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Co-evolution, organizational capacity building, logistics capabilities and operational agility during health emergencies

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Abstract

Purpose – Globally, health care facilities often fail to respond quickly to health emergencies, resulting in significant deaths. Thus, the study examines the mediating effect of logistics capabilities in the relationship between co-evolution, organization capacity building and operational agility.

Design/methodology/approach – SmartPLS 4.0.8.3, variance-based structural equation models (VB-SEM) were used to test direct and indirect hypotheses across 45 health facilities. The respondents were 140 nurses and doctors. Disproportionate stratified simple random sampling was used based on government and private health facilities in Kampala City, Uganda.

Findings – A significant and positive relationship exists between logistics capability and operational agility. However, co-evolution and organizational capacity are intimately linked to operational agility via logistics capability.

Research limitations/implications – A quantitative cross-sectional survey was conducted using self-administered questionnaires. The results did not show any variation in the operational agility of health facilities during emergency management; thus, qualitative approaches are needed.

Practical implications – During emergency management, health facilities need to cooperate by sharing information, building capacity to increase their responsiveness and flexibility. This should be done by sharing equipment, tools, drugs and medical supplies, and we hope to encourage joint medical research.

Originality/value – A complex adaptive systems (CAS) framework is used in this study to examine how co-evolution, organizational capacity building and logistical capability relate to the operational agility of healthcare during times of emergency.

Keywords Co-evolution, Organizational capacity building, Logistics capabilities, Operational agility, Emergency management, Healthcare facilities

Paper type Research paper

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1. Introduction

The global health pandemic emergencies like the outbreak of coronavirus (COVID-19) in 2019 and natural culminates like earthquakes, floods, hurricanes, wildfire and others take many systems and sectors unaware including the healthcare system (Torales *et al.*, 2020). The health care system is greatly taken at ransom due to the heavy influx of cases of individuals affected by such devastations. The influx of affected individuals put pressure on healthcare facilities in terms of resources needed in managing the cases, which again is worsened by the emergence of mutant forms of pandemics like coronavirus and Ebola, increasingly posing uncertainty to global healthcare systems (Suresh and Patri, 2017). The ever-changing situation requires the efficacy of managerial operations to be flexible, effective and responsive to the healthcare system changing external conditions without compromising the long-term objectives of the organization (Khan *et al.*, 2021).

The healthcare system's ability to be flexible, effective and responsive to changing operational conditions describes operational agility. Agility plays a vital role in managing healthcare challenges like COVID-19, Ebola, etc. care to enhance the operational performance to meet the dynamic demand of health facilities (Suresh and Patri, 2017).

Operational agility enables organizations to rapidly reconfigure existing processes and create new ones to take charge of dynamic conditions (Walter, 2020), as well as boosting invention, adaptability and creativity that are critical to coordination, collaboration, communication and successful problem solving (Harrald, 2006). Due to low operational agility by public healthcare facilities of many countries in handling pandemic emergencies like COVID-19, Ebola, floods, earthquakes, wildfires, hurricanes, etc. result into loss of lives of millions of people around the world (Gibson *et al.*, 2020). The situation is worsened when pandemic or natural disasters disrupt the transportation and logistics of health equipment, such as personal protective equipment (PPE), testing kits and other products. The reduced mobility of people makes it difficult for health officials and employees to manage supplies and logistics in the health sector (Kano and Hoon Oh, 2020).

The criticality of operational agility in the attainment of successive performance of organizations has attracted great attention from researchers and practitioner in different fields globally (Saputraa *et al.*, 2022; Feizabadi *et al.*, 2021), and scholars have used varied mechanisms that influence its realization. Scholars have examined business agility during COVID-19 using digital capability and ambidextrous leadership (Saputraa *et al.*, 2022), information technology (de Diego and Almodóvar, 2021; Ridwandono and Subriadi, 2019; Tallon *et al.*, 2018) (IT), ambidexterity and environmental dynamism (Lee *et al.*, 2015) and managing the tension between organizational agility and efficiency (Priyono *et al.*, 2020). Additionally, Fernandez-Giordano *et al.* (2021) explain the roles of a transactive memory system and the supply network flexibility of the firm as antecedents of a firm's supply chain agility. Dubey *et al.* (2020) explicate information alignment, collaboration, artificial intelligence-driven big data analytics capability and intergroup leadership. Ravichandran (2018) found that IT competence and innovation capacity have a significant relationship. Carvalho *et al.* (2019) focused on organizational culture. Akhtar *et al.* (2017) analyzed the role of Internet, dynamic data and information processing capabilities.

These extant studies have explored operational agility in terms of IT and dynamic capabilities in influencing agility performance in different sectors specifically during global health emergency (Czabanowska and Kuhlmann, 2021; Queiroz *et al.*, 2021; Liu *et al.*, 2020). Most of these extant studies have assessed operational agility and largely ignored the role of co-evolution, organizational capacity, and logistics capabilities. Besides the general acknowledgement that these are key determinants of operational agility (Alolayyan *et al.*, 2022), operational agility increases flexibility, responsiveness and effectiveness for organizations to swiftly respond to any highly demanding supplies as well as complex situations. Hence, agile organizations quickly respond to complex and emergent situations.

However, this study describes the operational agility of health facilities and tests a model for its achievement in public hospitals in handling emergencies hinging on the complex adaptive system framework. From the complex adaptive system, there are numerous agents who behave according to some set of rules and do adjust their behavior to that of other agents through interaction with and adaptation to each other. The key concepts of complex adaptive system include interconnected autonomous agents, self-organization, the edge of chaos and emergence. These concepts help to understand different aspects of agility as a desirable property for teams in a constantly changing environment (Mitleton-Kelly, 2003; Stacey, 2003).

In Uganda, the government instituted a lockdown in March 2020 after continents like the United States of America, South America, Australia and Europe had introduced the lockdowns. In March 2020, the first case of COVID-19 was confirmed. By December 2022, the total number of confirmed cases was 170,144, the death toll was 3,630 and 100,431 people were recovered (MoH, 2022 report). The health facilities like intensive care units (ICU) and health workers were highly stretched because the number of patients was high. There was a shortage of oxygen in the country and healthcare costs went up. At the end of 2022, some parts of the central and western region experienced an Ebola outbreak. Over 160 people were infected, including people who died. It was Uganda's fifth outbreak with the Sudan ebolavirus. The impact of pandemics like COVID-19, Ebola and floods has physical and mental exhaustion of the healthcare workforce, along with worn-out health facility infrastructure. Whenever there are pandemics, the vulnerability of low-income earners increases because they cannot access quality health services (Nuwematsiko *et al.*, 2022). This study therefore examines the relationship between co-evolution, organizational capacity building and logistics capabilities on operational agility of health facilities in handling health emergencies in Uganda. Specifically, the key research questions are:

RQ1. How do co-evolution, organizational capacity building and logistics capabilities relate to the operational agility of health facilities in a developing context?

RQ2. Do logistics capabilities mediate the relationship between co-evolution, organizational capacity building and operational agility of health facilities in a developing context?

To achieve the purpose and research questions of the study, data collected from 140 health works following a cross-sectional survey design were analyzed using partial least squares structural equation modeling (PLS-SEM) version 4.0.9.6. The rest of the paper is organized as follows. Section 2 present theoretical and reviews literature on co-evolution, organizational capacity building, logistics capabilities and operational agility. Section 3 describes the statistical methods and methodology employed in the study. Section 4 presents the results, while Section 5 discusses the findings and implications of the study, which are also highlighted, together with the limitations of the study in connection with recommendations for future research.

2. Theoretical framework and literature review

2.1 Theoretical framework

Complex adaptive systems (CAS) theory underscores the adaptability and evolution of systems in response to their environment, emphasizing interactions among system components rather than isolated elements, as highlighted by Holland (1996). This conceptual framework has advanced complexity science, aiding our comprehension of intricate scenarios within various disciplines, including healthcare, as explored by Wilson *et al.* (2001), Plsek and Greenhalgh (2001) and Fraser and Greenhalgh (2001). Within the healthcare domain, the applicability of CAS becomes evident when examining responses to sudden health crises, such as doctors' adaptive strategies or physiological processes like blood sugar regulation. The global management of health emergencies, including COVID-19

and Ebola, exemplifies the efficacy of CAS principles, as evidenced by studies such as those by Sweeney and Griffiths (2002) and Plsek and Greenhalgh (2001).

Central to CAS is the concept of "emergence," signifying unforeseen outcomes in systems that transcend localized components. Mittal (2013) elucidates CAS's role in understanding emergent phenomena, emphasizing its attributes of unexpected behaviors, intricate relationships and self-organization. Notably, alterations in one system component can reverberate throughout, influencing the system's overall dynamics, a viewpoint supported by McCarthy *et al.* (2006). Such integration of self-organization and emergence underscores the organic evolution of systems, as articulated by Hill (2011) and McCarthy *et al.* (2006). Using Uganda's healthcare system as an illustrative case, the CAS framework elucidates its adaptive responses to pandemic challenges, bridging theoretical constructs with pragmatic healthcare interventions.

In the context of health facilities, CAS elucidates how co-evolution, organizational capacity building and logistics capabilities synergistically enhance agility and responsiveness, especially during emergencies. Co-evolution emphasizes system components' mutual adaptations to external health threats, necessitating internal recalibrations. Concurrently, organizational capacity building entails reinforcing resources, expertise and infrastructures, enabling adept responses to evolving challenges. Additionally, effective logistics, encompassing resource management and distribution efficiencies, are pivotal for timely and effective emergency responses, aligning with CAS principles of interconnectedness and adaptive responses (Plsek and Greenhalgh, 2001). In conclusion, the intricate interplay among co-evolution, organizational capacity building, and logistics capabilities accentuates health facilities' operational agility. This collaborative nexus facilitates adept navigation of complexities, optimization of resource utilization and formulation of innovative strategies during health emergencies, underscoring the necessity for a comprehensive, complexity-science-informed approach to fortify healthcare systems (Fraser and Greenhalgh, 2001).

2.2 Co-evolution and operational agility

In humanitarian logistics, co-evolution is essential to see how organizations adjust to changes around them. Co-evolution means that as the environment changes, organizations also change their plans and strategies. This involves decisions like how to use resources, set up processes, build infrastructure and shape their culture. McKelvey (1997) points out that organizations can change their strategies when the environment changes, making sure they still meet their goals. To stay relevant and strong, organizations need to adjust their core values based on what's happening around them, as discussed by Dong *et al.* (2016). By learning from experiences and investing in technology, organizations can improve their operations and competitive edge, as mentioned by Neirotti and Raguseo (2017).

Using co-evolution in humanitarian logistics helps organizations combine their resources, skills and knowledge. This combination helps them adapt better to unpredictable situations, as noted by Sambamurthy *et al.* (2003) and Helfat and Raubitschek (2000). Also, working together and sharing information is crucial for adapting quickly, as emphasized by Lingard *et al.* (2012). Looking at this from the CAS theory perspective, it's like seeing organizations as parts of a bigger system that keeps changing. Organizations within this system interact with their surroundings and change their behaviors when needed, as Rammel *et al.* (2007) explain. CAS theory suggests that things emerge or develop because of these interactions and adaptability, as Hill (2011) and McCarthy *et al.* (2006) highlight.

To wrap up, in humanitarian logistics, co-evolution shows how organizations adjust to what's happening around them. When we link this idea to CAS theory, we see that

organizations must be flexible, work together and adapt to handle unpredictable challenges effectively; hence, we hypothesize that

H1. Co-evolution has a positive relationship with operational agility.

2.3 Co-evolution and logistics capabilities

In simple terms, co-evolution is like teamwork between organizations to improve how they handle logistics, especially when things change unexpectedly (Neirotti and Raguseo, 2017). This teamwork helps create new ways of doing things, like introducing new services, which is super important in areas like health where sharing information and being flexible are key (Eisenhardt and Martin, 2000; Matopoulos and Papadopoulou, 2010).

As organizations get better at delivering aid, they use things like outsourcing and technology to make their services faster and more reliable (Coyle *et al.*, 1996; Persson and Virum, 2001). These improvements are essential in today's digital age, where being on time and sharing information quickly are crucial (Meade and Sarkis, 2002; Attaran, 2007). However, there are challenges. Outsourcing can sometimes lead to problems like lower quality or less control (Jharkharia and Shankar, 2007). Still, working together with logistics providers is important because it helps save money and makes responses faster and better (Hesse, 2004; Gudmundsson and Walczuck, 1999).

Looking at all of this through the lens of CAS theory, we argue that logistics in humanitarian work is complex and needs flexibility, teamwork and innovation (Sweeney and Griffiths, 2002). This approach highlights the need to adapt and work together, especially using tools like online platforms to share information efficiently (Gudmundsson and Walczuck, 1999). In short, in humanitarian work, teamwork and adapting are essential for improving logistics. By understanding this relationship through CAS theory, we see the need for flexibility, teamwork and new ideas to handle the challenges in delivering aid effectively.

H2. Co-evolution and logistics capabilities are positively related.

2.4 Logistics capabilities and operational agility

Generally, businesses use information to spot opportunities and act on them quickly (Cai *et al.*, 2019). When it comes to logistics capabilities, a big part is about connecting different parts of the supply chain to meet goals efficiently (Ojha, 2008). This means making things like processes, structures and rules work together smoothly. By doing this, businesses can handle information faster, both within the company and with others involved (Bi *et al.*, 2014; Bowersox *et al.*, 1999). This efficient handling of goods and information helps supply chains be more flexible and responsive, ensuring everyone gets what they need when they need it (Stank *et al.*, 2005; Wong *et al.*, 2011). Additionally, using tech tools can make businesses more competitive, according to Ainomugisha (2022).

However, it's not all smooth sailing. Technology can make it tricky for organizations to share information, especially for those in healthcare who might struggle with costs and expertise. For healthcare to work well, from getting supplies to treating patients, it's crucial to have good logistics that connect everything (Saad *et al.*, 2021; Kannan and Tan, 2002). The COVID-19 pandemic made this even more challenging, especially since there wasn't much research on how logistics could help in such complex situations before. That's why this study looks into how good logistics can help in emergencies like COVID-19, especially in making operations flexible and responsive.

Looking at this through CAS theory, logistics capabilities show how different parts of the system can adapt and work together in complex situations. In emergencies like the COVID-19 pandemic, having strong logistics means the system can adjust quickly, be flexible and

respond effectively to challenges, showing the importance of adaptability and integration in humanitarian logistics.

H3. Logistics capabilities and operational agility are positively related.

H4. Logistics capabilities positively mediate in the relationship between co-evolution and operational agility.

2.5 Organizational capacity building and operational agility

Building up an organization's abilities helps it respond quickly and well to changes, uncertainty and problems in its environment (L'hermitte *et al.*, 2015). When a healthcare organization can build its capacity, it can better achieve its goals, especially in challenging times like the COVID-19 pandemic (Narasalagi and Shivashankar, 2015). Having a clear purpose is crucial for a healthcare organization, creating a sense of identity and confidence, especially during a crisis (McCann and Selsky, 2012). Leaders need to guide the organization, encourage commitment and support flexibility, but unfortunately, not all healthcare organizations in developing countries work together smoothly, making emergency responses more challenging.

Action-focused healthcare organizations are good at dealing with risks and uncertainties. To handle everyday situations, healthcare staff need the right skills, resources and clear processes. Delegating authority, quick decision-making, effective leaders and accurate information all work together to improve readiness and agility (Appelo, 2011; Weick and Sutcliffe, 2001). Agility can't be built by one person or organization alone, so collaboration is essential. Working together within and across healthcare chains leads to agility. Building agility means developing relationships that help solve problems beyond individual capabilities (McCann and Selsky, 2012). Staff need to understand each other's roles, and leadership should build trust and coordination within and beyond the organization (McCann and Selsky, 2012; Tatham and Kovács, 2010).

Using a learning-oriented approach, organizations identify and learn from past experiences to improve practices (Garvin, 1993). Learning fosters innovation and adaptability, getting rid of outdated practices (Scotney, 2014). Healthcare organizations should find new ways to solve problems, create knowledge and share it (Weick and Sutcliffe, 2001; Garvin, 1993). Learning allows organizations to look at issues as a whole, critically evaluating past experiences for agility (Senge, 2006; Redding and Catalanello, 1994). CAS theory suggests that assessing organizational capacity involves flexibility, learning from trends and integrating new knowledge to meet goals (Fraser and Greenhalgh, 2001). Learning from past experiences is crucial for agility, so it's important to analyze and use them to improve current practices. By making learning a regular part of the organization, it enhances agility.

H5. Organizational capacity building is related to operational agility.

2.6 Organizational capacity building and logistics capabilities

Organizations improve their healthcare services through learning (Bazaras *et al.*, 2016). Using IT helps action-oriented groups enhance visibility and strengthen relationships (Christopher, 2011). A focus on learning leads to ongoing improvement and innovation in services (Ramalingam and Mitchell, 2009). When organizations work together, especially during crises, using technology to share information becomes crucial (Altay and Labonte, 2014; Park *et al.*, 2013). According to CAS theory, organizations adapt and organize themselves in complex settings by working with others (Carmichael and Hadžikadić, 2019). In healthcare, collaboration, action and clear goals are essential. Managers play a crucial role

in managing departments, planning and improving healthcare delivery, especially during emergencies (Barysienė *et al.*, 2015; Ledauskaitė and Bazaras, 2008). Finding skilled healthcare workers who can effectively manage these tasks can be challenging.

Healthcare organizations must create motivation strategies, but some can increase costs, affecting growth (Bazaras *et al.*, 2016). These organizations need to adjust their logistics based on changing patient needs (Sukati *et al.*, 2012). Today's healthcare environment is dynamic, making service delivery challenging (Singhal *et al.*, 2011). To stand out and offer better services, good management is essential (Spekman *et al.*, 2002; Van de Ven, 1986). Sustainable healthcare means logistics partners, healthcare workers and suppliers must collaborate and innovate (Preuss, 2005). Overall, building organizational capacity is vital in today's complex healthcare landscape (Narasalagi and Shivashankar, 2015) (see Figure 1).

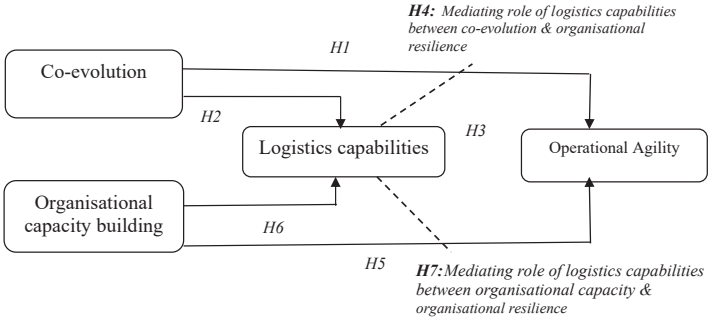
H6. Organizational capacity building and logistics capabilities positively relate.

H7. Logistics capabilities significantly relate mediates in the relationship between organizational capacity building and operational agility.

3. Methods

3.1 Research instrument and data collection

The quantitative data were collected using a questionnaire that ranged from 1 for strongly disagreeing to 6 for strongly agreeing, and this was used to avoid a middle point and make sure that respondents give a response while keeping items simple (Muhwezi *et al.*, 2023; Taherdoost, 2019). According to the Ministry of Health (MoH), there are 62 government and private hospitals in Kampala city (Ministry of Health, National Health Facility Master List, 2018), out of which a sample of 52 is drawn based on Krejcie and Morgan's (1970) sample determination table. Using a self-administered survey, responses were obtained from 45 government and private healthcare facilities, representing an 86.5% response rate, a response rate statistically sufficient to achieve the study purpose (Lau *et al.*, 2020). Disproportionate stratified simple random sampling was used based on government and private health facilities in Kampala City, Uganda. We measured operational agility by effectiveness, efficiency and responsiveness (Dingsøyr *et al.*, 2012). Co-evolution was assessed in terms of adaptability, feedback and collectivity (Mutebi *et al.*, 2021). As part of organization capacity building, action-oriented, collaborative, learning-oriented and purposeful activities were measured, while logistics capabilities were evaluated using



Source(s): Developed by the authors after theoretical review and empirical papers

Figure 1. Theoretical model

time management, cost, inter-organizational relationships, integration and information sharing (Zhao *et al.*, 2001). The questionnaire item for each study construct used to collect data is attached.

3.2 Measurement validation

Using Kaiser–Meyer–Olkin (KMO) and Bartlett's test, we established the adequacy and suitability of the data for confirmatory factor analysis (CFA) in PLS analysis. As a general rule, KMO values must be higher than 0.7 and Bartlett's test should be significant ($p < 0.05$) (Field, 2009). Both samples and data were adequate and suitable for CFA, since the KMO value is above 0.7 and Bartlett's test of sphericity is significant. Additionally, we run a reflective-formative higher-order constructs (HOC) PLS-SEM measurement model that follows a standard repeated indicator approach (Sarstedt *et al.*, 2019) to evaluate both reliability and validity. Sarstedt *et al.* (2019) consider items with factor loadings above 0.708 to be reliable and valid. Therefore, only items meeting this criterion were considered. Additionally, Cronbach's alpha and composite reliability values for both the HOC and the LOC were above the suggested cut-off of 0.7, indicating that study variables were internally consistent (Hair *et al.*, 2021). Furthermore, an AVE value above 0.5 confirms convergent validity (Hair *et al.*, 2021; Shamim *et al.*, 2017) (see Tables 1 and 2)

As recommended by Hair *et al.* (2021), hetero-monotrait (HTMT) ratios of 0.85 or lower confirm discriminant validity. The HOC and LOC variables met this criterion as well, as shown in Tables 3 and 4.

Lastly, we assessed the significance of formative LOC outer weights using Sarstedt *et al.* (2019). *p*-values and BCa range show that all outer weights of LOCs on their respective variables are significant at $p = 0.001$, confirming reflective-formative modeling (see results in Table 5).

3.3 Common method bias (CMB)

If common method bias (CMB) is not controlled (Flynn *et al.*, 2018), type I and type II errors can occur, compromising findings validity (Rodríguez-Ardura and Meseguer-Artola, 2020), especially in cross-sectional studies (Ketokivi, 2019). A pre-testing process included interviews, consultations and pilot tests with senior managers and academics. Additionally, we sequenced study variables in the questionnaire (starting with criteria and then predictors) and instructed respondents to rely on organizational documentation for operational agility information rather than personal experience (Dubey *et al.*, 2018). As well, variables' measures were tailored to fit the study context from previous refereed articles. As well, a six-point Likert scale was used to avoid a middle point and make sure that respondents gave a response while keeping items simple. The validity in the study was further enhanced by using multiple informants per sample unit (Robins and Wiersema, 2003). Following that, we conducted Herman single factor analysis (Harman, 1976). The results suggest that common method bias is unlikely to be a problem since a single factor explains 47.49% of variance.

3.4 Non-response bias test

Non-response bias occurs when researchers are unable to obtain information from sample units (Podsakoff *et al.*, 2012). Non-response bias was resolved procedurally and statistically. An introductory letter and a questionnaire were emailed to invited participants as part of the process. Two waves of data collection were conducted (Hulland *et al.*, 2018), characterized by early and late responses (Chen and Paulraj, 2004). To evaluate the effects of early and late responses on non-response bias, a multivariate chi-square test was used (Armstrong and Overton, 1977). Early and late respondents did not differ significantly in structural

Constructs	Item codes	Item loadings	Cronbach's alpha	rho_ A	Composite reliability	Average variance extracted (AVE)
Action orientated	A01	0.853	0.870	0.875	0.920	0.794
	A02	0.922				
	A03	0.897				
Adaptability	AD01	0.856	0.853	0.857	0.911	0.773
	AD02	0.914				
	AD03	0.867				
Collaborative	C01	0.831	0.858	0.871	0.905	0.705
	C03	0.725				
	C04	0.853				
	C05	0.937				
Collectivity	CY01	0.877	0.817	0.826	0.891	0.732
	CY02	0.807				
	CY03	0.880				
Effectiveness	E01	0.848	0.870	0.871	0.920	0.794
	E02	0.923				
	E03	0.901				
Flexibility	F01	0.695	0.729	0.752	0.847	0.651
	F03	0.856				
	F04	0.859				
Feedback	FK01	0.818	0.884	0.885	0.920	0.743
	FK02	0.844				
	FK03	0.876				
	FK04	0.908				
Innovation	I01	0.763	0.834	0.841	0.890	0.670
	I02	0.860				
	I03	0.893				
	I04	0.750				
Information exchange	IE01	0.912	0.871	0.876	0.921	0.795
	IE02	0.848				
	IE03	0.913				
Integration	IN02	0.919	0.821	0.821	0.918	0.848
	IN03	0.923				
Inter-organizational relationship	IOR02	0.803	0.885	0.891	0.921	0.745
	IOR03	0.899				
	IOR04	0.854				
	IOR05	0.892				
Learning orientated	L02	0.775	0.919	0.928	0.935	0.674
	L03	0.814				
	L04	0.848				
	L05	0.861				
	L06	0.886				
	L07	0.807				
	L08	0.747				
Purposeful	P01	0.933	0.931	0.933	0.951	0.828
	P02	0.902				
	P03	0.889				
	P04	0.915				
Responsiveness	R01	0.691	0.848	0.858	0.899	0.693
	R02	0.878				
	R03	0.859				
	R04	0.886				
Time Mgt and logistics cost	TL04	0.907	0.842	0.889	0.925	0.861
	TL05	0.948				

Source(s): Constructed by the authors form PLS-A analysis output

Table 1.
Validation of LOC

characteristics for dependents, independents and intermediates (Esser and Vliegenthart, 2017) (at 95% confidence level, p-value = 0.05).

3.5 Assessment for endogeneity

Using regression-based methods, such as PLS-SEM, and cross-sectional surveys pose an endogeneity issue (Hult *et al.*, 2018). Endogeneity occurs when a predictor construct explains both the dependent construct and its error term (Hair *et al.*, 2019). In Hult *et al.* (2018), endogeneity is primarily caused by omitted constructs correlated with predictor structures and dependent structures. Whenever an omitted construct affects both dependent and independent variables in a path model, there is a correlation between the independent variables and the error term (Clougherty *et al.*, 2016).

In regression analysis, the error term is assumed to have a zero value (Wooldridge, 2013), which violates a causal model assumption. Consequently, standard regression coefficient estimates tend to be biased, resulting in causally uninterpretable coefficient estimates (Papies, 2016). While methodological researchers have only recently begun discussing endogeneity with PLS-SEM (Hult *et al.*, 2018; Benitez *et al.*, 2016), PLS-SEM relies on regression analysis to estimate partial model structures, making endogeneity particularly relevant. A systematic method for identifying and treating endogeneity in PLS-SEM was developed by Hult *et al.* (2018). To control endogeneity, they use copulas to model the correlation between the endogenous variable and the error term. Park and Gupta (2012) developed this approach. Using instrumental variables that have a high correlation with the independent constructs but are uncorrelated with the error term of the dependent construct is a good way to explain the sources of endogeneity if the approach suggests there is an issue of endogeneity (Bascle, 2008).

Following the two-stage least squares estimation, we used Durbin's X^2-score and Wu and Hausman's F-statistics to assess the possibility of endogeneity for all regressors. In this study, Sargan (1958) and Basmann (1960) X^2 tests were used to evaluate the appropriateness of instruments (hospital size, years in operation, ownership and tenure). The Durbin χ^2 and Wu–Hausman F values, as well as the Sargan scores X^2 and Basmann tests, were

Table 2. Validation of HOC

Study variables	Cronbach's Alpha	rho_ A	Composite reliability	Average variance extracted (AVE)
Co-evolution	0.910	0.916	0.925	0.749
Logistics capabilities	0.929	0.931	0.938	0.784
Operational agility	0.853	0.859	0.884	0.712
Organisational capacity building	0.940	0.946	0.946	0.759

Source(s): Created by the authors form PLS-A analysis output

Table 3. Heterotrait-monotrait ratio (HTMT) for HOC

Latent variables	1	2	3
Co-evolution			
Logistics capabilities	0.74		
Operational agility	0.69	0.83	
Organizational Capacity	0.53	0.71	0.54

Source(s): Made by the authors form PLS-A analysis output

Table 4. Heterotrait-monotrait ratio (HTMT) for LOC

Constructs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Action orientated (1)															
Adaptability (2)	0.50														
Collaborative (3)	0.77	0.33													
Connectivity (4)	0.49	0.51	0.63												
Effectiveness (5)	0.37	0.31	0.65	0.71											
Feedback (6)	0.34	0.84	0.35	0.71	0.48										
Flexibility (7)	0.44	0.51	0.64	0.72	0.73	0.57									
Information exchange (8)	0.69	0.55	0.73	0.56	0.54	0.48	0.59								
Innovation (9)	0.63	0.52	0.74	0.77	0.79	0.57	0.71	0.69							
Integration (10)	0.75	0.51	0.69	0.64	0.72	0.50	0.76	0.81	0.68						
Inter-organizational relationship (11)	0.62	0.47	0.78	0.72	0.59	0.48	0.74	0.60	0.70	0.77					
Learning orientated (12)	0.66	0.61	0.49	0.31	0.30	0.50	0.37	0.38	0.29	0.54	0.30				
Purposeful (13)	0.83	0.41	0.70	0.49	0.29	0.24	0.34	0.52	0.56	0.71	0.74	0.48			
Responsiveness (14)	0.45	0.64	0.37	0.47	0.32	0.55	0.53	0.72	0.31	0.72	0.46	0.44	0.33		
Time management and logistics cost (15)	0.27	0.61	0.52	0.77	0.69	0.68	0.82	0.49	0.65	0.49	0.61	0.20	0.13	0.57	

Source(s): Authors developed the table form PLS-A analysis output

	β	*T* stat	*p* values	BCI
Action orientated → Organisational capacity building	0.244	7.859	0.000	0.19–0.32
Adaptability → Co-evolution	0.333	8.469	0.000	0.24–0.40
Collaborative → Organisational capacity building	0.293	6.747	0.000	0.23–0.41
Connectivity → Co-evolution	0.373	5.277	0.000	0.28–0.56
Effectiveness → Operational agility	0.432	5.734	0.000	0.34–0.65
Feedback → Co-evolution	0.455	12.680	0.000	0.39–0.52
Flexibility → Operational agility	0.369	8.480	0.000	0.30–0.047
Information exchange → Logistics capabilities	0.253	9.431	0.000	0.22–0.33
Innovation → Logistics capabilities	0.283	8.754	0.000	0.23–0.36
Integration → Logistics capabilities	0.202	7.988	0.000	0.17–0.28
Inter-organisational relationship → Logistics capabilities	0.318	12.169	0.000	0.28–0.37
Learning orientated → Organisational capacity building	0.369	5.334	0.000	0.19–0.48
Purposeful → Organisational capacity building	0.302	7.565	0.000	0.24–0.41
Responsiveness - > Operational agility	0.473	5.229	0.000	0.35–0.66
Time Mgt and logistics cost → Logistics capabilities	0.175	6.190	0.000	0.13–0.24

Table 5. Significance of outer weights

Source(s): Developed by the authors after the analysis of PLS-A results

non-significant at 5% significance, so endogeneity was not rejected. Table 6 below summarizes the results. Based on the presented results, we conclude that endogeneity is not a factor in this study (Hult *et al.*, 2018).

3.6 Data analysis

To answer research objectives and questions, associations between study variables must be tested. Variance-based regression was performed using PLS-SEM. Variance-based PLS-SEM is preferred since it tests direct and indirect relationships (Ramli *et al.*, 2018). SmartPLS version 4.0.8.3 was used in this study. The first step was to build a measurement model to assess the reliability and validity of the various constructs. To test the hypotheses, a structural model was generated and analyzed.

4. Results

4.1 Health facility characteristics

Results in Table 7 show that most health facilities had 50–100 COVID-19 beds, followed by 50–99 and 100–150. Moreover, 14 health facilities employed 10–15 nurses and doctors, while

Endogeneity test				Over identification test (instruments are valid)		
Variable	Hull hypothesis	Durbin score X^2 (*p*-value)	Wu–Hausman (*p*-value)	Null hypothesis	Sargan score X^2 (*p*-value)	Basmann X^2 (*p*-value)
Co-evolution	H0: Co-evol	1.833 (0.176)	1.756 (0.188)	H0: Co-evol	3.899 (0.564)	3.654 (0.600)
Org. capacity	H0: OrgCap	0.804 (0.370)	0.762 (0.385)	H0: OrgCap	5.024 (0.4413)	4.763 (0.445)
Log. capabilities	H0: LogCap	0.175 (0.676)	0.165 (0.686)	H0: LogCap	6.180 (0.289)	5.930 (0.313)

Table 6. Assessment of endogeneity test using 2-stage ordinary regression approach results

Source(s): Developed by authors for analysis of quantitative data

	Frequency	Percent		Frequency	Percent
COVID-19 bed capacity			*No of COVID-19 patients*		
<50	10	22.2	1–50	9	20.0
50–100	11	24.4	50–100	15	33.3
100–150	9	20.0	100–150	5	11.1
150–200	2	4.4	150–200	3	6.7
250–300	2	4.4	200–250	2	4.4
300–350	2	4.4	250–300	1	2.2
>350	9	20.0	>300	10	22.2
Total	*45*	*100.0*	*Total*	*45*	*100.0*
COVID-19 nurse and doctors			*No. of ambulances*		
1–5	2	4.4	1–5	20	43.3
5–10	9	20.0	5–10	18	40.8
10–15	14	31.1	10–15	6	12.5
15–20	6	13.3	15–20	2	3.3
25–30	3	6.7	Total	45	100.0
30–35	2	4.4	*Hospital*		
>35	9	20.0	Government hospital	32	71.1
Total	*45*	*100.0*	Private hospital	13	28.9
			Total	*45*	*100*

Source(s): Developed by authors after descriptive data analysis

Table 7. Health facility characteristics results

9 had 35 or more staff and 1–5 employees. Further, 15 health facilities admitted between 50 and 100 COVID-19 patients, while those admitted above 300 were 10. As far as emergency ambulances are concerned, 20 had between 1–5 and 18 had between 5 and 10. Finally, most of these facilities were government-owned.

4.2 Respondents' characteristics

The majority of respondents were female nurses and doctors, followed by males. The majority of nurses and doctors had worked in healthcare facilities for at least four years. Therefore, they could evaluate their healthcare facilities' operational agility. Bachelor's and master's degrees were their highest education levels, indicating they could interpret questions. Most respondents were between the ages of 31 and 40, followed by those between 41 and 50, 51 and 60 and younger than 30, as shown in Table 8 below.

4.3 Descriptive and correlations results for study variable

Based on the moderate means and fairly close standard deviations for the descriptive statistics in Table 9 below, it appears that co-evolution, organizational capacity, logistics capabilities and operational agility are practiced among the healthcare facilities studied. In regression analysis, linearity is assumed, so it is not applicable to variables without relationships. Thus, the significant correlation among study variables allows us to test hypotheses using PLS-SEM.

4.4 Structural model evaluation and hypotheses testing

In order to assess the PLS-SEM, inner variance inflation factor (VIF) values were analyzed. VIF values below 3.3 indicate that the model does not suffer from multicollinearity. The coefficient of determination (R^2) indicates that 48% of operational agility is explained by exogenous variables (co-evolution, organization and logistics capabilities). Predicted variances over (0) are statistically significant. The prediction accuracy of our model was

	f	Percent
Education level		
Diploma	17	12.1
Bachelor's degree	93	66.4
Master's degree	30	21.4
Total	*140*	*100*
Operational tenure		
01–03	48	34.3
04–05	63	45
06–10	27	19.3
10 and above	2	1.4
Total	*140*	*100*
Gender		
Male	64	45.7
Female	76	54.3
Total	*140*	*100*
Age bracket		
Below 30	16	11.4
31–40	64	45.7
41–50	35	25
51–60	22	15.7
61 and above	3	2.1
Total	*140*	*100*

Source(s): Developed by authors after descriptive data analysis

Table 8. Respondents' characteristics

Latent variables	Mean	Std. dev.	1	2	3	4
Co-evolution	3.86	0.54	1.000			
Logistics capabilities	3.90	0.49	0.74	1.000		
Operational agility	3.84	0.64	0.69	0.83	1.000	
Organizational Capacity building	3.91	0.53	0.53	0.71	0.54	1.000

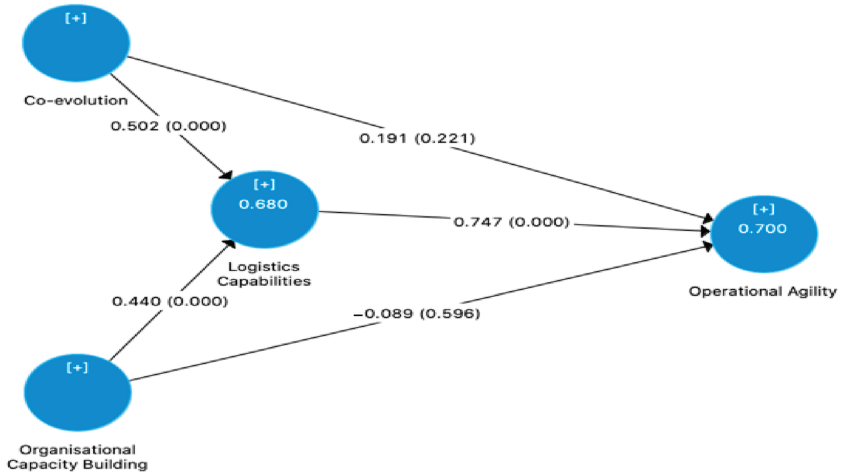
Note(s): $N = 45$, **., *. Correlation is significant at the 0.01 and 0.05 level (2-tailed)

Source(s): Developed by authors after conducting correlational data analysis

Table 9. Descriptive and correlations results for study variable

assessed using Stone and Geisser's cross-validated redundancy index (Q^2) by blindfolding and measuring seven omission distances. The predictive relevance of operational agility is (0.39), while logistics capability is (0.41). Since Q^2 is greater than zero, endogenous constructs are relevant. In terms of effect sizes (f^2), operational agility (0.24) and logistics capability (0.35) appear moderately significant. Using SmartPLS, *p*-values for path coefficients were calculated using a bootstrapped process with 95% significance based on 10,000 sub-samples. Table 2 presents the results, which are supported by Figure 2.

Logistics capabilities and operational agility have a positive and significant relationship. Co-evolution, organizational capacity building and logistics capabilities are positively correlated. According to Table 10, co-evolution and operational agility have a positive relationship, but not significantly, whereas organizational capacity building has a non-significant negative relationship. Logistics capabilities also significantly contribute to co-evolution and operational agility, accounting for 66% variance and 420.59% variance between organizational capability and operational agility, confirming the indirect relation



Source(s): Developed by authors after conducting PLS_SEM using SmartPLS

Figure 2.
PLS-SEM for operational agility

Direct effect	β	*T* stat	*p*-values	BCI	F2	Decision
CO → LC	0.50	4.36	0.00	0.18–0.64	0.56	Rejected
CO → OA	0.19	120	0.23	−0.11–0.51	0.06	Supported
LC → OA	0.75	4.46	0.00	0.38–1.07	0.60	Rejected
OCB → LC	0.44	3.68	0.00	0.16–0.62	0.43	Rejected
OCB → OA	−0.09	0.52	0.60	−0.45–0.20	0.01	Supported

Indirect effect	β	*T* stat	*p*-values	BCI	VAF	
CO → LC → OA	0.38	3.15	0.00	0.17–0.65	66%	Supported
OCB → LC → OA	0.33	2.58	0.01	0.11–0.62	420.59%	Supported

Total effect	β	*T* stat	*p*-values	BCI
CO → LC	0.50	4.36	0.00	0.18–0.68
CO → OA	0.57	4.69	0.00	0.36–0.79
LC → OA	0.75	4.46	0.00	0.38–1.07
OCB → LC	0.44	3.68	0.00	o.16–0.62
OCB → OA	0.24	1.38	0.17	−0.15–0.48

Predictive criteria	R^2	Adj.R^2	Q^2	Q^2-predict	RMSE	MAE
LC	0.68	0.67	0.63	0.44	0.63	0.44
OA	0.70	0.68	0.67	0.63	0.76	0.55

Note(s): *Key:* operational agility (OA); co-evolution (CO); organizational capacity building (OCB) and logistics capabilities (LC)
Source(s): Created by authors after PLS_SEM analysis

Table 10.
Hypotheses testing results

between co-evolution, organizational capacity building and operational agility. Hence, logistics capability is a complementary mediator between organizational capacity building and operational agility and a full mediator between co-evolution and operational agility.

5. Discussions

In spite of a positive correlation, co-evolution and operational agility have no significant relationship. This means healthcare facilities can manage immediate and short-term operational risks by maintaining operational flexibility and responsiveness. Interdependent healthcare facilities can also continuously adapt to achieve their goals. This adaptation allows them to provide emergency medical services more effectively during pandemic outbreaks like COVID-19 and Ebola by sharing resources such as oxygen cylinders, vehicles and research and development. Consequently, healthcare facilities can reduce operating costs and achieve their objectives. Additionally, healthcare facilities with management teams that communicate effectively with pandemic outbreak suppliers are better able to adapt to unexpected changes. Pandemic emergency units in healthcare facilities can identify risks and opportunities by sharing information. For instance, the outpatient department can share information with emergency units and isolate suspected outbreak patients immediately.

The findings further reveal that feedback is related to effectiveness. Providing feedback to employees and encouraging them to work together toward a common goal can help hospitals adjust their employees' behavior in response to a constantly changing operating environment. Therefore, hospitals dealing with COVID-19 must collect customer feedback to manage the health emergency effectively. Frontline workers at the MoH and health emergency treatment centers continue to receive positive feedback for their dedication, hard work and commitment in rendering medical services to emergency patients like those with COVID-19 or Ebola. For their efforts, frontline health workers involved in the fight against these diseases received close to 80,000 Ugandan shillings ($22) per day as a risk allowance. Such positive feedback encouraged health emergency treatment facility employees to maintain selfless behavior in providing patient care, leading to quicker patient recoveries across the country. This aligns with Dong *et al.* (2016), who indicate that firms develop their core values over time to adapt to change and survive, and Lingard *et al.* (2012), who emphasize how inter-individual collaboration enhances emergency response and information flow. As CAS theory posits, agents and organizations in CAS maintain interactions with each other and their environment, allowing them to modify their behavior as their environment changes (Rammel *et al.*, 2007).

A significant and positive correlation exists between co-evolution and logistics capabilities. Health facilities that cooperate with one another can develop logistics capabilities by introducing integrated processes and service innovations to deliver health emergency services. Collectivity is also related to logistics capabilities, as the results indicate. Health facilities that share emergency tasks and provide mutual support can combine their efforts effectively due to cooperative traits, unity and frequent communication, facilitating real-time information sharing between stakeholders, including the MoH, the pandemic taskforce, ambulance personnel, doctors and nurses.

Our study found that the MoH shared information with regional hospitals about standard operating procedures such as washing hands with soap and water, using sanitizers frequently, keeping a distance of two meters, wearing face masks and avoiding touching soft parts to prevent the spread of pandemic diseases. Moreover, feedback was found to be associated with logistics capability. Health facilities that pay close attention to patients' responses can introduce service innovations like sharing COVID-19 or Ebola information with them in real-time. Health facilities that regularly seek feedback from their emergency

units can share pandemic supply forecasts. Our research found that health facilities had to provide feedback on COVID-19 and Ebola cases and supplies. The health facilities we studied required physicians to provide daily reports on the number of patients admitted, recovered and newly diagnosed.

This study supports findings by Coetzee *et al.* (2016) and Williams *et al.* (2017) that feedback loops facilitate learning and adaptation in dynamic environments, improving organizational performance. It also aligns with scholars (Neirotti and Raguseo, 2017), who found that organizations can adapt to changing operating situations through co-evolution. This finding aligns with CAS theory, which emphasizes the importance of building relationships through feedback loops and information sharing within teams (Lingard *et al.*, 2012).

A positive and significant relationship exists between logistics capability and operational agility. Health facilities were able to respond quickly and effectively to pandemics like COVID-19 and Ebola by integrating their services and collaborating. Health facilities with higher innovative capabilities, such as parcel tracing and emergency services, are more likely to treat pandemic outbreak patients effectively.

Our investigation revealed that health emergency units used rapid testing kits and laboratory equipment to screen people suspected of having COVID-19 or Ebola. Treatment centers were able to administer the right combination of drugs or medications for patients diagnosed with the disease based on infection rates, resulting in rapid recovery for both emergency room patients and those treated at home.

Furthermore, the findings suggest that integrating technology into health facility operations increases their effectiveness in providing health emergency services. Health facilities that share sensitive information with COVID-19 or Ebola patients are often stable and up-to-date. The MoH and pandemic emergency units used WhatsApp to share real-time information about case management and updates. They also used websites, television and radio to inform the public about newly diagnosed cases, bed capacity and ICU facilities. For example, the MoH shared instructional videos on COVID-19 and Ebola case management via the Government of Uganda COVID-19/Ebola Response Information Hub. By integrating stakeholders' information systems, health facilities and workers can respond more effectively to pandemics, resulting in lower costs and quicker access to information. According to the study, health facilities that cooperate on emergencies and share information are more likely to develop more efficient operating models and make significant changes in their emergency response. Emergency units coordinated with MoH headquarters to fight COVID-19 and Ebola.

Generally, these units implemented decisions of the MoH and the Permanent Secretary of Health, such as using protective equipment like face masks, face shields, gloves and other PPE while working to avoid infection. These findings are consistent with Ainomugisha (2022) and Yen and Hung (2017) demonstrating that collaborative organizations are more flexible and capable of responding to disruptions when they are innovative and use information technologies. Based on CAS theory, a network of interconnected, interdependent, adaptive organizations can self-organize by interacting frequently to cope with difficult situations (Arena, 2009; Lindberg and Clancy, 2010).

In this study, logistics capabilities positively correlated with organizational capacity. Health facilities with continuous learning and collaboration are more likely to develop logistics capabilities like service innovation. Being purposeful also contributes to health facilities' ability to innovate. As a result, health facilities that recognize pandemics and purposefully offer emergency services such as parcel tracking can effectively screen people for COVID-19. Health facilities in Uganda, with support from the MoH, introduced services like parcel tracing during the second wave of cases. Occasionally, health facilities tested communities reporting high COVID-19 and/or Ebola prevalence rates using rapid testing kits

in selected towns, border points and markets. Furthermore, health facilities introduced thermometers to test patient temperatures, and those working in emergency units wore PPE.

The results show that health facilities with emergency resources provide more healthcare. Using PPE and following standard operating procedures (SOPs) that prevent exposure to COVID-19 and/or Ebola, health facility employees can work without fear, inspired and focused on providing patient care. A health facility's pandemic emergency unit can share information with patients in real time when it has the necessary resources. Health facilities were sharing COVID-19 and/or Ebola patient information with the MoH. Daily reports included the number of patients admitted and the number of positive and negative tests conducted each day. The results suggest that health facilities working on COVID-19 and/or Ebola health emergency services integrated their IT systems. Health facilities that establish and maintain relationships with key stakeholders within and outside their medical chain are more likely to integrate their operations successfully. By sharing sensitive patient information with other health facilities, emergency units built robust capabilities to cope with emergencies.

The study also found that health facilities dedicated to active learning and self-development are likely to integrate technology into their operations. Health facilities shared best practices for managing COVID-19 and/or Ebola information in real time by integrating their IT systems. This finding supports authors' conclusions (Altay and Labonte, 2014; Park *et al.*, 2013) that organizations collaborating are more likely to use IT to exchange relevant and timely information, strengthening coordination and collaboration during crises. It extends CAS theory, which says organizations emerge through interactions with many interdependent organizations and participants, self-organizing and creating novel outcomes unintentionally. Ugandan health facilities providing emergency services operate in a CAS, where drivers, nurses, laboratory technicians, the pandemic task force and medical officers continuously learn and interact with each other, the MoH and the World Health Organization (WHO). As a result, health facilities developed patterns of self-organization, introducing innovations like temperature guns.

Organizational capacity building has a negative and insignificant relationship with operational agility. Health facilities delayed responding to pandemic cases like COVID-19 and/or Ebola due to a lack of capacity, despite being mandated to provide emergency healthcare. Their operational agility suffered as they reorganized operations, acquired necessary medical logistics and hired more health workers. Hospitals took time to instill purposefulness traits like aligning goals and objectives, creating processes to achieve the overall purpose and sharing a sense of common purpose, preventing a timely response to health emergencies. The MoH quickly designated facilities as treatment centers during COVID-19 and/or Ebola outbreaks but took time to mobilize human resources due to the health risks. Many medical workers hesitated to be resourceful in emergency healthcare for COVID-19 and/or Ebola patients, fearing virus contraction, leading to increased cases and deaths due to delayed responses.

The study found that collaboration negatively and insignificantly impacts operational agility. Health facilities' response to health emergencies was delayed due to time-consuming collaborative initiatives like developing trust, maintaining relationships and understanding competencies. This limited their ability to manage pandemic cases effectively. Collaborative initiatives led to delays in providing medical services to COVID-19 and/or Ebola patients, particularly those referred to distant facilities, resulting in higher fuel costs and increased patient deaths.

Learning orientation negatively and insignificantly affects operational agility. Health facilities took longer to research and decide on response strategies for COVID-19 and/or Ebola cases. MoH officials and top medical staff took a long time to research and adapt best practices, changing treatment guidelines and developing cheaper testing kits. This delayed

decision-making and hospital response times, impacting their ability to respond to emergencies quickly and effectively.

This study contradicts previous studies by L'hermitte *et al.* (2015), who found that purpose, action, collaboration and learning are dimensions of agility, the ability to react quickly to changes, uncertainty and disruptions. The findings do not support Musonda (2016), who claims that organizational capacity building enhances resource and skill deployment.

Extending CAS theory, we propose that organizations within CASs are interdependent, learning from each other, their environment and experiences, helping them adapt to unexpected situations (Palmberg, 2009; Zimmerman *et al.*, 1998). The learning process for COVID-19 was time-consuming, resulting in delayed decision-making and extended hospital response times.

5.1 Conclusion

In summary, this study highlights the significant relationship between logistics capabilities, co-evolution, organizational capacity building and operational agility within healthcare systems, guided by complex adaptive system theory. While logistics capabilities positively impact both co-evolution and operational agility, co-evolution's link to operational agility lacks statistical significance. Organizational capacity building shows a non-significant negative association with operational agility. Crucially, logistics capabilities act as a key mediator between organizational elements and operational agility, emphasizing their vital role in healthcare agility.

5.2 Implications, limitations and areas for further research

5.2.1 Theoretical implications. The theoretical contributions stemming from the study's findings, grounded in complex adaptive system theory, can be articulated as follows:

One of the primary theoretical contributions lies in deepening our comprehension of the intricate relationships within complex adaptive systems, specifically within healthcare settings. The study elucidates how logistics capabilities are not merely peripheral elements but integral components that significantly shape operational agility. By establishing a positive and significant relationship between logistics capabilities and operational agility, the research underscores the critical role of logistics in influencing system responsiveness and adaptability.

Secondly, the study introduces a nuanced understanding of mediation dynamics within complex systems. The revelation that logistics capabilities act as a complementary mediator between organizational capacity building and operational agility and a full mediator between co-evolution and operational agility offers a sophisticated theoretical framework. This insight enriches the existing literature by highlighting the multifaceted roles logistics capabilities play in mediating and enhancing system dynamics, emphasizing their centrality in shaping organizational outcomes.

Thirdly, the study's emphasis on significant variances, such as the 66% and 420.59% variances observed, contributes quantitatively to our theoretical understanding. These metrics provide empirical evidence of the magnitude of influence logistics capabilities exert on organizational capability and operational agility within complex systems. Such quantitative insights pave the way for future research endeavors to delve deeper into the granularity of these relationships, potentially uncovering additional layers of system dynamics.

Lastly, by highlighting the positive correlations among co-evolution, organizational capacity building and logistics capabilities, the research reshapes our theoretical lens on organizational evolution within complex systems. It underscores the need to perceive

organizations not as static entities but as evolving, interconnected systems that adapt in tandem with external shifts while bolstering internal capacities. This reconceptualization offers a more holistic perspective, emphasizing the symbiotic relationships that drive organizational resilience and effectiveness.

5.2.2 Practical implication. Firstly, recognizing the significant positive relationship between logistics capabilities and operational agility stresses the importance for healthcare facilities to invest in robust logistical systems. Facilities must prioritize the development and enhancement of logistical frameworks. This ensures timely access to medical resources, patient care equipment and pharmaceuticals, facilitating a more rapid and effective response to patient needs, particularly during emergencies or surges in demand.

Secondly, the positive correlations among co-evolution, organizational capacity building and logistics capabilities highlight the need for a comprehensive approach within healthcare settings. Healthcare facilities should cultivate environments that evolve with medical advancements and changing patient demographics (co-evolution) while consistently strengthening their foundational capacities. This dual approach ensures facilities remain adaptive, resilient and equipped to meet evolving healthcare demands.

Thirdly, the positive inclination of co-evolution toward operational agility, despite its lack of statistical significance, suggests that healthcare practitioners should closely examine scenarios where adapting to medical advancements or external changes leads to increased agility. This understanding will help facilities identify areas needing further organizational adjustments to optimize patient care delivery.

Moreover, the non-significant negative relationship between organizational capacity building and operational agility prompts healthcare facilities to evaluate their growth strategies critically. While expanding capabilities and services, facilities must be cautious not to introduce bureaucratic or procedural complexities that could impede rapid and effective patient care.

Most notably, the study's emphasis on logistics as both a complementary and full mediator underscores its strategic importance in healthcare settings. Healthcare facilities should not view logistics merely as a supportive function but as a vital component of their operational strategy. By ensuring logistics systems are agile, adaptable and aligned with the facility's evolving needs, healthcare practitioners can optimize patient outcomes and enhance overall operational efficiency within a dynamic healthcare landscape.

5.3 Limitations and areas for further research

A quantitative cross-sectional survey was conducted using self-administered questionnaires. Nevertheless, this did not capture detailed information about pandemic emergency treatment. Qualitative approaches are appropriate for detailed responses. Additionally, health sector agility measures are scarce, and we've domesticated most items from other sectors. Resilient systems, on the other hand, can guarantee operational agility, which is why research on resilient health systems is needed. Further analysis of the cause of delays in providing treatment in public health facilities requires a survey of lead-time management.

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Supplementary material

The supplementary material for this article can be found online.

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