 percent. This supports the findings of Li et al. (2017) and Chen et al. (2019), as both studies established the critical role information sharing among collaborators in the supply chain played in the actualisation of swift disruption recovery.

Another interesting aspect of the findings of this study is that though the study shows a significant relationship holistically when considering firm size categories as a moderation, there is a significant difference in the interaction between the variables under study. The study reveals that when the medium-scale firms are isolated to investigate the relationship, it exhibits no significant relationship between all supplier collaboration practices and supply chain visibility and velocity. However, when examining supplier collaboration and supply chain flexibility (among medium firms alone), information sharing had a significant relationship with it, while all other supplier collaboration practices had no significant effect on supply chain flexibility. On the contrary, when testing big firms in

isolation, supplier collaboration practices retain significant effects on supply chain visibility, flexibility and velocity. This is a very interesting finding worth further investigation.

Overall, the finding of the study indicates a significant relationship between supplier collaboration and supply chain disruption recovery. This is evident in the effect of supplier collaboration on all the dimensions of supply chain disruption recovery adopted in the study. The study result highlights the relevance of the theory of constraint to the business environment, especially in the relationship between focal firms and suppliers. Constraint theory encourages business managers to see suppliers as part of a broader system essential to their performance, rather than see them as easily dispensable sources of input. Because, on one hand, the suppliers are capable of posing major constraints to production processes, and, on the other hand, capable of improving the resilience and overall organisational performance significantly. Thus, collaboration efforts must be intensified to minimise constraints and reap the benefits of collaboration practices such as a resilient supply chain simultaneously.

6. CONCLUSION

The focus of this study was to assess the role of supplier collaboration on the supply chain resilience of manufacturing firms. Three main hypotheses were tested and the results were all significant and positive. The study concludes that supplier collaboration had a significant effect on supply chain visibility, supply chain flexibility, and supply chain velocity.

The study makes valid contributions to the understanding of supply chain resilience from an African perspective. The literature on supply chain resilience is concentrated on developed economies and a few on developing economies. This study highlights the Nigerian and by extension, West-African perspective to supply chain resilience, as it reveals that supplier collaboration affects the flexibility, visibility and velocity of supply chains to enable resilience. Nigeria being the biggest economy in West-Africa to some extent reflects the sub region in the relationship between business concepts because the peculiarities among the countries (in the sub region) in business are similar. The study also establishes that supplier collaboration had the most effect on supply chain flexibility. The study reveals that resource sharing and information sharing had the most effect on the resilience of manufacturing firms. Prior studies conducted on resilience were not explicit on which parameter under supplier collaboration had the most effect on supply chain resilience. In addition, and more interestingly, the study reveals that among medium-scale firms, supplier collaboration practices did not affect supply chain visibility and supply chain velocity. Though there is a significant relationship between information sharing and supply chain flexibility, all other practices of supplier collaboration did not affect supply chain flexibility.

The relevance of this study to industry practitioners is that manufacturing organisations that intend to pursue a resilient supply chain to quickly and swiftly recover from disruptions can implement supplier collaboration strategies to achieve this feat. But more importantly, the focus must be on optimising resource sharing and information sharing to have the most resilient supply chains. As suggested by Gu et al. (2021), conscious efforts must be made in the acquisition of IT infrastructure to enable information sharing in real-time to aid the visibility and flexibility of supply chains to recover from disruption. Information such as product germane ingredients, inventory levels, demand predictions, point-of-sale data,

changing preferences in customer taste and feedback, as well as predicted disruptions are all critical information to be shared among supply chain members to facilitate flexibility, visibility, and velocity across the chain. Resource in terms of human capital and equipment can be shared by partner firms to achieve the overall objective of customer satisfaction. Tangible assets such as buildings, superior technology, and facility sharing greatly influence supply chain performance (Cao et al., 2010; Kumar, Banerjee 2012), they are significantly related to supply chain visibility (Maghsoudi, Pazirandeh, 2016), therefore, manufacturing supply chain members must imbibe the culture of resource sharing if resilience is the goal. Medium-scale manufacturers should focus more on enhancing information-sharing capacities between them and their supply chain partners because all other practices did not affect resilience measurement constructs.

Despite the contributions of this study, it does hold some limitations. First, the study focuses on a network of focal firms and suppliers. Further studies should endeavour to expand its scope to capture multiple supply networks, perhaps, two or three focal firms and their suppliers. Further studies could also research the intricacies of second-tier suppliers of a manufacturing firm, and how these supplier collaboration strategies affect resilience when they are considered. The study is also limited to manufacturing firms in Lagos. Further studies could investigate manufacturing firms outside the economic capital of the nation, and or outside the food and beverage industry. Finally, future studies are encouraged to further explore the impact of different business sizes on the relationship outcomes in supplier collaboration and disruption recovery context.

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