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Modelling the importance of collaborative culture and its dimensions for supply chain collaboration: a necessary condition analysis

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Abstract

Purpose – This paper assumes necessity rather than sufficiency logic to model the relationship between collaborative culture and supply chain collaboration as triangular rather than linear. Specifically, this study aims to determine whether overall collaborative culture and its dimensions (i.e. collectivism, long-term orientation, power symmetry and uncertainty avoidance) are necessary for supply chain collaboration and the minimum levels of overall collaborative culture and its dimensions that are required for high levels of supply chain collaboration.

Design/methodology/approach – Based on the literature, collaborative culture and its four dimensions, namely, collectivism, long-term orientation, power symmetry and uncertainty avoidance, were modelled as conditions having supply chain collaboration as their outcome. The study used the necessary condition analysis to test the triangular relationships between the conditions and the outcome among a sample of firms ($N = 166$) in the downstream petroleum sector.

Findings – The results revealed that collaborative culture and its dimensions are necessary conditions for supply chain collaboration, and that high levels of collaboration are possible, although not guaranteed when at least a basic level of collaborative culture or its dimensions are present. Hence, different levels of supply chain collaboration require firms to have different levels of collectivism, long-term orientation, power symmetry and uncertainty avoidance. Thus, at 30% supply chain collaboration, only overall collaborative culture is necessary.

Research limitations/implications – A significant limitation of this research is that, although several antecedents of supply chain collaboration exist, this study explored only the cultural antecedents of supply chain collaboration.

Practical implications – The dimensions of collaborative culture are necessary but not sufficient for supply chain collaboration. Therefore, managers should adopt a holistic approach to investment in a collaborative culture, as an over-investment in any of the dimensions may not compensate for an under-investment in the others.

Originality/value – As one of the first studies to use necessity rather than sufficiency logic to test the relationship between collaborative culture and supply chain collaboration, this research unearthed the non-linear (triangular) relationship between the constructs. It contributes to understanding how

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collaborative culture and its dimensions serve as bottleneck conditions constraining supply chain collaboration.

Keywords Collectivism, Long-term orientation, Power symmetry, Uncertainty avoidance, Supply chain collaboration, Necessary condition analysis, Ghana

Paper type Research paper

1. Introduction

Supply chain collaboration, "a long-term partnership process in which supply chain partners work closely together to achieve common goals and mutual benefits" (Cao & Zhang, 2013, p. 57), is one of the critical determinants of performance in buyer–supplier relationships. It is "key to performance advances that result in sustainable competitive advantage, which subsequently leads to economic development" (Acquah, 2020, p. 1). Leveraging the resources and capabilities of both upstream and downstream supply chain partners is required for competitive advantage and success in a hypercompetitive and dynamic business environment (Acquah, 2020; Sihite, Poltak, Hidayat, & Sijabat, 2022; Fawcett et al., 2012). Successful supply chain collaborations are characterised by sharing resources, risk, information and joint decision-making for a robust response to changing customer requirements (Fawcett et al., 2015; Nauman et al., 2022). Through collaboration, supply chain partners gain access to complementary resources and build capabilities that enhance productivity, competitiveness and profitability (Acquah, 2020; Rachmawati & Salendu, 2022). Accordingly, managing supply chain flows through risk sharing and effective information sharing is critical and depends on effective supply chain relationships (Shehzad et al., 2021). Although several drivers of supply chain collaboration exist, the role of collaborative culture as a key organisational context in understanding this phenomenon cannot be overemphasised (Kumar et al., 2021). Collaborative culture has been identified as a potential precursor of supply chain collaboration in buyer–supplier relationships. Previous studies (Cao & Zhang, 2013; Zhang & Cao, 2018; Kumar et al., 2016) have established direct relationships between collaborative culture and supply chain collaboration, while others (Acquah, 2020; Acquah, Naude, & Sendra-García, 2021a, 2021b) have also demonstrated a direct link between the dimensions of collaborative culture and supply chain collaboration.

The established nexuses between collaborative culture (including its dimensions) and supply chain collaboration raise the question of whether certain levels of collaborative culture are needed for supply chain collaboration in buyer–supplier relationships (Nguyen et al., 2022; Le, 2021; Khairuddin et al., 2021). Theoretically, as culture is viewed as a resource that enables supply chain collaboration, some degree of collaborative culture is necessary to build stronger buyer–supplier relationships (Luther et al., 2017; Porcu et al., 2020; Wright et al., 2022). Thus, collaborative culture may be necessary but not sufficient for supply chain collaboration.

Notwithstanding, prior research relied mainly on traditional statistical tools such as SEM, focusing exclusively on the net effects of collaborative culture on supply chain collaboration and testing how collaborative culture (Cao & Zhang, 2013) or its dimensions (Acquah et al., 2021a, 2021b) predict or drive supply chain collaboration. The linear approach does not allow for uncovering the necessary collaborative cultural antecedents (both in kind and degree) for successful supply chain collaborations. This type of thinking stems from one aspect of causality, *sufficiency logic*, wherein a sufficient cause (e.g. a dimension of collaborative culture) produces the outcome (e.g. supply chain collaboration) and ignores the other aspect of causality, *necessity logic*, wherein a necessary cause (e.g. a

dimension of collaborative culture) allows the outcome (e.g. supply chain collaboration) to exist (Dul, 2016; Van der Valk et al., 2016).

To this end, using necessity logic to study the relationship between culture and collaboration, and therefore modelling a triangular rather than a linear relationship, this study offers valuable contributions to theory and practice. Accordingly, this study sought to determine whether overall collaborative culture is necessary for supply chain collaboration, the minimum level of overall collaborative culture that is required for high levels of supply chain collaboration, whether dimensions of collaborative culture, comprising, collectivism, long-term orientation, power symmetry and uncertainty avoidance are necessary for supply chain collaboration and the minimum levels of these dimensions required for high levels of supply chain collaboration. Consequently, the study addressed the following research questions:

RQ1a. What level of overall collaborative culture is necessary for supply chain collaboration?

RQ1b. What minimum level of overall collaborative culture is required for high levels of supply chain collaboration?

RQ2a. What dimensions of collaborative culture are necessary for supply chain collaboration?

RQ2b. What minimum levels of these dimensions of culture are required for high levels of supply chain collaboration?

In addressing these research questions, this study used a new statistical approach, necessary condition analysis (NCA) (Dul, 2016), to assess whether collaborative culture and its four dimensions are necessary for supply chain collaboration. Moreover, for a nuanced interpretation and actionable insight, this study explored the required level of collaborative culture and its dimensions necessary for high supply chain collaboration levels.

Overall, the findings of this paper offer theoretical and managerial implications for researchers and businesses. Theoretically, the study provides new knowledge to the literature by supporting the operationalisations of collaborative culture and its dimension as necessary ingredients for supply chain collaboration. More specifically, this study highlights the bottleneck roles collectivism, long-term orientation, power symmetry and uncertainty avoidance play in constraining supply chain collaboration and indicating the level at which each becomes necessary for supply chain collaboration.

The subsequent sections of the paper are organised along these lines: Section 2 (theoretical background, concepts and hypotheses) provides a brief overview of the study's theoretical underpinnings and literature on the dimensions of collaborative culture and supply chain collaboration whiles describing the relationships between the constructs. Section 3 (method, sample and procedure) outlines the research design, measures and data collection procedures. Subsequently, the results are presented in Section 4 (results). Section 5 (discussions) provides the discussions on the results of the study, whiles the limitations and future research suggestions, as well as conclusions are presented in Section 6 (limitations and future research) and Section 7 (conclusions) respectively.

2. Theoretical background, concepts and hypothesis

2.1 Theoretical background

According to the resource-based theory (RBT), firms are a collection of resources and capabilities (Tho, 2018). These resources differ from firm to firm. Hence, to be successful, a resource-based approach to strategy is encouraged as the uniqueness of a firm's resources

drives superior performance. For resources to be unique, they do not only have to be rare and inimitable but also non-substitutable and value-adding (Tho, 2018). Inter-firm relationships are the means through which firms gain access to resources outside the firm. Therefore, this study, like prior ones (Acquah et al., 2021a, 2021b; Acquah, 2020), uses the RBT to explain the necessary condition relationship between collaborative culture and supply chain collaboration.

2.2 Concepts

This section discusses the various concepts that have been used in the study. This includes collaborative culture and its dimensions: collectivism, long-term orientation, power symmetry and uncertainty avoidance and supply chain collaboration. Whereas, collaborative culture and its dimensions are discussed in Section 2.2.1, supply chain collaboration is discussed in Section 2.2.2.

2.2.1 Collaborative culture and its dimensions. Organisational culture refers to the pattern of shared values and beliefs that help individuals understand how organisations function, which then becomes the foundation for the organisation's norms and way of life (Kumar et al., 2017). Hence, it is the norms that organisations develop from their experiences in dealing with their environmental challenges (Nikol'chenko & Lebedeva, 2017; Acquah, 2020; Sihite et al., 2022). A firm's collaborative culture comprises "collectivism, long-term orientation, uncertainty avoidance, and power symmetry – which denote firm-level equivalents of national cultural dimensions of Hofstede (1991)" (Cao & Zhang, 2013, p. 41).

Collectivism refers to "the component of collaborative culture denoting the degree to which an organisation embraces a collective rather than an individualistic consciousness when dealing with supply chain members" (Acquah, 2020, p. 244). Collectivists treasure communal characteristics and emphasise collective and shared efforts towards collaboration (Seo et al., 2016; Yılmaz & Pardalos, 2017; Kumar et al., 2021). In addition, collectivism refers to how supply chain partners support cooperatives instead of having an individualistic approach to dealing with their partners (Kumar et al., 2016).

Long-term orientation refers to "the degree to which supply chain partners are desirous of exercising their efforts to build lasting relationships with supply chain members" (Acquah et al., 2021a, 2021b, p. 244). Hence, it constitutes the limit to which supply chain partners are interested and motivated to work towards long-term relationships with their partners (Van Dijk, 2016; Nguyen et al., 2022). It signifies firms' willingness and commitment to building long-lasting inter-organisational relationships that inure to the benefit of all parties (Seo et al., 2016; Khairuddin et al., 2021).

Power symmetry denotes "The extent to which a firm believes that supply chain partners should have an equal say in their relationships" (Cao & Zhang, 2013, p. 41). Power symmetry measures how supply chain members believe in the balance of power and influence in supply chain relationships. Supply chain relationships, characterised by unequal power distribution and influence among collaborative partners, are described as having a high power distance (Lei et al., 2017; Le, 2021). However, these supply chain relationships with a balance of power among partners are described as having a low power distance (Van Dijk, 2016).

Uncertainty avoidance, signifies "the extent to which a firm feels threatened by and tries to evade ambiguous situations in the supply chain" (Zhang & Cao, 2018, p. 149). It denotes how collaborative partners seek to eschew ambiguity and vagueness in their relationships with other supply chain members (Seo et al., 2016; Villena-Manzanares et al., 2020; Porcu et al., 2020; Le, 2021). Hence, Kumar and Rahman (2015) suggest that supply chain members faced with high levels of ambiguity and unpredictability turn to inter-organisational relationships for solace.

2.2.2 Supply chain collaboration. *Supply chain collaboration* signifies "a long-term partnership process where supply chain partners work closely together to achieve common goals and mutual benefits" (Cao & Zhang, 2013, p. 58). Each company belongs to a supply chain, whether known or unknown (Shehzad et al., 2022). Furthermore, supply chains involve diverse players with varied interests that require management (Wright et al., 2022). As a result, supply chain partners must work towards the common goal to benefit the entire supply chain (Ralston et al., 2017).

2.3 Collaborative culture and its dimensions as necessary conditions

Prior researchers (Acquah et al., 2021a, 2021b), using sufficiency logic, suggest that collaborative culture and its dimensions ("collectivism, long-term orientation, power symmetry, and uncertainty avoidance") are sufficient conditions for supply chain collaboration. However, ascertaining the dimensions necessary for supply chain collaboration, as well as the necessary levels of these dimensions, is equally important. Accordingly, if the necessary level of a cultural dimension is not in place, supply chain collaboration will fail. Prior research showed a positive link between culture and collaboration, ranging from weak to very strong correlation (Kumar et al., 2016; Ramjaun et al., 2022). Even though supply chain collaboration is usually associated with collaborative culture and its dimensions (Kumar et al., 2016; Acquah et al., 2021b), it can exist without it. The choice of necessity logic for this study is in line with recent studies that have used it in examining sophisticated phenomena such as advertising irritation (Sharma et al., 2022), sense of power and self-efficacy (Korman, 2022) and impulsive consumption (Yu, Cheah, & Liu, 2022). Consequently, this study proposes that collaborative culture and its dimensions consisting of collectivism, long-term orientation, power symmetry and uncertainty avoidance are necessary (at different levels) but not sufficient for successful supply chain collaboration. Figure 1 is a conceptual model displaying the proposed necessity relationships between collaborative culture, its dimensions and supply chain collaboration.

3. Method, sample and procedure

3.1 Necessary condition analysis

Even though necessity logic has not been used in the social sciences, its existence can be traced to several centuries ago (Dul, 2016; Kumar, 2021). Similarly, necessity logic underpins the theory of constraints (Goldratt & Cox, 1984; Kumar, 2021). Accordingly, this study views the nexus between culture and collaboration from a lens similar to the theory of constraints by identifying the most critical dimension of collaborative culture that limit supply chain collaboration. In recent times, researchers assert that analysis tools anchored on sufficiency thinking, such as multiple regression (Sharma, Dwivedi, Mariani, & Islam, 2022; Jaiswal & Zane, 2022), structural equation modelling (Lee et al., 2022; Lee & Jeong, 2021) and PLS-SEM (Yu et al., 2022; Pinochet et al., 2022), are not enough in unearthing the nuanced relationships between conditions and outcomes. Hence, to ascertain the level of necessity of collaborative culture and its dimensions, this study used NCA (Dul, 2016). In NCA, effect size signifies the degree of constraints that the ceiling line places on the outcome of interest and determines the level of the necessary condition.

3.2 Sample and procedure

Data were collected from 166 firms in Ghana's downstream petroleum sectors using the key informant approach. The sample comprises 99 oil marketing companies, 30 bulk distribution companies and 37 LPG marketing companies. Regarding the sex of the respondents, 101 were male. The females were 65. While 56% of the respondents had master's degrees, 37% had bachelor's degrees; 2.4, 4.2 and 0.6% had a certificate, HND and PhD, respectively. Ten supply

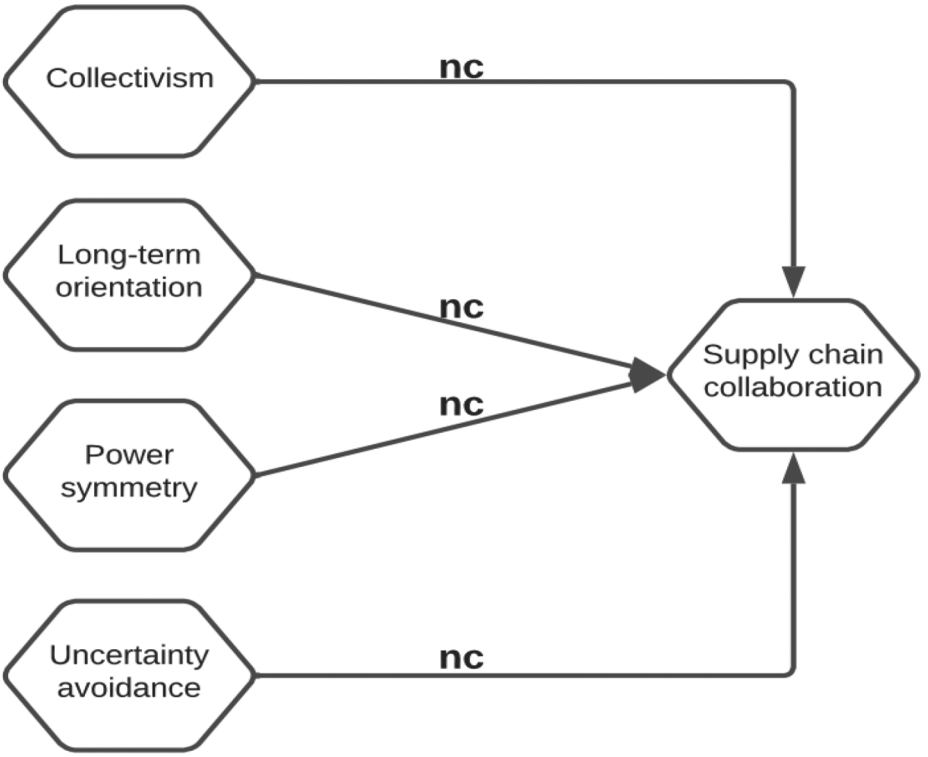

Figure 1.
Conceptual framework

Note: nc = necessary condition
Source: The author

chain experts from academia confirmed the validity, clarity and reliability of the scales and constructs through email. Other ten copies of the questionnaires were sent to experts from the industry to comment on the suitability and practicality of the constructs and measurement items. The expert feedback was incorporated into the development of the draft, which was then sent to 20 potential respondents to test the questionnaires' validity, clarity, reliability and practicality. Relevant comments from the pilot test were considered in the final draft of the questionnaire.

3.3 Measures

3.3.1 Conditions. The study operationalised collaborative culture and its four dimensions as its conditions. All conditions were measured with four items, each adapted from Cao and Zhang (2013) on a seven-point Likert scale that ranges from (1) strongly disagree to (7) strongly agree. Sample items include *collectivism*: "we consider it as normal to try to cooperate as much as possible"; *long-term orientation*: "we are willing to make specific investments for long-term relationships"; *power symmetry*: "believe that firms in the supply chain that are in a powerful position should have more to say in their relationships than their partners"; and *uncertainty avoidance*: "we go to great lengths to avoid unclear and ambiguous situations in our supply".

3.3.2 Outcome. Supply chain collaboration was operationalised as the outcome construct in this study. *Supply chain collaboration (SCC construct)* consists of 30 items, measuring eight dimensions adapted from Cao and Zhang (2013) and Piboonrungroj (2012):

(1) joint activities (e.g., "we have a joint team");
(2) information, risk and resource sharing (e.g. "share any risks that can occur in the supply chain");
(3) decision synchronisation (e.g. "we jointly develop demand forecasts");
(4) sharing intangibles (e.g. "both dedicate personnel to manage the collaborative processes");
(5) joint knowledge creation (e.g. "we jointly search and acquire new and relevant knowledge");
(6) collaborative communication (e.g. "we have open and two-way communication");
(7) synchronised performance management (e.g. "we work together to improve supply chain performance"); and
(8) goal congruence (e.g. "we agree on the importance of collaboration across the supply chain")

All items were measured on a seven-point Likert scale, ranging from (1) strongly disagree to (7) strongly agree.

3.4 Analysis strategy

This study modelled overall collaborative culture and its dimensions as conditions that are necessary but not sufficient for supply chain collaboration. The NCA was used because it helps to identify the "degree to which a condition is necessary (but not sufficient) for an outcome" (Dul, 2016). To determine the degree of necessity, NCA ascertains the ceiling line using two common ceiling techniques, namely, the ceiling envelopment technique with a free disposal hull and the ceiling regression technique with a free disposal hull, hereinafter referred to as CE-FDH and CR-FDH, respectively (Dul, 2016; Tho, 2018, 2019). Table 1 presents the descriptive statistics of the study.

4. Results

4.1 Effect size and significance testing

For the effect size analysis, the study assessed the effect sizes (d) of all conditions and outcomes by examining their statistical significance (Dul, 2016). For a condition to be considered necessary, three criteria have to be met:

(1) there must be theoretical justification;
(2) the effect size (d) must be greater than zero; and
(3) the p-value should be less than (0.05) (Dul, 2016).

Table 2 presents each ceiling line's associated effect size, accuracy and zones. Table 2 shows that the CE and CR lines' results are similar. Accordingly, only the results for the CR line are discussed. The results (Table 2) suggest that collaborative culture and its four dimensions satisfy these requirements (Dul, 2016). For the CR technique shown in Table 2, the effect size for the conditions ranges from 0.218 to 0.326, while the ceiling accuracy ranges from 94.6% to 97.6%. The ceiling zone also ranged from 3.959 to 7.460.

Table 1.
Descriptive statistics

Construct	Scale minimum	Empirical minimum	Scale maximum	Empirical maximum	Mean	STD	1	2	3	4	5	6
Collaborative culture	1	2.812	7	7.000	5.054	0.901	*(0.771)*					
Collectivism	1	2.250	7	6.771	5.125	1.190	0.751	*(0.872)*				
Long-term orientation	1	1.750	7	7.000	5.378	0.995	0.826	0.611	*(0.816)*			
Power symmetry	1	1.000	7	7.000	4.839	1.275	0.745	0.289	0.500	*(0.801)*		
Uncertainty avoidance	1	1.500	7	7.000	5.194	1.181	0.793	0.457	0.522	0.480	*(0.871)*	
Supply chain collaboration	1	3.063	7	6.771	4.877	0.877	0.649	0.389	0.566	0.575	0.490	*(0.862)*

Notes: Italic values in parentheses = Cronbach's alpha for each construct; off diagonals are correlations amongst the constructs
Source: The author

Construct	Method	Accuracy (%)	Ceiling zone	Scope	Effect size (d)	*p*-value	Condition inefficiency	Outcome inefficiency
Collaborative culture	CE-FDH	100	4.979	15.528	0.321	0.000	10.448	0.000
	CR-FDH	89.2	5.197	15.528	0.335	0.000	15.229	21.037
Collectivism	CE-FDH	100	4.152	17.744	0.234	0.000	4.211	50.686
	CR-FDH	95.8	3.959	17.744	0.223	0.000	0.000	58.286
Long-term orientation	CE-FDH	100	0.355	22.884	0.355	0.000	8.774	44.908
	CR-FDH	94.6	0.326	22.884	0.326	0.000	0.000	39.206
Power symmetry	CE-FDH	100	5.343	20.716	0.258	0.000	16.667	47.558
	CR-FDH	97.6	4.511	20.716	0.218	0.011	7.276	53.030
Uncertainty avoidance	CE-FDH	100	5.690	19.933	0.285	0.000	18.286	49.414
	CR-FDH	97.0	5.032	19.933	0.252	0.000	0.000	50.628

Notes: [a] $0 < d < 0.1$ = small effect; $0.1 \leq d < 0.3$ = medium effect; $0.3 \leq d < 0.5$ = large effect; $d \geq 0.5$ = very large effect
Source: The author

Table 2.
Results of NCA

4.2 Necessary condition analysis

The scatter plots for supply chain collaboration versus collaborative culture and its dimensions are shown in Figure 2. The empty spaces in the upper-left corners of each plot suggest the likely presence of necessary conditions between the outcome (i.e. supply chain collaboration) and the conditions (i.e. collaborative culture and its dimensions). The scatter plots also display three distinct ceiling lines: ordinary least squares (OLS), CE-FDH and CR-FDH. Both CE-FDH and CR-FDH used only observations close to the ceiling zone. Hence, while CE-FDH is a pairwise linear line, CR-FDH is a continuous linear line because the higher the accuracy, the smaller the ceiling zone and CE-FDH produces smaller ceiling zones. This study used CR-FDH for the following reasons: firstly, it improves the CE-FDH and hence has fewer limitations. Secondly, it is the default technique for parametric data. Lastly, it is less sensitive to outliers and measurement errors (Dul, 2016; Shahjehan & Qureshi, 2019).

Firstly, we assessed the accuracy, representing the number of observations above the ceiling line. For supply chain collaboration against the dimensions of culture, accuracy ranges from 94.6 to 97.6, signifying high accuracy and the presence of the necessary condition. In addition, ceiling zones represent the empty spaces at the top-left corner of the scatter plots for collaborative culture and each of its four dimensions, ranging from 0.326 to 5.690, while the ceiling scope also ranges from 17.744 to 22.884. Furthermore, the effect sizes denoting the ceiling zone divided by the scope also ranged from 0.218 to 0.355 (Table 2). Hence, based on the criteria proposed by Dul (2016), effect sizes for collectivism ($d = 0.223$), power symmetry ($d = 0.218$) and uncertainty avoidance ($d = 0.252$) are deemed to be medium, whereas those for long-term orientation($d = 0.326$) and collaborative culture ($d = 0.335$) represent large effect sizes. Moreover, the results (Table 2) show condition inefficiency ranging from 0.000 to 15.229. This means that a collectivism level of 100%, long-term orientation level of 100%, power symmetry level of 92.724% and uncertainty avoidance level of 100% are not necessary for achieving even the highest level of supply chain collaboration.

More specifically, the scatter plot [Figure 2(a)], describing the effect of overall collaborative culture on supply chain collaboration, contains an empty space in the upper-left corner of all ceiling lines, implying the presence of a necessary condition. Moreover, the effect size of this condition was 0.335 (large effect). The ceiling lines and bottleneck table suggest that high levels of supply chain collaboration were only possible with an overall

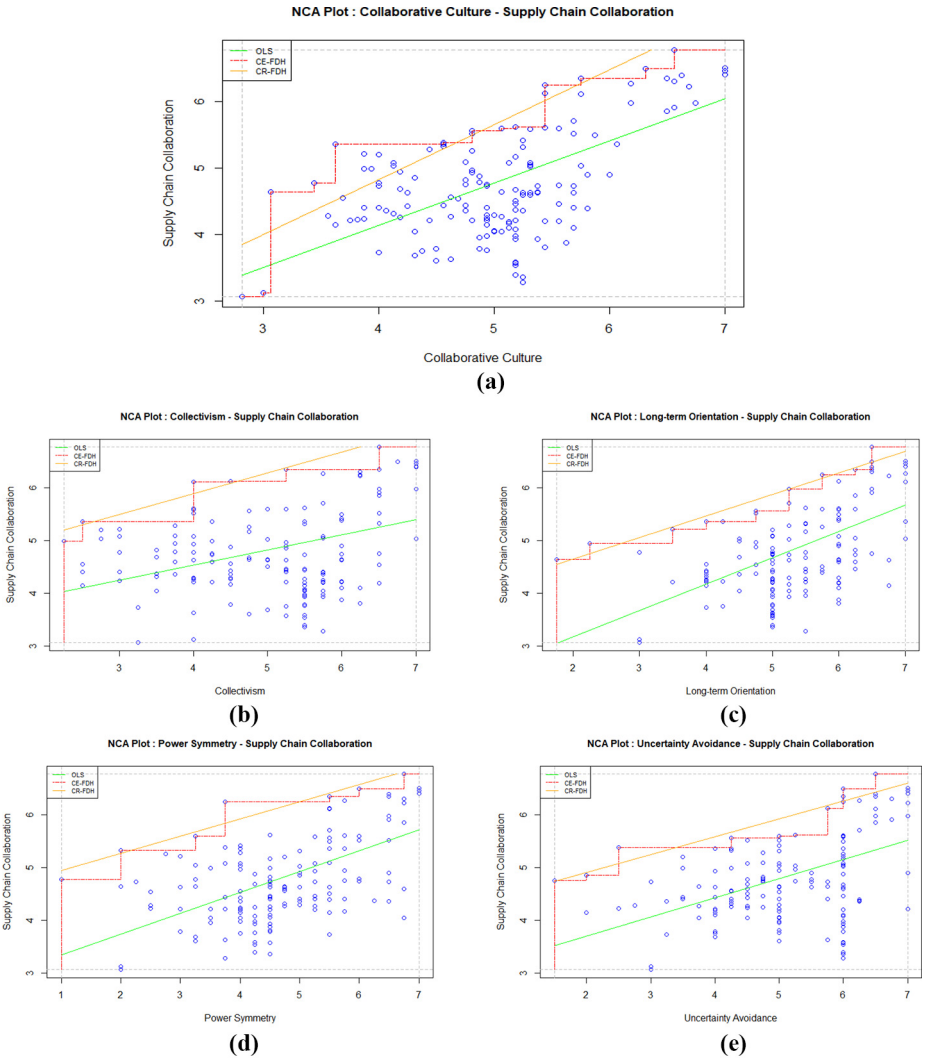

Figure 2.
Scatter plots for collaborative culture, its dimensions and supply chain collaboration

Source: The author

collaborative culture score of 63.3 and above. Nevertheless, granting this collaborative culture score is necessary to achieve higher supply chain collaboration, and it is not sufficient for high supply chain collaboration. In other words, without this level of collaborative culture, a high level of supply chain collaboration is guaranteed not to occur, although the presence of this level of collaborative culture does not guarantee high levels of supply chain collaboration. Accordingly, a collaborative culture score of 63.3% and above makes the occurrence of supply chain collaboration possible but does not necessarily guarantee high supply chain collaboration.

To ascertain the necessity of the dimensions of collaborative culture for supply chain collaboration, researchers conducted an NCA for each of the four cultural dimensions. Scatter plots (Figure 2) for collaborative culture [Figure 2(a)], collectivism [Figure 2(b)], long-term orientation [Figure 2(c)], power symmetry [Figure 2(d)] and uncertainty avoidance [Figure 2(e)] revealed the presence of a necessary condition. These findings are consistent with the effect sizes for collectivism (d = 0.223), long-term orientation (d = 0.326), power symmetry (d = 0.218) and uncertainty avoidance (d = 0.252). The bottleneck table (Table 3) suggests that for a high level of supply chain collaboration to be possible, minimum levels of 44.6, 69.1, 55.4 and 69.5 for collectivism, long-term orientation, power symmetry and uncertainty avoidance, respectively, are necessary. Nonetheless, akin to the overall collaborative culture, these levels are necessary but not sufficient for high levels of supply chain collaboration.

4.3 Bottleneck analysis

The NCA results with the CR-FDH bottleneck are presented in Table 3, wherein the levels of collaborative culture and its dimensions necessary for the desired level of supply chain collaboration were ascertained through the bottleneck stated as a percentage of the range of observed values, where 0% denotes the lowest value with 100% denoting the highest value (Dul, 2016; Tho, 2019). A critical assessment of NCA results (Table 3) suggests that all conditions (i.e. collaborative culture and its four dimensions) display different necessary levels for supply chain collaboration. In summary, the NCA shows that all dimensions of culture are necessary for supply chain collaboration.

After the effect size analysis, the study performed a bottleneck analysis (Table 3). For the desired outcome construct (supply chain collaboration) in the first column, Table 3 shows the minimum values required for each condition construct in the following columns. From the results (Table 3), for a medium-to-high level of supply chain collaboration (30%–80%), the necessary level of collectivism must be at least 5.0%, while for 40%–80% of supply chain collaboration, long-term orientation must be at least 17.1%. Further, at 60%–80% of supply chain collaboration, power symmetry must be at least 17.4%, whereas, at 50%–80% of supply chain collaboration,

Y Supply chain collaboration (%)	X_1 Collaborative culture: NC from 21.037%	X_2 Collectivism: NC from 58.3%	X_3 Long-term orientation: NC from 39.2%	X_4 Power symmetry: NC from 53.0%	X_5 Uncertainty avoidance: NC from 50.5
0	NN	NN	NN	NN	NN
10	NN	NN	NN	NN	NN
20	NN	NN	NN	NN	NN
30	9.6	NN	NN	NN	NN
40	20.4	NN	NN	NN	NN
50	31.1	NN	17.1	NN	9.9
60	41.8	5.0	34.4	17.4	29.7
70	52.6	24.8	51.7	36.4	49.6
80	63.3	44.6	69.1	55.4	69.5
90	74.0	64.4	86.4	74.3	89.4
100	84.8	84.2	NA	93.3	NA

Source: The author

Table 3. Bottleneck levels (in percentages) using CR-FDH (NN = not necessary)

uncertainty avoidance must be at least 9.9%. However, for a very high level of supply chain collaboration (i.e. 90%–100%), collaborative culture should be 84.8%, whilst collectivism, long-term orientation, power symmetry and uncertainty avoidance levels should be at least 64.4, 86.4, 74.3 and 89.4%, respectively.

Lastly, Table 3 also represents the threshold for the four dimensions of culture that are necessary to achieve the desired level of supply chain collaboration. This study, in line with Dul (2016) and Shahjehan & Qureshi (2019), categorises the desired level of supply chain collaboration into three distinct levels: 0%–25%, > 25% < 75% and > 75% represent low, medium and high levels, respectively. None of the cultural dimensions is necessary for low levels (0%–25%) of supply chain collaboration. On the other hand, all four dimensions of culture become necessary for the medium level (25%–75%) of supply chain collaboration. Accordingly, for a high level (above 75%) of supply chain collaboration, all four dimensions of culture are also necessary. For instance, the results show that 40% of the desired level of supply chain collaboration requires at least 1.4% collaborative culture.

5. Discussions

This paper identifies collaborative culture and its dimensions as constraints for successful supply chain collaboration. Collectivism had a medium and significant effect size on supply chain collaboration. This finding concurs with prior studies (Kucharska & Kowalczyk, 2016; Lei et al., 2017; Acquah et al., 2021a), where collectivism was observed to relate to collaboration in buyer–supplier relationships. The findings also showed that long-term orientation had a medium but significant effect size on supply chain collaboration. This finding implies building collaborative culture where supply chain partners expect their relationship to be for the long term, believe in the value of the relationship and trust the partnership's ability to smooth out all short-term imbalances in the long term. This result aligns with prior studies (Kumar et al., 2016; Acquah et al., 2021b), where long-term orientation was observed to relate to collaboration in buyer–supplier relationships.

The results further revealed that power symmetry had a medium but significant effect size on supply chain collaboration. This implies building a collaborative culture where supply chain members believe that supply chain partners exert the same influence on each other and have the view that powerful firms within the supply chain should satisfy the less powerful firms in collaborative relationships. This result is in line with prior studies (Kumar et al., 2016; Acquah et al., 2021b; Ramjaun, Rodrigues, & Kumar, 2022) that established a positive link between power symmetry collaboration in buyer–supplier relationships. Accordingly, uncertainty avoidance also had a medium but significant effect size on supply chain collaboration. This implies building a collaborative culture where supply chain partners strive to prevent ambiguous and risky situations that threaten the supply chain's survival, as well as going the extra mile to eliminate uncertain and ambiguous circumstances in the supply chain. This is inconsistent with prior studies (Lei, Le, & Nguyen, 2017; Acquah et al., 2021a) that found a connection between uncertainty avoidance and collaboration in buyer–supplier relationships.

5.1 Theoretical implications

The theoretical implications of this study are twofold. Firstly, the results suggest that within this instant data set, collaborative culture and its dimensions are necessary for both medium and high levels of supply chain collaboration. Furthermore, the findings reveal that different

levels of supply chain collaboration require firms to achieve different threshold levels of collaborative culture and its dimensions. Secondly, the findings suggest that at medium-to-high levels of supply chain collaboration, the four dimensions of collaborative culture act as complements rather than substitutes, as these levels of supply chain collaboration require the presence of all dimensions of culture. This finding advances the existing literature on the combined effects of the dimensions of culture by suggesting that the dimensions of culture jointly allow for supply chain collaboration.

5.2 Managerial implications

From a managerial perspective, this study has two implications. Firstly, it provides an understanding of the necessary conditions for supply chain collaboration, in addition to the required degrees of these conditions. Secondly, the study provides insight for managers regarding the degree to which firms engage in inefficient use of resources. For example, the findings suggest that for lower than desired levels of supply chain collaboration, managers should direct their attention to those cultural dimensions necessary for achieving the preferred or higher level of supply chain collaboration. On the other hand, firms that have over-invested in enhancing the dimensions of culture should redirect resources to other conditions below the required threshold levels to achieve supply chain collaboration (bottlenecks). A summary of research questions, key findings and implications are displayed in Table 4.

6. Limitations and future research

Despite its numerous theoretical and practical contributions, our study has certain limitations that need to be acknowledged. The study used a single respondent in an organisation, which probably creates a common method bias despite the procedures put in place to reduce its impact on the result. Future studies could therefore use multiple respondents in an organisation to reduce the possibility of common method bias. Future studies should consider the mediators or moderators to these relationships. The study was limited to petroleum downstream, affecting the study's generalisability. Future studies could consider the entire petroleum industry or collect data from firms in all industries in Ghana.

7. Conclusions

The value addition of supply chain collaboration in today's dynamic business environment has speared the search for the underlining mechanisms and drivers of supply chain collaboration in buyer–supplier relationships. Prior research has associated high levels of collaborative culture with successful supply chain collaboration (Acquah, 2020). This research determines whether overall collaborative culture and its four dimensions are necessary conditions for the occurrence of supply chain collaboration. Thereafter, if overall collaborative culture and its dimensions are necessary for supply chain collaboration, then the study sought to determine if a minimum threshold of collaborative culture or any of its four dimensions is required for high levels of supply chain collaboration to be possible in the downstream petroleum sector. Consistent with the study's objectives, overall collaborative culture and its dimensions were found to be necessary for supply chain collaboration. Besides, it was also observed that a basic level of overall collaborative culture and its dimensions is required for supply chain collaboration to be possible.

Table 4.
Summary of research questions, key findings and implications

Research question	Key findings	Theoretical implications	Managerial implications
Is collaborative culture necessary but not sufficient for supply chain collaboration?	Collaborative culture is necessary but not sufficient for supply chain collaboration as it becomes necessary from 21% of supply chain collaboration	This study is the first to consider the nexus between collaborative culture and supply chain collaboration from a sufficiency logic perspective by modelling collaborative culture as a necessary condition for supply chain collaboration	For successful supply chain collaboration, firms should pay attention to collaborative cultural behaviour by prioritising the in their investment decisions because collaborative culture is necessary for successful supply chain collaborations
What minimum level of overall collaborative culture is required for low, medium and high levels supply chain collaboration?	For high level of supply chain collaboration (above 79%), low to high levels of collaborative culture (21%–84.8%) is required	This study highlights the bottleneck role of collaborative culture in constraining supply chain collaboration and established the level at which collaborative culture becomes necessary supply chain collaboration	This study provides insight into requirements that firms seeking high levels of collaboration with their supply chain partners must meet with regards to collaborative cultural dimensions
Are the dimensions of collaborative culture (i.e. collectivism, long-term orientation, power symmetry and uncertainty avoidance) necessary for supply chain collaboration?	All dimensions of collaborative culture are necessary but not sufficient for supply chain collaboration from 58.35 (collectivism), 39.2% (long-term orientation), 53% (power symmetry) and 50.5% (uncertainty avoidance)	This study extends the literature on how collectivism, long-term orientation, power symmetry and uncertainty avoidance relate to supply chain collaboration by establishing them as necessary but not sufficient conditions for supply chain collaboration	Firm should make the necessary investment in collectivism, long-term orientation, power symmetry and uncertainty avoidance because they are necessary, albeit not sufficient for successful supply chain collaboration
What minimum levels of these dimensions of culture (i.e. collectivism, long-term orientation, power symmetry and uncertainty avoidance) are required for high levels of supply chain collaboration?	For high supply chain collaboration (above 79%) low to high levels of collectivism (9.6%–84.8%), long-term orientation (34.4%–86.4%), power symmetry (17.4%–93.3%) and uncertainty avoidance (29.7%–89.4%) are required	This study highlights the bottleneck roles collectivism, long-term orientation, power symmetry and uncertainty avoidance play in constraining supply chain collaboration and indicating the level at which each becomes necessary for supply chain collaboration	For higher level of supply chain collaboration managerial attention should target all dimensions of collaborative culture. Firm that that have overinvested some dimensions should refocus their attention other more critical dimensions that act as bottleneck

Source: The author

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