



## Research article

# Necessary condition analysis of organisational capabilities for a resilient service operation in the hotel industry in Ghana

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## ABSTRACT

Resilience in service operation is essential for minimising service failures. Based on a necessity logic, this study sought to examine whether innovation, transparency, flexibility, collaboration and agility are necessary antecedents of resilience in service operations of hotels, and to determine the minimum level of each capability required for optimal level of resilience. A survey of managers of Star-rated hotels in the Greater Accra region of Ghana was conducted. The conditions (agility, transparency, innovation, collaboration and flexibility) and outcome (resilience) variables were operationalised and modelled as necessary determinants of service resilience. Structured questionnaires were administered, from which 167 validated responses were analysed with necessary condition analysis (NCA) package in R. NCA explores necessity relationships both 'in kind' and 'in degree' to identify underlying capabilities and the corresponding levels that must be developed and sustained. The study found innovation, transparency, collaboration, flexibility, and agility to be necessary determinants of service resilience. However, from lower to medium levels of resilience (30%–80%), transparency, collaboration, flexibility, and agility are identified as bottlenecks. Innovation becomes important when higher resilience goals are sought. From a managerial standpoint, this study provides insight into critical antecedents of resilience within service operations. In addition, the study sheds light on the degree of resource allocation appropriate for different levels of firm resilience.

## 1. Introduction

Building capabilities to overcome disruptions is necessary for survival and growth. These capabilities are a product of a multiplicity of organisational resources that have been developed or acquired through internal growth and supply chain interactions. Like most economic sectors, Hotels, as an integral part of the tourism industry, are vulnerable to the effects of natural disasters that limit human mobility [1]. Over the past decades, the hospitality industry in Ghana has played a significant role in the promotion of the country as a historical destination [2]. Nevertheless, evidence from the Ghana Statistical Service COVID-19 Business Tracker shows that firms in the accommodation and food sectors were heavily affected by the disruption. The importance of resilience among supply chains is attributed to the increased market uncertainties both locally and globally, which has shifted the focus of firms from profitability to the quest for resilient organisations [3]. In addition, other global economic risks such as geopolitical tensions and political instability are enough evidence that building resilience into operational processes is necessary for survival.

The hotel supply chain is characterised by different categories of service providers and actors such as suppliers, employees, and consumers, requiring a high degree of interaction among them, which creates the potential for high service failures. Besides, the

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inseparability of production from consumption means that supply chain failures easily travel from the point of supply to the point of consumption, providing little or no opportunity for rework. In addition, hotels are characterised by continuous (24/7) operation with unpredictable demand, which makes service failure more likely than in other industries [4]. Further, as one of the countries with huge tourism potential, the hotel industry operates in a highly competitive marketplace with high customer expectations and lower switching costs [5]. Consequently, it is one of the sectors where competitive advantage is defined by how much resilience a firm possesses.

The existing literature on competitive advantage distinguish among three types of capabilities: first-order capabilities [6], threshold or operational capabilities and higher-order or dynamic capabilities, which is characterised by learning, continuous innovation, reconfiguration [7,8]. The categorisation of capabilities into first and second order form the foundation of an organisation's ability to function even in the face of uncertain business conditions. When an entity faces constraints above what it can accommodate, switching to survival strategies requires distinctive capabilities [7,9]. Although several drivers of supply chain resilience exist, within the context of supply chain discourse, capabilities such as flexibility [10], information exchange and process coordination [11,12], agility [12], risk management culture [13], supply chain visibility [14], supply chain innovation [15], supply chain collaboration [16] and supply chain learning [17] contributes to a firm's operational and dynamic capabilities. According to the resource-based perspective, organisations survive by maintaining acceptable levels of these capabilities.

As posited by the RBV, these capabilities are necessary but not sufficient. According to Ref. [18] "a necessary determinant (such as flexibility, agility, innovation, transparency and collaboration) must be present for achieving an outcome, but its presence is not sufficient for the outcome". This study explores the capabilities as necessary causal conditions [19], because without them, management will fail in their quest to build resilient organisations. On this note, the purpose of the study was to examine whether innovation, transparency, flexibility, collaboration and agility are necessary for organisational resilience, and determine the minimum level of each capability required for optimal level of resilience. Accordingly, the study was guided by the following research questions:

**RQ1.** What dimensions of organisational capabilities are necessary for supply chain resilience?

**RQ2.** What minimum levels of these dimensions are required for an optimal level of resilience?

To address the aforementioned research questions, Necessary Condition Analysis (NCA) [20] was used to investigate the necessity conditions if any present in the dataset. Using the NCA methodology, this study sought to identify capabilities both 'in kind' and 'in degree' that are necessary to respond to and recover from service failures and disruptions effectively. Applying the NCA methodology will advance the understanding of drawing causal inferences and its implications for predictions. Further, this study offers a useful addition to resource-based reasoning by modelling the lower order and operational capabilities as necessary determinants.

The remaining content of the article is organised into the following sections: Section two provides an overview of the theoretical justifications of the study, the conceptual development, and the hypotheses. Section three presents a description of the methods, which includes sampling, operationalisation, and validation of the measurement items and data collection procedures. Section four provides the results, including reliability and validity tests, while Section five focuses on discussion. Section six presents the conclusions, implications of the study, limitations, and directions for future research.

## 2. Literature review

### 2.1. Resilience in the hotel sector

The hospitality sector is extremely vulnerable to both man-made and natural disasters. It is no surprise that there is a growing interest and body of literature on the concept of resilience. Resilience in the hospitality sector has been mostly viewed from a natural disaster perspective and is evidenced by key contributors, such as Ref. [1], towards Disaster Resilience Framework for Hotels (DRFH). The risks emanating from these disasters nevertheless eventually disrupt internal operations. Hence, there is a need to explore capabilities that can be deployed internally to guarantee consistent and reliable service. The rich body of literature on organisational resilience converges on the multifaceted nature of the concept. This view has occasioned diverse perspectives towards definition, conceptualisation, and measurement [21]. In terms of definition, Ref. [22] explains resilience from absorptive and adaptive dimensions. Similarly, Ref. [23] described resilience as either active or passive engagement and adjustment of a system to change. Ref. [24] examine resilience as a process of adaptation and change to a new functional state. Ref. [25] defines resilience from an engineering, ecological, and systems perspective.

Another area of debate that has implications for measurement and modelling is the conceptual domain of resilience. This was more pronounced during the outbreak of COVID-19, where there was a surge in publications on this subject [26]. Various authors proposed strategic changes to business models and an increase in complementary skills and competencies to cope with future disruptions [27–29]. Whether resilience should be conceptualised as a cause or effect, a process, or an outcome is still a subject of debate among scholars. Ref. [30] examined resilience as both a cause and effect. In their study, they found a positive effect of organisational capability, SC flexibility, and SC integration on resilience, which, in turn, recorded a significant influence on firm performance.

The current study dwells on the integrative approach of Ref. [31], who explored the attributes or characteristics that contribute to developing resilient organisations. According to the authors, resilience is a function of capabilities such as responsiveness, flexibility, and agility. Accordingly, the current study explores resilience as a function of the organisational capabilities that are valuable, rare, imitable, and non-substitutable [7]. These capabilities, including innovation, transparency, collaborative culture, flexibility, and agility, have been reported as essential capabilities for resilience. Leveraging the resources and capabilities of supply chain partners and actors, both upstream and downstream, is required to attain a competitive advantage [32]. The hotel industry is highly

competitive and requires certain capabilities to survive in the dynamic environment [5]. The industry has grown with diverse services, serving both local and international customers. The sector has witnessed significant investment in infrastructure over the years. The sector's main source of revenue is directly proportional to the mobility of people either for business, tourism, holidays or other personal reasons.

Like most firms, the hotel supply chain is made up of upstream actors such as suppliers of food items, internet and communication services, maintenance and repair services, electrical and electronic equipment, furnishings, and transport services [5]. Some hotels decide to maintain some of these value chain activities as in-house provisions when they have the capability to do so. The actors downstream are mainly individual customers, holidaymakers, tourists, and organisations. Inseparability, high visibility, heterogeneity, customer centricity, and largely intangible offerings characterise the service operations of hotels [5,33]. These characteristics have implications for ensuring an optimal customer experience. Satisfaction of the customer is of paramount importance to the hotel industry because dissatisfaction is immediately voiced [34,35].

For hotel operations to guarantee consistent service levels and customer experience, several measures, from managerial to infrastructure development, are proposed [36]. However, the need to acknowledge resilience in service operations is underexplored. According to the propositions of the RBV, resilience in this context is a core competency that is achieved by the continuous deployment of internal capabilities. Similarly, Ref. [1] describes resilience as an ongoing process that requires constant learning, flexibility, adaptation, and evaluation. Organisational resilience is described [7,37,38] as a long-term strength and a demonstration of the ability of businesses to identify risks, take preventative measures against them, and set up early warning systems.

Among hotels, these capabilities result from both tangible and intangible resources. Tangible resources include physical assets, technological infrastructure, and an inventory of materials and other supplies. Intangible resources include relationships with major suppliers, partners, and customers alike, as well as brand and reputation. So, the ability of hotels to be agile, flexible, transparent, innovative, and collaborative depends on the accumulation of both tangible and intangible resources and the capability to deploy them. Ref. [22], in addition to the model of absorptive and adaptive paths to resilience, explore a set of key capabilities needed to be successful at the different stages of the two paths. The work of Ref. [22] justifies a necessity methodology for exploring organisational capabilities as necessary determinants. Hence, the focus of this study was to explore the necessary capabilities and their minimum levels appropriate for firms to cope, recover, or survive in challenging business conditions.

## 2.2. Theoretical background

Over time, firms accumulate a bundle of unique resources both tangible and intangible. According to the Resource-based view (RBV), these unique resources, which are developed overtime, form the foundation for developing core competencies for competitive advantage [39,40]. The theory subsequently establishes a link between resources, capabilities and core competencies. When resources have been purposefully leveraged to achieve specific tasks, the firm develops capabilities, which overtime become core competencies. The RBV further suggests that the extent to which core competencies can sustain a firm's competitive advantage depends on the value, rareness, imitability and non-substitutability (VRIN) of these resources. Firms that accumulate resources that possess the VRIN characteristics are better positioned to differentiate themselves, offer unique value propositions and outperform other players in the same industry [5,7]. Competitive advantage is a corporate objective that requires both strategic and operational planning by exploiting the internal capabilities of the firm.

While the RBV recognise the role of critical resources in creating sustainable competitive advantage, some resources must be maintained for operational purposes to the extent that their presence becomes necessary for firms to survive. These are described as operational capabilities. The RBV assumes that entities that can strategically configure and align their internal competencies with opportunities to exploit economic gains, as well as minimise the threats that exist in the external business environment, can achieve competitive advantage. Studies that have used the RBV have mostly examined how core competencies can be aligned with opportunities to create competitive advantage and less focus on how internal capabilities can be re-aligned to minimise threats, disruptions and unforeseen events [41]. Thus, resilience has become a threshold competency where organisations must continuously reexamine their supply chains for continuous improvement. Along this line, certain capabilities have been identified as integral to the resilient organisation: helping organisations to prepare, sense and respond. These capabilities are subsequently discussed and modelled as necessary conditions.

## 2.3. Conceptual development

### 2.3.1. Innovation

Innovation is necessary for firms to respond to rapid changes in products, services and customers' demands [42]. Ref. [43] emphasise open innovation as a strategic tool to improve service innovation. Innovation within the hotel supply chain involves finding creative solutions to enhance efficiency, reduce costs, and improve guest experiences. This could include implementing technology-driven systems for front-desk services, inventory management, automated procurement processes, or exploring sustainable sourcing practices. By continuously seeking innovative approaches, hotels can optimize their supply chain operations, streamline processes, and deliver exceptional value to their guests. The extant literature on competitive advantage has shown that innovation affects an organisation's ability to compete and perform. However, compared to the manufacturing sector, hotels show less inclination to commit to research and development because service companies in general place less emphasis on product innovation and more emphasis on organisational innovation [44,45].

### 2.3.2. Transparency

Transparency of operations goes beyond visibility as used in a supply chain context. While visibility is about gaining control of upstream and downstream logistics operations, transparency is deliberately sharing operational information with consumers and other relevant stakeholders about quality standards, compliance and openness of the service operation [46]. The concept of transparency is related to customers' perceptions of the organisations as open and fair, and helps customers to lessen the risk of ambiguity associated with a business's service offerings [47]. Transparency is an essential factor for forming strong bonds between the organisation and its supply chain partners, thus enhancing collaboration. Transparency also plays a crucial role in building trust and credibility with existing and potential guests, as it allows them to make informed decisions and feel confident in their choice of service provider [48]. Additionally, transparency of operations helps organisations to foster a culture of accountability and responsibility within their supply chain, leading to improved customer loyalty and collaboration.

### 2.3.3. Collaboration

Collaboration is critical for seamless coordination among the various stakeholders and actors in the hotel supply chain [49]. Ref [49] define collaboration as a partnership process where two or more independent firms work closely to plan and execute supply chain operations towards a common goal and mutual benefit. In a hypercompetitive environment that calls for efficient, lean agile and flexible operations, organisations also become more vulnerable to disruptions. Collaboration serves as a cushion to diffuse the impact of disruptions among the supply chain [50,51]. Hotels work closely with suppliers, distributors, and logistics partners to ensure flexible, timely and reliable delivery of goods and services. Collaboration is hypothesised as an antecedent because maintaining high levels of cooperation and collaboration, according to Ref. [51] facilitates flows and constrains the spread of supply chain disturbance.

### 2.3.4. Flexibility

Flexibility during crises is an important attribute for hotel supply chain due to the sector's exposure to unpredictable and uncertain environment [52]. According to Ref. [53], flexibility in the context of service operations refers to aspects of providing the right services to the expectation of consumers even during demand fluctuations. Demand fluctuations, seasonality, and unforeseen events require hotels to be flexible. A flexible supply chain allows hotels to meet guest expectations promptly, whether it is responding to last-minute requests or accommodating personalized preferences. Ref. [54] discovered a link between supply chain flexibility and the creation of competitive advantage. Flexibility in the supply chain may increase an organisation's competitiveness, especially when deciding how to incorporate new technologies. Furthermore, flexibility facilitates effective risk management by diversifying suppliers, developing and maintaining contingency plans to mitigate disruptions [55].

### 2.3.5. Agility

Agility is defined as the ability to predict, respond quickly and cost-effectively to unpredictable market changes and increasing levels of environmental turbulence, both in terms of volume and variety [56]. Agility is demonstrated by proactiveness and sensing capabilities to reconfigure operations and react speedily to marketplace changes. Leveraging data analytics and technology solutions, such as real-time inventory tracking or demand forecasting, allows hotels to make data-driven decisions and adapt swiftly to changing circumstances. According to Ref. [57], sustainability of the hotel business is closely linked to revenue management, and one way of managing revenue is to employ techniques for predicting occupancy rates for hotels. By continuously monitoring market trends and customer preferences, hotels can identify emerging opportunities and respond appropriately with tailor-made solutions.

## 2.4. Necessity hypotheses

This section discusses the key capabilities and justification why they must be examined from a necessity perspective.. As the business environment evolves, it is expected that certain capabilities that distinguish a firm from another and contribute to its competitiveness will no longer be sufficient. At this point, these capabilities will move from becoming a core competency to operational or threshold capabilities. In the strategy literature, Ref. [58] defines threshold competencies or capabilities as "those capabilities needed for an organisation to overcome operational bottlenecks, compete in a given market and achieve parity with its competitors in that market". The current study adds to existing methodological reasoning, by hypothesising that resilient firms are more likely to navigate and overcome disruptions, adapt to changing circumstances, and maintain their performance even in the face of challenges.

A necessity condition is defined as a condition that must be present for an outcome to occur. In other words, necessity logic views the conditions as having a constraining effect on the outcome. The study makes a necessity argument based on core organisational capabilities that must be present for resilience to occur. Capabilities are formed from the combination of skills, knowledge, technology, organisational routines and culture [59]. To this end, organisational capabilities must be available and exchanged among supply chain partners that contribute to its long-term survival and competitiveness. Ref. [6] describes three types of capabilities that have been offered in the strategy literature. The first-order capabilities define how a firm can 'earn a living' [6]. The second type of capabilities enable operational advantage. The third type is the higher-order or dynamic capabilities which is characterised by learning, integration, reconfiguration and disruptive innovations [60]. Based on in-depth search of the literature and insights from global supply chains, studies such as [61–64]) proposed appropriate combination of capabilities such as innovation, transparency, collaboration, flexibility and agility as critical drivers for achieving operational excellence, meeting customer expectations, and staying competitive in the dynamic business environment. However, these studies established only one aspect of causality, which is "sufficiency".

Accordingly, ascertaining the drivers necessary for supply chain resilience, as well as the necessary levels of these dimensions, is equally important and may corroborate the findings of the sufficiency logic. For example, in Ref. [32], the author employed necessity

logic to examine the dimensions of collaborative culture as necessary drivers for supply chain collaboration. Also, Ref. [65] based on necessity logic, examined critical success factors for implementing lean practices, in Ref. [66] authors concluded that creativity was a necessary condition for intelligence. In Ref. [67], emphasis was laid on relational capabilities for successful inter-firm collaboration. The proposition of these authors suggests a necessity relationship between the development of relational capabilities and the achievement of successful inter-firm collaboration. It can be deduced that the necessity approach to exploring necessary capabilities produces potent outcomes to support business decisions. The proposed necessity relationships between innovation, transparency, collaboration, flexibility and agility as conditions and resilience as outcome is displayed in the conceptual model in Fig. 1.

### 3. Research methods

#### 3.1. Sampling and data collection procedures

A survey of hotel managers of star-rated hotels in the Greater Accra region of Ghana was conducted. As of December 2018, the Ghana Tourism Authority database showed that licensed accommodation units comprised 9 (5-star rated hotels), 25 (4-star rated hotels), 54 (3-star rated hotels), 103 (2-star rated hotels), 223(1-star rated hotels) giving a total of 414 licensed star hotels in the Greater Accra region. Respondents were mainly managers of hotels in the one and two-star categories. Hotels in one and two-star categories usually exhibit similar operational and organisational capabilities, so they were considered homogeneous for analysis and managerial implications [5]. The respondents were largely managers and front desk staff of the sampled hotels in each star-rated category. Those with managerial positions were in the four-star and five-star rated categories. Based on the convenience sampling, 167 valid responses were obtained and used for further analysis. Ethical clearance was sought from the Institutional Review Board of University of Cape Coast. Anonymity and informed consent of the respondents was ensured by including a statement at the introductory section of the questionnaire to that effect.

#### 3.2. Measurement and questionnaire development

The conditions (agility, transparency, innovation, collaboration and flexibility) and outcome (resilience) variables in the model (Fig. 1) were operationalised and measured using existing items developed and validated in other similar studies (Table 1). The adapted measures were deemed appropriate because they have been administered to respondents in different cultural contexts and have proved reliable and valid. Reliability indicators reported range between (0.6–0.87) across all studies, making the instrument appropriate. Table 1 shows the details of the variables, the corresponding items and the sources of the items for each variable. All items were measured on a seven-point Likert scale, ranging from (1) weak disagreement to (7) strong agreement. The draft questionnaire was sent to experts in the hospitality sector to comment on the suitability and the conceptual clarity of the constructs and measurement items. Feedback from the experts was incorporated into refining the final questionnaire. According to Ref. [68], these procedures ensure robustness and applicability of instruments which are adopted from other sources and contexts.

#### 3.3. Analytical procedure

Analysis was undertaken using Necessary Condition Analysis (NCA) developed by Ref. [18]. NCA is an approach that enables the identification of necessary conditions in a dataset [20]. While regression-based techniques determine the best fit through a set of observations, NCA analyses the observations by producing two important lines, called ceiling lines, on top of the data. The ceiling lines separate the space with observation from the space without observation and help in determining the degree of necessity in the scatter

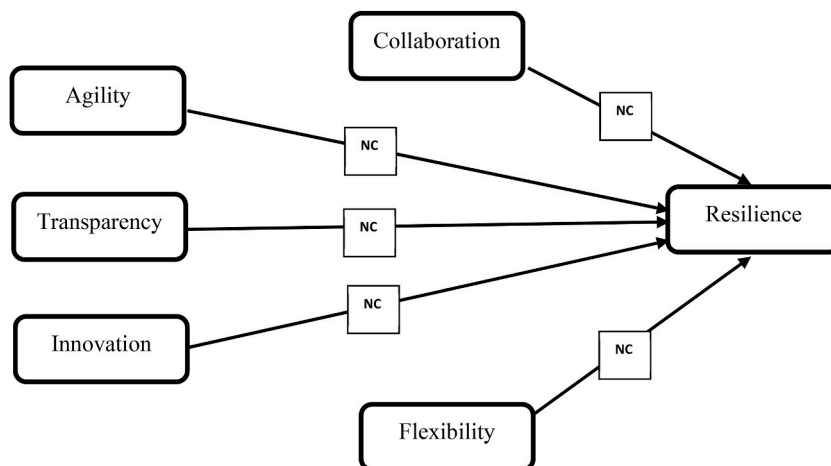


Fig. 1. Research model.

**Table 1**  
Measurement items for conditions and outcomes.

Variable	Indicators	Source
Resilience	a. The firm has a continuous monitoring system that evaluates internal operations for vulnerabilities. b. The firm deploys alternative plans associated with identified risks. c. The firm would quickly recover to its original state. d. The firm can quickly deal with disruptions. e. The firm can evaluate the levels of risk facing the supply chain. f. The firm maintains high situational awareness at all times. g. The firm cope with changes brought by the supply chain disruption h. The firm quickly adapt to the supply chain disruptions	[69,70]
Innovation	a. The firm has innovative service packages and other physical assets. b. The firm has a state-of-art infrastructure that can incorporate information. c. The firm is flexible and open to changes. d. The firm has technology for real-time tracking. e. The firm pursues creative methods and services.	[71,72]
Transparency	a. The firm maintains excellent communication using ICT. b. The firm shares timely information with its customers. c. The firm shares timely information with its suppliers. d. The firm track delivery to customers and from suppliers. e. The firm aggressively and frequently solicits customer feedback. f. The firm monitors the performance of its suppliers.	[73]
Collaboration	a. The firm develops long-term relationships with suppliers. b. The firm develops long-term relationships with its customers. c. The firm makes joint decisions with suppliers for new ideas on most issues. d. The firm uses simple plans collectively from stakeholders. e. The firm jointly set goals for a collaborative effort f. The firm aggressively shares resources to help suppliers improve their capabilities.	[50,74]
Flexibility	a. The firm uses a flexible sourcing strategy for key and critical components b. The firm makes provision for safety stock inventories of certain critical materials c. The firm changes service capacity when necessary. d. The firm rotate workers among different tasks e. The firm continuously focuses on improving its efficiency by removing waste from operations. f. The firm is flexible in terms of accommodating service mix and customer requests.	[75]
Agility	a. The firm can keep up with demand fluctuations. b. The firm encourages an improved level of customer service. c. The firm has a reliable delivery service to our customers. d. The firm quickly identify opportunities for environmental changes. e. The firm is responsive to changing market needs. f. The firm restores product flow to its original state after being disrupted. g. The firm can increase level of customization h. The firm can increase frequency of new service mix	[75]

plots. Also, the choice of NCA over fsQCA for determining necessary conditions is that in the former, both necessity ‘in kind’ and ‘in degree’ are determined, while the latter only defines necessity ‘in kind’ [76].

Before the NCA procedure, the PLS-SEM procedure was first applied to generate latent variable scores, which are composite scores for each construct expressed as a linear combination of their underlying indicators [77]. Unlike PLS-SEM, the NCA technique does not allow for linking indicators directly to their constructs, and according to Ref. [78], the PLS-SEM approach for computing composite scores is recommended compared to other forms of creating composites. The composite scores generated using PLS-SEM were stored in CSV and subsequently imported into R software. NCA runs on areas in scatter plots above the OLS regression line, so highly skewed data and extreme outliers can reduce the empty space and the necessity effect size [18,77]. Accordingly, all necessary data distribution checks, such as excess kurtosis, skewness of the data, and outlier analysis, were undertaken, and the results are presented in Table 2. Table 2 also shows the correlation among the variables.

The NCA procedure was undertaken with a free software package implemented in R [79]. Specifically, the following codes generates the ceiling lines, calculate all NCA parameters (such as ceiling zone, ceiling accuracy, scope, effect size and p-value) as well as the bottleneck table.

**Table 2**  
Latent variable descriptives.

Construct	Mean	SD	Excess Kurtosis	Skewness	1	2	3	4	5
Agility [1]	5.274	1.302	0.949	-1.165					
Collaboration [2]	4.957	1.312	-0.153	-0.726	0.6293				
Firm Resilience [3]	5.165	1.165	-0.271	-0.626	0.6343	0.6202			
Flexibility [4]	4.994	1.428	0.383	-0.735	0.6448	0.7146	0.6259		
Innovation [5]	5.076	1.244	0.595	-0.751	0.5870	0.6497	0.6230	0.7337	
Transparency [6]	4.438	1.180	-0.196	-0.577	0.5569	0.6093	0.5178	0.4872	0.4689

**Step 1.** `model <- nca_analysis(dat, c("Innovation", "Collaboration", "Transparency", "Flexibility", "Agility"), "Resilience", test.rep = 10,000)`

**Step 2.** `nca_output(model, summaries = TRUE, bottlenecks = TRUE)`

#### 4. Results

The results of the NCA procedure are discussed in this section. First, the scatter plots showing the default ceiling lines are presented. Second is the NCA statistical test for significance and effect size, and lastly, the bottleneck table is also discussed. Before necessity relationships was established, the data was examined for validity and reliability and results presented in [Table 3](#). An analysis of the reliability was undertaken by examining the composite reliability and rho\_A. The validity of the measurement model was also assessed via the average variance extracted (AVE). Based on the recommended thresholds, the measurement model was considered reliable and valid.

##### 4.1. Identifying the empty space using the scatter plot

The scatter plot allows for testing necessary condition hypotheses by comparing an observed data pattern with an expected data pattern. [Figs. 2–6](#) shows the scatter plots.

Visual inspection of the scatter plots in [Figs. 2–6](#) shows empty spaces in the upper left corner, suggesting possible necessity relationships between the conditions (flexibility, collaboration, agility, innovation and transparency) and the outcome (firm resilience). NCA uses these empty spaces to determine the presence of a necessary condition for a given outcome [80]. By analysing these empty spaces, NCA can identify the factors that must be present in order for the outcome to occur. This helps in understanding the underlying causes and potential interventions that can influence the occurrence of the event or outcome. In addition to the OLS regression line, CE-FDH and CR-FDH are the two ceiling lines which separate the space without observations from the space with observations. The CE-FDH is a stepwise linear line that is recommended for discrete data and irregular patterns (non-linear) of observations near the ceiling line, while CR-FDH is a trendline through the CE-FDH. The CR-FDH is recommended for continuous data or when the patterns of observations near the ceiling line is approximately linear [81]. The level of condition X that is necessary to reach a certain level of outcome Y is determined by the ceiling lines. NCA's effect size quantifies the size of the empty space above the ceiling lines. After visual inspection, the effect size was obtained using the argument in R as follows: `nca_output(model, summaries = TRUE)`.

##### 4.2. NCA's statistical test of significance (p-value) and necessity effect size (d)

After establishing the empty spaces in the upper left corner, the NCA statistical test whether the empty space may be a random result not caused by a necessity relationship between the conditions and the outcome variables [18]. The *p*-value protects the researcher from concluding that the empty space is empty because of necessity, whereas in reality, it is a random result of unrelated variables. A small *p*-value indicates that the data is not compatible with the null hypothesis ( $H_0$ ) and that it must be rejected. Therefore, for a condition to be concluded as necessary, Ref. [18] provides three main criteria:

- Theoretical support for the necessity hypotheses,
- A large effect size for substantive significance ( $d > 0$ ), and
- A small *p*-value for statistical significance ( $p > 0.05$ )

Following the aforementioned criteria, the following parameters were examined: ceiling accuracy, necessity effect size (*d*), and the *p*-value of the effect size. [Table 4](#) presents the results for both CE-FDH and CR-FDH. However, the parameters corresponding to CE-FDH ceiling technique were subsequently discussed because it is the recommended technique when data is categorical, or when the condition and outcome have few levels of measurement using categorical scales. The effect size (*d*) can have values between 0 and 1 ( $0 \leq d \leq 1$ ). According to Ref. [77], the necessity effect size (*d*) and its statistical significance (10,000 permutations) establish whether the conditions are necessary for the outcome. The effect size (*d*) is calculated by dividing the empty space (called the ceiling zone) by the entire area with and without observations (called the scope). Ref. [18] suggests that  $0 < d < 0.1$  can be characterised as a small effect,  $0.1 \leq d < 0.3$  as a medium effect,  $0.3 \leq d < 0.5$  as a large effect and  $d \geq 0.5$  as a very large effect.

From [Table 4](#), innovation recorded effect size of 0.108 ( $p < 0.05$ ), transparency was 0.200 ( $p < 0.05$ ), collaboration 0.190 ( $p <$

**Table 3**  
Construct reliability and validity.

Constructs	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
Agility	0.909	0.918	0.929	0.652
Collaboration	0.882	0.898	0.911	0.631
Firm Resilience	0.887	0.887	0.910	0.560
Flexibility	0.839	0.848	0.881	0.553
Innovation	0.856	0.859	0.902	0.699
Transparency	0.838	0.846	0.885	0.608

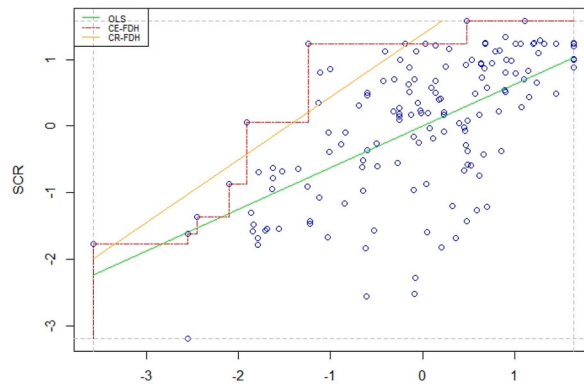


Fig. 2. NCA plot between Flexibility and SCR.

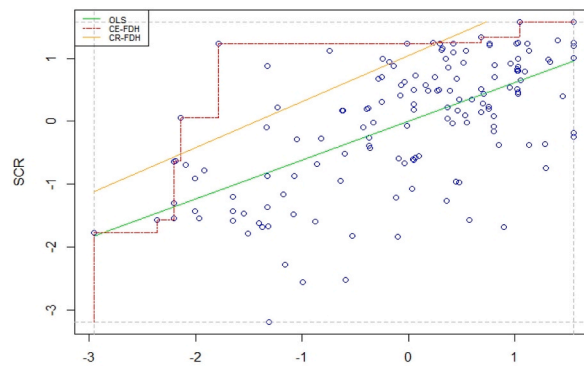


Fig. 3. NCA plot between Collaboration and SCR.

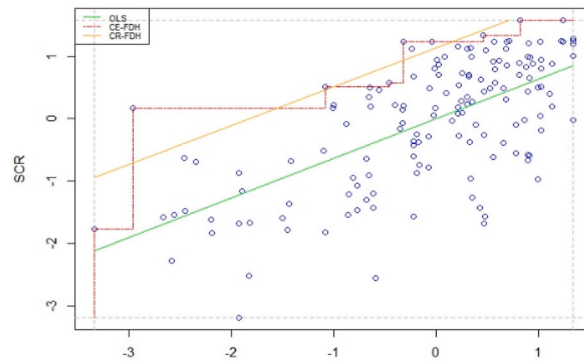


Fig. 4. NCA plot between Agility and SCR.

0.05), flexibility 0.276 ( $p < 0.05$ ), and agility 0.227 ( $p < 0.05$ ). Based on the recommended thresholds, the effect sizes corresponding to innovation, transparency, collaboration, flexibility and agility are deemed to be medium. The NCA's results (see Table 4) indicate that innovation, transparency, collaboration, flexibility and agility are meaningful ( $d \geq 0.1$ ) and significant ( $p < 0.05$ ) necessary conditions for resilience. Studies such as Ref. [66] consider  $d > 0.1$  as practically meaningful. This also show that these conditions could be bottlenecks or constrain the manifestation of firm resilience. The ceiling accuracy represents the number of observations above the ceiling line. When the appropriate ceiling line is selected, the ceiling accuracy is close to 100%. Observations in Table 4 shows that all the ceiling lines recorded an accuracy of 100%. Even when CR-FDH is selected, ceiling accuracy values ranging from 90.7 to 98.1, a further indication that necessity conditions exist in the data.



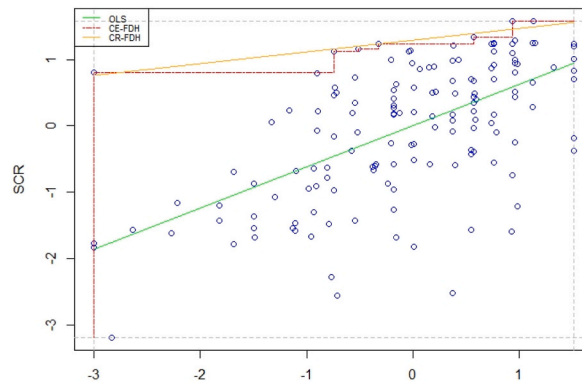


Fig. 5. NCA plot between Innovation and SCR.

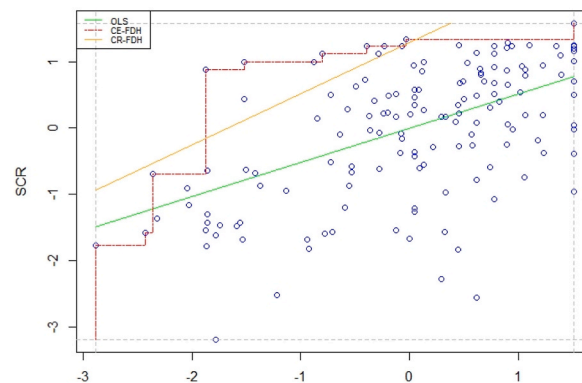


Fig. 6. NCA plot between Transparency and SCR.

Table 4  
NCA statistical test and effect size.

Construct	Ceiling technique	Ceiling Zone	Ceiling Accuracy (%)	Scope	Effect Size	Fit (%)	P-value	Condition Ineff	Outcome Ineff
Innovation	CE-FDH	2.325	100.0	21.514	0.108	100	0.019	12.849	83.781
	CR- FDH	1.867	98.1	21.514	0.087	80.3	0.039	0.000	82.856
Transparency	CE-FDH	4.179	100.0	20.937	0.200	100	0.000	0.000	29.836
	CR- FDH	4.104	90.7	20.937	0.196	98.2	0.000	25.858	47.126
Collaboration	CE-FDH	4.088	100.0	21.476	0.190	100	0.000	11.252	29.836
	CR- FDH	4.968	94.4	21.476	0.231	78.5	0.000	18.346	43.336
Flexibility	CE-FDH	6.855	100.0	24.874	0.276	100	0.000	22.265	29.836
	CR- FDH	6.755	95.0	24.874	0.272	98.5	0.000	27.592	24.994
Agility	CE-FDH	5.070	100.0	22.314	0.227	100	0.000	11.128	29.836
	CR- FDH	5.119	96.9	22.314	0.229	99.0	0.000	13.453	46.988

Note:  $0 < d < 0.1$  = small effect,  $0.1 \leq d < 0.3$  = medium effect,  $0.3 \leq d < 0.5$  = large effect and  $d \geq 0.5$  = very large effect.

### 4.3. Bottleneck analysis

The bottleneck table (Table 5) shows the extent to which conditions are necessary for different levels of outcome (necessary condition in degree). It is a tabular representation of the ceiling line in the scatter plot. The bottleneck table helps in resource allocation to the required conditions. The bottleneck table can be produced using the argument: `nca_output (model, bottlenecks = TRUE)`.

The bottleneck table can be generated for a single condition; however, it is particularly useful for comparing multiple conditions for a certain outcome. Even in multiple conditions, the necessity of a condition for a desired outcome is independent of each other [77]. The first column of a bottleneck table represents different levels of the outcome, and the next columns represent the corresponding levels of the conditions for each level of the outcome. These levels can be expressed as a percentage of the range, as actual values, or as percentiles. They indicate that higher levels of outcome can only be achieved with higher levels of a condition. By default, the values of the outcome and conditions in the bottleneck table are shown as percentage of the range from 0% to 100% [18]. Often, we find that

**Table 5**  
Bottleneck table.

SCR	Innovation	Transparency	Collaboration	Flexibility	Agility
0	NN	NN	NN	NN	NN
10	NN	NN	NN	NN	NN
20	NN	NN	NN	NN	NN
30	NN	10.3	13.2	19.6	8.0
40	NN	11.9	16.7	28.1	8.0
50	NN	11.9	16.7	31.9	8.0
60	NN	23.0	18.1	31.9	8.0
70	NN	23.0	25.9	44.8	8.0
80	NN	23.0	25.9	44.8	64.4
90	50.0	47.3	25.9	44.8	64.4
100	87.2	100.0	88.7	77.7	88.9

most of the conditions are not necessary (NN) for very low levels of the desired outcome [77].

Table 5 shows all the identified capabilities as necessary conditions for firm resilience, because there is theoretical support, large effect sizes ( $d > 0.1$ ) and relatively low p-values ( $p < 0.05$ ). In addition, the bottleneck table (Table 5) specifies the critical levels of innovation, transparency, collaboration, flexibility and agility that are necessary to maintain desired levels of resilience among hotels. For example, none of the capabilities are considered necessary for up to a level of 20 percent of firm resilience. Beyond 20 percent, up to 80 percent, all capabilities are necessary, except for innovation. When the level of resilience is set at 80 percent, the following levels of capabilities are necessary: transparency (23.0%), collaboration (25.9%), flexibility (44.8%) and agility (64.4%). When resilience goal of the firm is set at a higher level of 90 percent, the following levels of the capabilities become necessary: innovation (50.0%), transparency (47.3%), collaboration (25.9%), flexibility (44.8%) and agility (64.4%). So essentially, the NCA provides a further test of significance and relevance depending on a set target of the outcome (endogenous) construct.

## 5. Discussion

Resilience in service operations is fundamental to reducing service failures, risk, and vulnerability in hotel supply chains [82] and as an organisational capability that confers competitive advantage [22,83]. As the business environment evolves, firms must constantly reconfigure their operational capabilities to respond to changing times while sustaining their competitive advantage. This requires organisations to stay innovative, agile, and flexible and adapt their strategies, processes, and technologies to meet new market demands while leveraging collaborative and value-adding relationships with suppliers and clients. Increasing research into supply chain resilience proposes that certain capabilities are critical for organisations to effectively prepare, sense, and respond to all forms of disruptions in the supply chain.

For example, Ref. [84] focused on strategies that firms can use to build resilient supply chains. Other authors have used various descriptions such as ‘critical’, ‘urgent’ and precondition, although the approach adopted in these studies was limited to determining sufficient causal conditions. Some capabilities must be explored and proposed as necessary conditions. NCA and its methodology is a proposed approach for testing necessity relationships [20]. When we assume that a condition X is a necessary cause for an outcome Y, it implies that X is needed for Y, X is critical for Y, or X must be present for Y to be produced. X is also said to be a constraint, a bottleneck, or a critical factor that must be present to achieve Y [85].

Related studies have established sufficient factors that are collectively described as supply chain capabilities and sufficient determinants of firm resilience. However, this study explores the necessary capabilities for building firm resilience. Specifically, the study examines whether innovation, transparency, flexibility, collaboration and agility are necessary conditions or constraints for supply chain resilience, and determines the minimum levels of these capabilities that are required for desired levels of resilience. The study was guided by two objectives: to identify the dimensions of organisational capabilities that are necessary for supply chain resilience, and to determine the minimum levels of these dimensions that are required for high levels of resilience.

In objective one, the study found innovation, transparency, collaboration, flexibility, and agility to be necessary determinants of supply chain resilience. While the scatter plots suggest necessity condition in kind, the bottleneck table formulates the necessity relationship in degree, by specifying the levels of condition necessary for desired levels of the outcome. Overall findings show that transparency, collaboration, flexibility, and agility are required at the early stages of developing resilience in the service operations, while innovation only became necessary when firms sought high levels of resilience. The bottleneck table (Table 5) indicates a progressive increase in the necessary levels of capabilities as resilience goals increase. Transparency and collaboration consistently play important roles across different levels of resilience. Flexibility and agility become more critical as resilience goals increase, reaching their highest levels at 90% resilience. The role of innovation becomes notably important at the 90% resilience level. As customers demand improved service expectations, hotels must improve on their technological capabilities.

Although innovations such as artificial intelligence, automation, mobile technologies, and the Internet of Things (IoT) enhance guest experience, the results show that innovation seems to be critical only at higher levels of resilience. A study by Ref. [86] shows that customer orientation and collaboration is a key success factor for hotel’s innovation capabilities. However, it seems that innovation in service organisations differs from that in manufacturing, which invests heavily in R&D due to the importance of innovation to manufacturing operations, whereas service sector firms place comparatively less emphasis on this area. According to Ref. [44],

hospitality firms show less inclination towards research and development.

From lower to medium levels of resilience (30%–80%), transparency, collaboration, flexibility, and agility are predicted to be bottlenecks. As a highly competitive industry, the hotel industry must meet customer expectations, requiring certain capabilities to survive in a dynamic environment. The service value chain is characterised by high variability and variety. This means that hotels need to constantly adapt and quickly respond to changing customer demands and market trends, which is crucial for success in the hotel industry. Additionally, the service value chain in the hotel industry involves multiple stakeholders, such as guests, employees, suppliers, and partners, requiring effective communication and coordination to deliver a seamless experience [87].

The peculiar nature of the service value chain is further highlighted by Ref. [88] characterisation of service based on intangibility, inseparability, heterogeneity, and perishability. So, Ref. [89] proposed increasing customer value co-creation as an approach to ensuring transparency while encouraging collaboration, agility, and flexibility. By co-creating value with customers, organisations can also foster a sense of ownership and loyalty among their customer base. This not only enhances the overall service experience but also helps in adapting to changing customer demands and market dynamics.

## 6. Conclusion, limitations and future studies

Albeit the concept of organisational resilience is not novel, the ability of organisations to successfully confront and navigate the unforeseen remains pivotal determinant of success. Firms must understand the factors that contribute to building organisational resilience in a dynamic and ever-changing business environment. Resilient firms possess a set of threshold competencies that enable them to effectively respond to and recover from disruptions. Related studies have established sufficient factors that are collectively described as supply chain capabilities and sufficient determinants of firm resilience. However, this study explores the necessary capabilities for building firm resilience. Specifically, the study examines the roles of innovation, transparency, flexibility, collaboration, and agility as necessary conditions or constraints for firm resilience and determines the minimum thresholds of these capabilities necessary to achieve desired level of resilience.

From managerial perspective, it provides an understanding of the necessary conditions for resilience within their operations and supply chain as a whole. Given that transparency and collaboration consistently emerge as necessary for resilience, hotel management should strategically focus on enhancing operations transparency and fostering collaboration internally and with external partners in the value chain. This might involve maintaining transparent communication with key suppliers and customers and building partnerships with local businesses in the tourism industry. Hotels should invest in programmes and training that enhance both the adaptive and absorptive capacity of their staff. This could include cross-training employees, implementing flexible work schedules, and staying agile in response to market changes. The bottleneck table indicates that innovation becomes notably significant at a high resilience level (90%). Hotel management should foster a culture of innovation, encouraging staff to explore new technologies. This might involve investing in new technologies to augment operations and the customer experience. Regular assessment of resilience goals, ensures that capabilities are aligned with the dynamic needs of the hotel industry.

Also, the study shed insights on the degree of resource allocation appropriate for different levels of firm resilience. As an organisational capability that confers competitive advantage, some capabilities must be explored and proposed as necessary condition for building this capability. NCA and its methodology is a proposed approach for testing necessity relationships. NCA is a promising approach that aims to address the limitations of previous studies by testing necessity relationships both ‘in kind’ and ‘in degree’ using linear algebra. By applying this methodology, the study identifies the specific capabilities that are essential for firm resilience. Although, no single statistical method is without weaknesses in determining causality, the NCA approach offers an alternative understanding of the necessary conditions involved, allowing for complimentary analysis to support decisions. Finally, the study advances the strategy literature by complementing sufficient logic with necessity logic.

The study acknowledges the following limitations: the use of questionnaires often compels respondents to give a positive impression of their organisation’s activities. This bias may have caused the findings to be more positive than they were. Also, the study was based on developing economy context with different business environment. So, findings may not be a true reflection of the entire hotel industry. Consequently, capabilities described as necessary conditions should be interpreted in a limited context by taking cognisance of differences in socio-economic development, business culture and the general business environment of the hotel sector.

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### Availability of data and materials

The dataset used in this study is available and accessible upon request.

### CRedit authorship contribution statement

**Daniel Ofori:** Writing – review & editing, Writing – original draft, Methodology, Conceptualization.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.heliyon.2024.e26473>.

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