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Adaptability capacity framework for sustainable practices in the Ghanaian construction industry

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Received 26 January 2022
Revised 20 April 2022
22 June 2022
Accepted 1 September 2022

Abstract

Purpose – The urgent need to preserve the ecosystem, which faces a threat from non-environmentally-friendly anthropogenic activities, has led to the study of adaptive capacity implementation. There is an indication that the construction industries in developed countries are relatively better equipped to pursue sustainable construction than those in the developing world. Despite this, sustainable construction is yet to be established in developing countries. This research aims to develop a framework to drive and enable small and medium-sized (SME) firms in Ghana to implement adaptive capacity.

Design/methodology/approach – The study adopted a quantitative approach, and 400 responses were retrieved as a sample size for which a six-factor adaptive capacity implementation framework was arrived at for SMEs in the Ghanaian construction industry. The data gathered from the respondents were analysed using IBM SPSS version 26 and AMOS version 24, and a structural equation modelling was also used to determine the work's validity based on the AMOS software.

Findings – The findings revealed that education and training, government support and a centralised information hub significantly influence adaptive capacity outcomes in Ghana.

Practical implications – It is recommended that the government, corporate and professional institutions that desire to preserve the country's ecosystem be guided by this study's adaptive capacity implementation framework.

Originality/value – This study's novelty also lies in the integrated framework for adaptive capacity implementation developed to aid small- and medium- sized enterprises in Ghana's construction industry to ensure environmentally-friendly construction activities.

Keywords Adaptive capacity, Small- and medium-sized (SME) firms, Construction industry, Framework, Sustainable practices

Paper type Research paper

1. Introduction

Adaptability is used interchangeably with adaptive capacity. The concept is expressed as "the capacity of actors in a system to influence resilience" (Pisano, 2012; Mensah, 2017). According to Gunatilake and Perera (2018), adaptability is a system's capacity to adjust if the existing environment changes. He *et al.* (2021) illustrate adaptive capacity by comparing it to the social-ecological system. The illustration opines people's willingness within a specific community to deal with changes in their setting by identifying, learning a new thing and modifying their interactions (Ramachandra and Karunasena, 2017). The concept of adaptive capacity was initially used in biological sciences for living things to adapt to a specific range of environmental conditions, including climate change (Waidyasekara and Senaratne, 2020). In the context of environmentally sustainable construction (ESC) adaptation, adaptive

Built Environment Project and Asset Management
Vol. 13 No. 1, 2023
pp. 89-104

2044-124X
DOI 10.1108/BEPAM-01-2022-0016

capacity can be categorised under social-ecological resilience and generally refers to the ability of the methods to adjust, to adapt to lasting developmental impacts. According to Intergovernmental Panel on Climate Change (IPCC) (2018), economic wealth living, technological advancement, information and skills, infrastructures, institutions and equity are the main determinants of adaptive capacity. Hogarth and Wójcik (2016) discussed Adaptive Capacity and compared it to humankind's ability to be more satisfactory in the selective constraint of circumstances, including environmental change. The thought can change a system's vulnerability to high esteem. Thus, the adaptive capacity of SME construction firms, as an actor within a social-ecological system of the construction industry, is referred to as the capacity to influence resilience to lead to an effective adjustment. Also, to the demand for ESC as a global process of change in the construction industry, by observing the changes, learning the innovation and altering the interactions between adapters.

Adapting the construction industry to Sustainable Construction (SC) practices is essential (Ranadewa *et al.*, 2021). The infrastructural deficit in developing countries with the quest for accelerated development is a precipitator of vigorous developmental activities. Such activities must be well managed based on sustainable development (SD) principles to not retard global efforts towards achieving sustainability. Hence, the adaptability of social-ecological systems, such as the construction industry, needs improvement in changing industry practices associated with SD. According to Mensah (2017), environmental sustainability was captured under goal number seven of the Millennium Development Goals (MDG) in the year 2015 (United Nations Conference on Sustainable Development (UNCSD), 2012). However, this target's achievement was a mirage, especially in developing countries (Du Plessis, 2014). Therefore, in 2015, the global goals of SD were established by the UN to foster the implementation of the MDGs. The purposes replaced the MDGs, which were not achieved by the said date of 2015 across the globe (Sengupta *et al.*, 2015; Mensah, 2017). Subsequently, the need to develop and pursue the global goals of SD has become indispensable. Seventeen goals of SD, having the target year of 2030, have been established. These are Sustainable Development Goals (SDGs), where industry, innovation and infrastructure are captured under goal number nine (9) to oversee SC. To achieve the SDGs by the target year 2030 within 15 years duration, all developmental sectors need to strengthen research, innovation and industrial efforts. With this coherent ideological plan, the construction industry, for its part, has a significant role to play by having the adaptive capacity to reduce the magnitude of disruptive events in construction projects delivery to the effect of the environment, especially in ensuring resilient infrastructure in an environmentally sustainable manner. Du Plessis and Brandon (2015) have argued that a considerable paradigm shift is needed to travel smoothly on the definite curve to sustainability. The shift towards the social-ecological system's adaptive capacity needs to be given global attention (Du Plessis, 2014). Humans need to provide guidelines for interpreting ESC practices and the relevant strategies to determine the path towards adapting to changes in the planetary system.

SME construction firms' capability to adapt to ESC processes is primary to the construction industry's overall contribution to SDG achievement. It is worthy to note that SME construction firms remain significant stakeholders in the building industry. Mensah (2017) and Agyekum *et al.* (2021) observe that SME construction firms, especially those in developing countries, lack the capabilities to pursue requirements to ensure the effective achievement of the sustainability agenda. Furthermore, there is a lack of frameworks and little use of theories to guide the interpretation of sustainability issues in the construction industry (Hettige *et al.*, 2017; Sarkis *et al.*, 2011). Moreover, merely identifying these barriers would not facilitate adequate adaptation to SC. Understanding the nature and context of barriers against ESC adaptation, enablers and drivers of ESC are primary to developing SME construction firms' capability to adapt to ESC. Thus, understanding the complexities surrounding sustainability in the construction sector is crucial. However, most industry players in developing countries in Africa cannot effectively apply the knowledge, requisite skills and technology needed to establish SC (Du Plessis, 2005, 2007; Mensah, 2017). Against this background, the study aims to develop a framework that will drive and enable small- and medium-sized (SME) firms in Ghana to implement adaptive capacity in their project delivery. The study provides valuable contributions to literature. Firstly, the magnitude of disruptive events through construction projects' delivery to the environment has been addressed in this study. Secondly, an appropriate guideline to facilitate a paradigm shift to foster effective adaptation to ESC, especially SME Construction firms in Ghana, the study country, has also been captured.

2. Small and medium-sized firms in Ghana for adaptive capacity

The ultimate purpose of SC worldwide is to achieve infrastructural projects and the ecosystem for humanity and future generations. The subject of adaptive capacity is relatively new in the selected area of study, focusing on how SME construction firms implementation of ESC projects. Ametepey *et al.* (2015) observed that SME construction firms formed one of the backbones of the country's economy. They cannot do away with the adaptive capacity for ESC practices. Adjarko *et al.* (2016) posit that SME construction firms are a significant segment of Ghana's economy.

According to Oduro (2020), the "Ministry of Water Resources Works and Housing (MWRW&H) of Ghana groups the classification in collaboration with the Registrar General's Department". Oduro (2020) posits that the D1K1 class of contracting firms is categorised as large firms with D2K2 contracting firms as a medium, while D3K3 and D4K4 are categorised as small firms. Regarding money issues, each category in the firm's class could tender for a project within a certain financial threshold (Ofori-Kuragu *et al.*, 2017). However, this study emphasised the D4K4, D3K3 and D2K2 contracting firms, which are classified as SME construction firms for building and civil works (Oduro, 2020).

The country has regulatory bodies to monitor Ghana's adaptability policies for ESC. According to Braune (2016), the adaptation is to set a standard to measure green building qualities; promote integrated whole-building design to achieve SC. Moreover, recognise the innovative conditions, identify lasting life-cycle benefits and raise awareness of ESC. This effort requires stakeholders in the construction industry, especially contractors registered as SME construction firms, to adapt to SC practices that align with SD principles. Ofori-Kuragu *et al.* (2017) observed that the SME construction firms had not kept pace with the increasing awareness and adoption of ESC practices. Ametepey *et al.* (2015) point out that the SME construction firms' willingness to respond to the organisation's requirements is a significant challenge for SC.

2.1 Conceptual framework for adaptive capacity

Most adaptation for SC practices for the benefit of SD studies have combined the development of new knowledge and the commitment to adaptive capacity for ESC innovations. For instance, the European Network of Construction Companies for Research and Development, ENCORD (Buelvas, 2010), postulated the introduction of penalties such as increased taxation for contributing to carbon emissions and subsidising incentives for ensuring energy efficiency. Du Plessis (2002), Li *et al.* (2012) and Mensah (2017) pointed out the following strategic importance of SC practices, which, based on resilience theory when employed in the SME construction firms, would spearhead the efforts being made to establish SC globally. These SC practices include using indigenous building materials locally rather than transporting construction materials to the site from a more extended or "cross-country" distance which may contain hazardous substances to human health (Li *et al.*, 2012; Mensah, 2017). Unuigbe *et al.* (2020) admit that applying appropriate technology through research to develop materials that would suit the local environment is a factor that works perfectly with the pressure and release model. According to the resilience concept, the improvement of affordable natural ecological cycled materials such as bamboo is a plus. Mensah (2017, p. 51) posits that there should be a commitment to blending modern artistic work with traditional building practices and using building materials with a longer life span. The above approach goes hand-in-hand with industry members practising blue infrastructure by considering eco-sensitive technology and using manual methods where possible and more efficient.

Moreover, establishing and building institutional capacities to promote SD while increasing public awareness of sustainability and creating a SD concept into construction education curricula would contribute to the right direction. Hollings (1973) and Rogers (2003) theories were adapted for this current study. Therefore, based on this study's literature review, the following variables have been hypothesised to develop construction firms' adaptive capacity framework. The primary constructs for the framework development include adaptability and integration (ADI), adaptation success (ADS) and adaptive change (ADC). Moreover, education and training (EAT), government support (GVS) and centralised information hub (CIH) are also captured as gaps to promote adaptive capacity framework development, with each having 15 variables, respectively. Table 1 shows the summarised framework.

The following research questions were formulated based on the literature review and conceptual framework presented in Figure 1.

RQ1. To what extent could adaptability and integration for best construction practices influence the Ghanaian construction industry's implementation?

RQ2. To what extent does education and training implementation among SME construction firms influence the Ghanaian construction industry's adaptive capacity?

RQ3. To what extent does government support influence SME construction firms' adaptive change for best practices in project delivery in the Ghanaian construction industry?

RQ4. How can a centralised information hub be created to support SME construction firms' adaptability in the Ghanaian construction industry?

RQ5. To what extent does the hypothesised SME construction firm's adaptive capacity framework fit into the identified implementation factors?

3. Methodology

The research approach that underpins the study – This research study adopts a literature review and a field questionnaire survey based on a quantitative approach methodology. Quantitative research involves ascertaining amounts or quantities of one or more variables in a study (Leedy and Ormrod, 2010; Garg, 2019). From a similar explanation, quantitative analysis is based on testing a theory collected of variables, deliberated with numbers and analysed using statistical methods to observe whether the proposed phenomena holds (Naoum, 2012; Creswell, 2003; Creswell and Plano Clark, 2010). Leedy and Ormrod (2010) emphasise that the quantitative research methodology discovers explanations that give general applicability. The intention was to establish and confirm relationships and develop relevance that contributes to existing theories.

The population of the study – According to Arthur-Aidoo *et al.* (2016), the population of an investigation is essential in research to improve reliability and validity. The target population

Latent variable constructs	Measurement variables
Adaptability and integration (ADI)	Level of SME firm's knowledge; Social systems; Psychological factors/values; Perceptions and willingness; Socially responsible organisations; Effective adaptation commitment; Individual economic wealth; Communication networks; Technological development; Technology inequality; The rich-poor gap in society; Adequate training and appraisals; Participation in decision-making; Building active communication
Adaptation success (ADS)	Desire to learn innovation; An agent of change recognition; Behaviour change for innovation; Resources and technology; Information and skills; Institutions and equity; SME's mutual understanding; System environmental quality; Social capital; Overall work satisfaction; Defects reduction; Decrease construction project cost; Client satisfaction after project; Continuous improvement
Adaptive change (ADC)	Innovation decision process; A collaborative effort of adaptation; Opinion leader's recognition; Dissemination and implementation; Interpersonal communication; Exposure to external impacts; Compatibility of the innovation; Human health factor; Social equity; Low-carbon economy; Total lower cost of Construction; Best construction value to clients; Socio-cultural values; Tendencies to push resilience
Education and training (EAT)	Low computer literacy levels; Incompatibility of new service; Learning and interactions; A higher level of ignorance; Interpersonal communication; Mental grasp of change; Information exchange; Waste minimisation; Environmental requirements; Protection of sensitive; ecosystems; Lean design and Construction; Environmental regulations; Carbon reduction strategy; Noise and dust minimisation
Government support (GVS)	Systems internally; Country's geographical location; Cultural values and sensitivity; Regional climatic environment; Reluctance to change the culture; Human-in-nature perspective; Performance drivers; National adaptation for innovation; Policy reform for the innovation; Subsidising company's incentives; Prerequisite on emission taxation; successful Edifying performance; Vulnerability reduction; Urging sustainable principles
Centralised information hub (CIH)	Social network communication; Effective commitment; Ecological information sharing; Dissemination of information; Members interpersonal contacts; Organisational social interaction; Inter-organisational relationships; The spread of messages and awareness; Capacity to control information; Innovation accomplishment; Higher positive feedback; Knowledge creation; Access to computer and Internet; Technological progression
Adaptive capacity brings about	Ease of learning innovative trends; Ease of innovative application during project execution; Optimisation of resources and technology; Opportunity to attract incentives from the government; Wavier of CO_2 emission taxation; Application of sustainable principles in projects execution; Establishment of information and skills in the entity; Development of Capacity to adapt to changing environment preservation principles; Opportunity for information exchange with other small and medium-sized entities; Achievement of lean design; Ability to apply sustainability principle during contract execution; Achievement of Construction; Minimisation of waste in the entity; Contribution/ reduction of a carbon footprint as an entity; Ability to adapt to the changing context of work in the new era; Ability to adapt to new working methods; Ability to adapt new materials for construction

Source(s): Author's Conceptual Framework

Table 1. Conceptual framework latent constructs

for the field survey consisted of participants in the professional bodies in the construction industry across all the 16 regions in Ghana, the study country, who were on the institution's database. The professionals are the members from the Ghana Institution of Engineering (GhIE), Civil division only in good standing, working for contractors, consultants and the

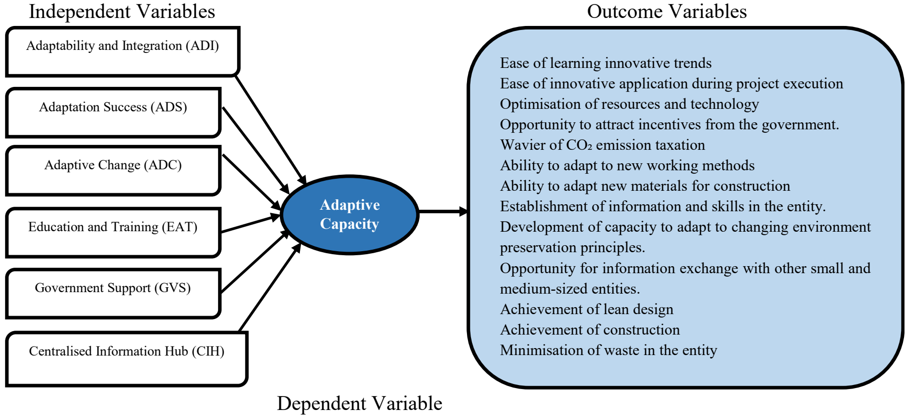

Figure 1.
An integrated conceptualised framework for adaptive capacity

public sector institutions estimated to be approximately 1,000 ranging from Professional Engineering Technologist to Fellow members. The Ghana Institution of Surveyors (GhIS), quantity surveying division members only in good standing work for contractors, consultants and public sector institutions of 1800 population on the database. The Ghana Institute of Architects (GIA) members in good standing working for contractors, consultants and public sector institutions in construction who have extensive knowledge of the subject to a size of 2000 on the institution register. The selected division professionals were the sample frame and selection of the study. Those in the public sector include the district, municipal and metropolitan authorities responsible for construction permits, project inspection, planning, design and works directorates.

Sampling procedure and sample size – The sample size used in this study was determined based on the data collection expense and the need for sufficient statistical power to validate the conceptual framework. The sample size for this study was not based on the entire population of the selected professionals; therefore, the sample size was not equal to the population size. According to Neuman (2006), how large a sample should depend on the kind of data analysis the study plans to use, how accurate the sample has to be for the study purposes and the population characteristics; therefore, 400 responses were retrieved as a sample size for this study.

Survey administration – The survey questions were formed based on the theoretical backbone of the study's literature review. The data collection stage of the study adopted a formal administration of questionnaires through Microsoft Google Forms as a data collection instrument to aid the achievement of the study's objective. On the contrary, secondary data denotes data gathered and processed by other researchers and further reanalysed for diverse purposes (Rubin and Babbie, 2008). The primary analysis was conducted in this study. The primary data helped the researcher investigate the framework for adaptability and integration of best construction practices in the Ghanaian construction industry.

Data analysis technique – Structural equation modelling (SEM) with EQS software was proposed for the data analysis technique for this research, which is very sensitive to sample size and offers stability when estimating a small sample (Williams *et al.*, 2004; Aigbavboa, 2013). Ametepey (2019) researched sustainable road infrastructure for developing countries and used SEM. The empirical study observed that larger sample sizes increase precision in making inferences about the population. Aigbavboa (2013) posit that at least 300 participants in SEM analysis are considered comfortable; up to 500 participants render very well, while up to 1,000 participants deliver excellent results. The main method used for collecting the primary data includes a structured questionnaire. The data gathered from the respondents were analysed using IBM SPSS version 26 and AMOS version 24. The SPSS software aided in computing the descriptive analysis (such as mean, standard deviation (SD), frequencies and percentages) and exploratory factor analysis tool and information processing for the study. The SEM was also used to determine the work's validity based on the AMOS software.

4. Analysis and results

4.1 Testing the influence of the adaptability and integration, and adaptation success on the outcome of adaptive capacity

The SEM in AMOS was executed to check the effect of adaptability and integration and adaptation success on adaptive capacity (see Figure 2). The model first confirmed that it

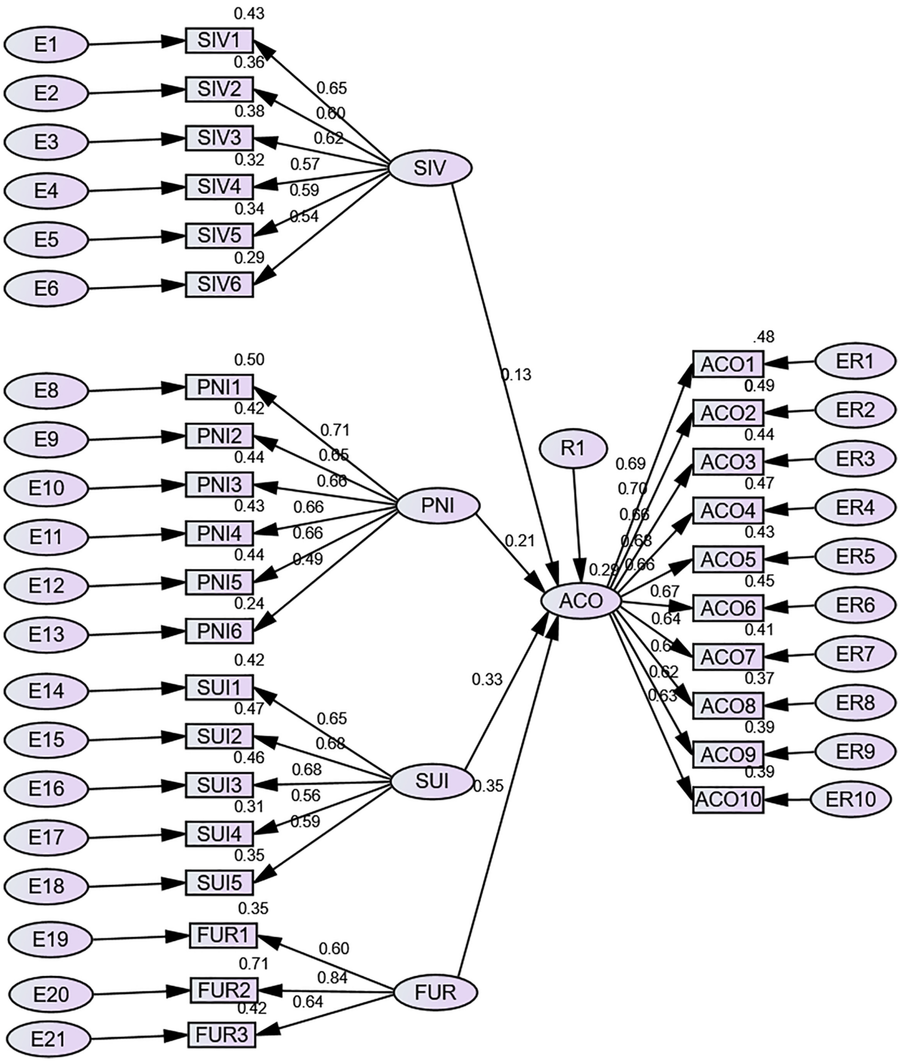

Figure 2.
SEM for the effect of the adaptability and integration, and adaptation success on the outcome of adaptive capacity

provided values in the acceptable range, as Hu and Bentler recommended (1999). The sample data yielded the S – Bχ^2 of 4.378 with 401 degrees of freedom (df) with a probability of $p = 0.0000$. This chi-square value indicated that the departure of the sample data from the postulated model was significant and, hence, indicative of a good fit for the model for the effect of adaptability and integration and adaptation success on adaptive capacity. It also suggested that the postulated model adequately describes the sample data. SEM model for the effect of adaptability and integration and adaptation success on the outcome of adaptive capacity features are presented (Figure 2).

Table 2 shows the correlation values, standard errors and statistics test. From the table, the correlation values were less than 1.00, and all the p-values were smaller than 0.05, except SIV on ACO. The highest standardised coefficient parameter was the FUR on ACO, which was 0.349.

The R-Square values indicate that SIV, PNI, SUI and FUR explained 28.7% of ACO variance. Therefore, the results suggest that PNI, SUI and FUR significantly influence ACO, whilst SIV insignificantly influences ACO (Table 2). Thus, PNI, SUI and FUR have a relationship with ACO, whiles SIV have no relationship with ACO.

4.2 Testing the influence of the adaptive change and education and training on the outcome of adaptive capacity

The SEM in AMOS was executed to check the effect of adaptive change and education and training on adaptive capacity (see Figure 3). We first confirmed the model fits that provided values in the acceptable range, as Hu and Bentler recommended (1999). The sample data yielded the S – Bχ^2 of 4.059 with 523 degrees of freedom (df) with a probability of $p = 0.0000$. This chi-square value indicated that the departure of the sample data from the postulated model was significant and, hence, indicative of a good fit for a model for the effect of adaptive change and education and training on adaptive capacity. It also suggested that the postulated model adequately describes the sample data (Table 3).

The SEM model for the effect of adaptive change and education and training on adaptive capacity features is presented (Figure 3). For a variable to be included in the analysis, thus enabling the model to be described as well-fitting, the residuals covariance matrix distribution should be symmetrical and centred around zero (Byrne, 2010).

Table 3 shows the correlation values, standard errors and statistics test. From the table, all the correlation values were less than 1.00, and all the p-values were smaller than 0.05 significant level except PBA on ACO. The highest standardised coefficient parameter was the CRT on ACO, which was 0.480.

The R-Square values indicate that CRT, SOC, PBA and IPA explained 41.5% of ACO variance. The results, therefore, suggest that CRT, SOC and IPA significantly influence ACO. Whiles PBA insignificantly influences ACO (Table 3). Thus, CRT, SOC and IPA have a relationship with ACO, whiles PBA have no relationship with ACO.

Table 2.
Factor loading and p-value of the effect of adaptability and integration, and adaptation success on the outcome of adaptive capacity

Hypothesised relationships (path)	Unstandardised coefficient (λ)	Standardised coefficient (λ)	p-value	R-square	Significant at 5% level
ACO ← SIV	0.120	0.125	0.116	0.287	No
ACO ← PNI	0.196	0.208	0.006		Yes
ACO ← SUI	0.341	0.327	0.000		Yes
ACO ← FUR	0.409	0.349	0.000		Yes

Source(s): Author’s compilation of hypothesis results

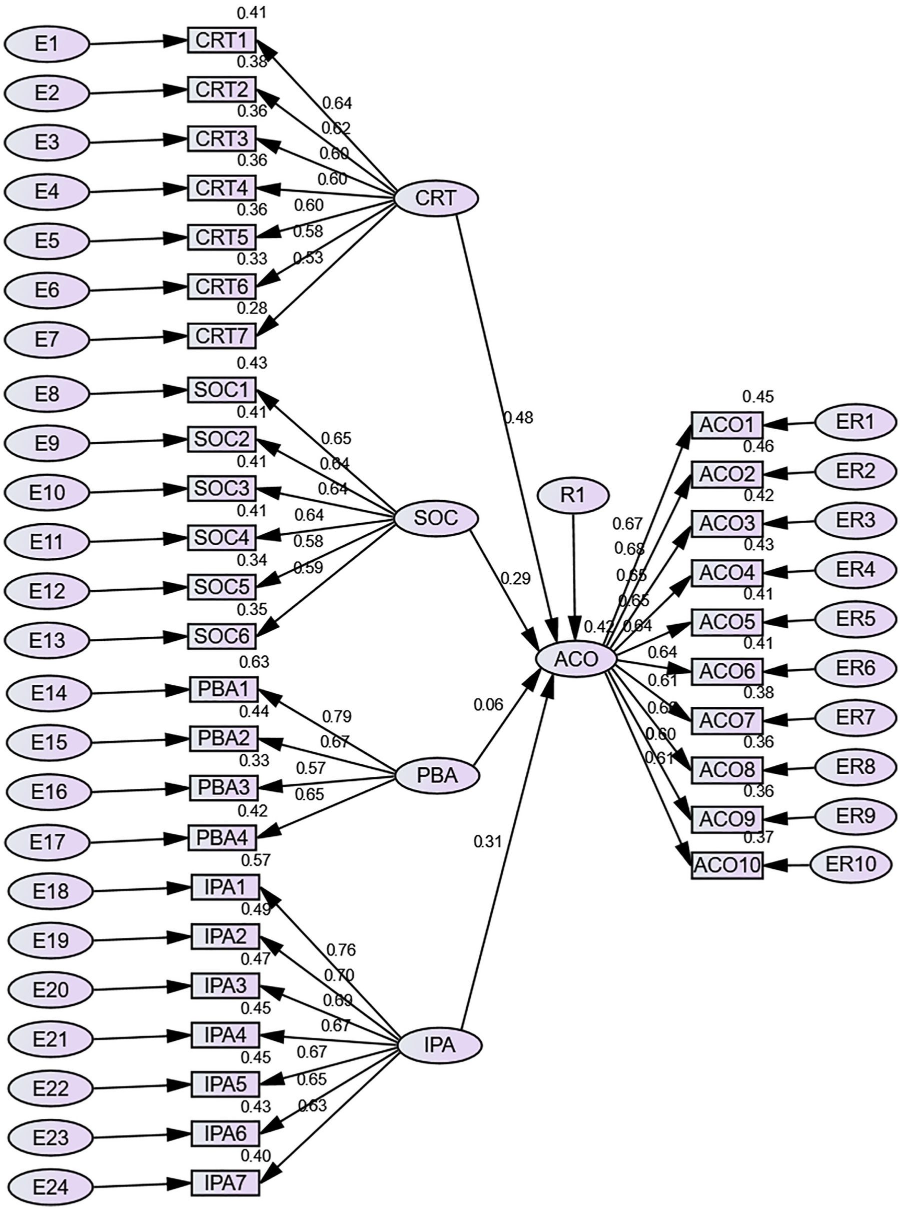

Figure 3.
SEM for the effect of adaptive change and education and training on the outcome of adaptive capacity

4.3 Testing the influence of the government support and centralised information hub on the outcome of adaptive capacity

The SEM in AMOS was executed to check the effect of government support and a centralised information hub on adaptive capacity (see Figure 4). The analysis first confirmed the model fits that provided values in the acceptable range, as Hu and Bentler recommended (1999). The sample data yielded the $S-B\chi^2$ of 4.413 with 401 degrees of freedom (df) with a probability of

p = 0.0000. This chi-square value indicated that the departure of the sample data from the postulated model was significant and, hence, indicative of a good fit for a model for the effect of government support and centralised information hub on adaptive capacity. It also suggested that the postulated model adequately describes the sample data.

The SEM model for the effect of government support and a centralised information hub on adaptive capacity features is presented (Figure 4). For a variable to be included in the analysis, thus enabling the model to be described as well-fitting, the residuals covariance matrix distribution should be symmetrical and centred around zero (Byrne, 2010).

Table 4 shows the correlation values, standard errors and statistics test. From the table, all the correlation values were less than 1.00, and all the p-values were smaller than 0.05 significant level except for IMD on ACO. The highest standardised coefficient parameter was the IDE on ACO, and its parameter coefficient was 0.418.

The R-Square values indicate that POB, IDE, IMD and ITD explained 47.2% of ACO variance. The results, therefore, suggest that POB, IDE and ITD significantly influence ACO. On the other hand, IMD insignificantly influences ACO (Table 4). Thus, POB, IDE and ITD have a relationship with ACO, but IMD has no relationship with ACO.

5. Discussion of findings

A confirmatory factor analysis results were used to answer the research questions: To what extent could adaptability and integration for best construction practices influence the Ghanaian construction industry's implementation? From the confirmatory factor analysis, out of the 14 indicator variables, 12 indicator variables made up of 2 sub-scale components were realised as SIV (SIV1, SIV2, SIV3, SIV4, SIV5 and SIV6) and PNI (PNI1, PNI2, PNI3, PNI4, PNI5 and PNI6). It was found that all the measured variables were significantly associated with the two sub-scale components (SIV and PNI) under the adaptability and integration (ADI) construct. The parameter with the highest standardised coefficient was the indicator with the variable "building active communication" (PNI1) with a parameter coefficient of 0.702.

From the confirmatory factor analysis on *Adaptive Success* (ADS), out of the 14 indicator variables, 7 indicator variables made up of 2 sub-scale components realised as SUI (SUI1, SUI2, SUI3, SUI4 and SUI5) and FUR (FUR1, FUR2 and FUR3). It was found that all the measured variables were significantly associated with the two sub-scale components (SUI and PNI) under the ADS construct. The parameter with the highest standardised coefficient was the indicator with the variable "Social capital" (FUR2) with a parameter coefficient of 0.745.

From the confirmatory factor analysis FOR *Adaptive Change* (ADC), out of the 14 indicator variables, 13 indicator variables made up of 2 sub-scale components were realised as CRT (CRT1, CRT2, CRT3, CRT4, CRT5, CRT6 and CRT7) and SOC (SOC1, SOC2, SOC3, SOC4, SOC5 and SOC6). It was found that all the measured variables were significantly associated with the 2 sub-scale components (CRT and SOC) under the ADC construct. The parameter with the highest standardised coefficient was the indicator with the variable "Social equity" (SOC1) with a parameter coefficient of 0.651.

Table 3. Factor loading and p-value of the effect of adaptive change and education and training on the outcome of adaptive capacity

Hypothesised relationships (path)	Unstandardised coefficient (λ)	Standardised coefficient (λ)	p-value	R-square	Significant at 5% level
ACO ← CRT	0.485	0.480	0.000	0.415	Yes
ACO ← SOC	0.261	0.287	0.000		Yes
ACO ← PBA	0.049	0.060	0.346		No
ACO ← IPA	0.243	0.315	0.000		Yes

Source(s): Author's compilation of hypothesis results

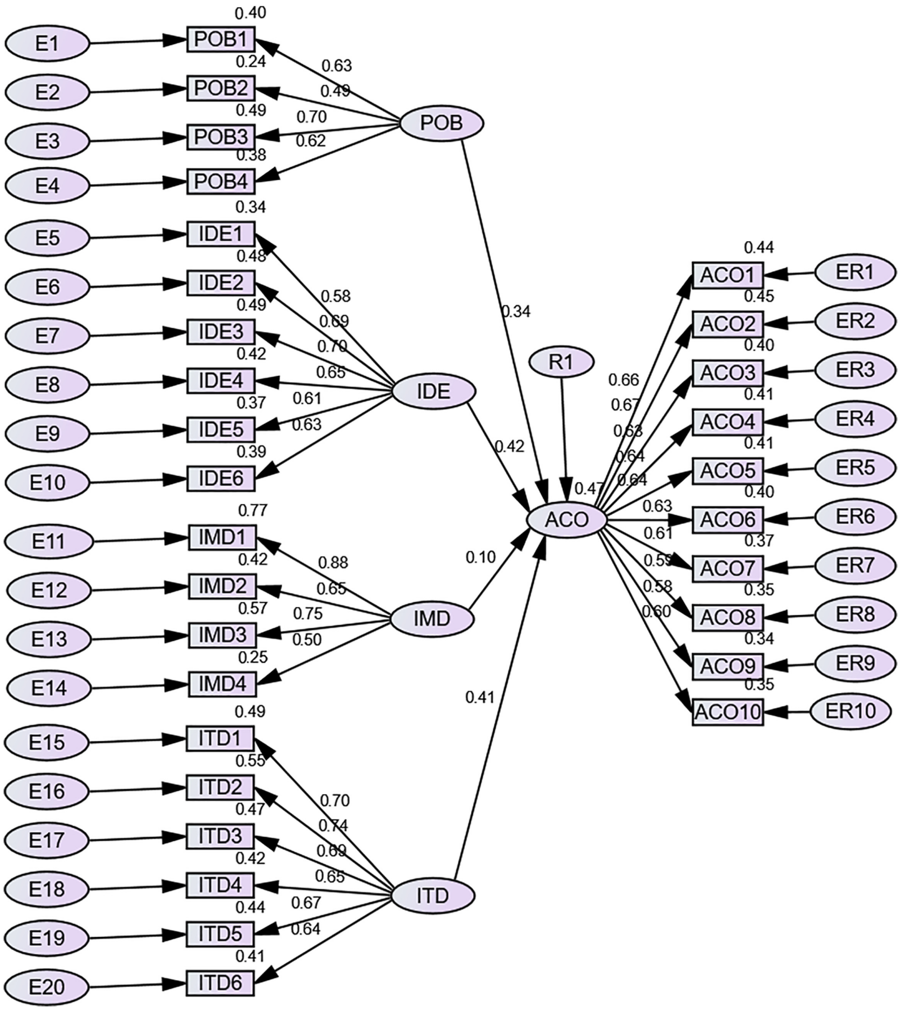

Figure 4.
SEM for the effect of the government support and centralised information hub on the outcome of adaptive capacity

Table 4.
Factor loading and p-value of the effect of the Government Support and Centralised Information Hub on the outcome of adaptive capacity

Hypothesised relationships (path)	Unstandardised coefficient (λ)	Standardised coefficient (λ)	p-value	R-square	Significant at 5% level
ACO ← POB	0.342	0.343	0.000	0.472	Yes
ACO ← IDE	0.432	0.418	0.000		Yes
ACO ← IMD	0.067	0.097	0.126		No
ACO ← ITD	0.381	0.413	0.000		Yes

Source(s): Author's compilation of hypothesis results

To what extent does education and training implementation among SME construction firms affect the Ghanaian construction industry's adaptive capacity? From the confirmatory factor analysis, out of the 14 indicator variables, 11 indicator variables made up of 2 sub-scale components were realised as PBA (PBA1, PBA2, PBA3 and PBA4) and IPA (IPA1, IPA2, IPA3, IPA4, IPA5, IPA6 and IPA7). It was found that all the measured variables were significantly associated with the 2 sub-scale components (PBA and IPA) under the education and training (EAT) construct. The highest standardised coefficient parameter was the indicator with the variable "protection of sensitive ecosystems" (IPA1) coefficient of 0.762.

To what extent would government support affect SME construction firms' adaptive change for best practices in project delivery in the Ghanaian construction industry? From the confirmatory factor analysis, out of the 14 indicator variables, 10 indicator variables made up of 2 sub-scale components were realised as POB (POB1, POB2, POB3 and POB4) and IDE (IDE1, IDE2, IDE3, IDE4, IDE5 and IDE6). It was found that all the measured variables were significantly associated with the 2 sub-scale components (POB and IDE) under the *government support* (GVS) construct. The parameter with the highest standardised coefficient was the indicator with the variable "edifying successful performance" (IDE3) with a parameter coefficient of 0.702.

How can a centralised information hub be created to support SME construction firms' adaptability in the Ghanaian construction industry? From the confirmatory factor analysis, out of the 14 indicator variables, 10 indicator variables made up of 2 sub-scale components were realised as IMD (IMD1, IMD2, IMD3 and IMD4) and ITD (ITD1, ITD2, ITD3, ITD4, ITD5 and ITD6). It was found that all the measured variables were significantly associated with the 2 components (IMD and ITD) under the *centralised information hub* (CIH) construct. The highest standardised coefficient parameter was the indicator with the variable "member's interpersonal contacts" (IMD3) with a parameter coefficient of 0.741.

To what extent does the hypothesised SME construction firm's adaptive capacity framework fit into the identified implementation factors? From the confirmatory factor analysis, out of the 17 indicator variables, 10 indicator variables made up of 1 component realised as ACO (ACO1, ACO2, ACO3, ACO4, ACO5, ACO6, ACO7, ACO8, ACO9 and ACO10). The parameter with the highest standardised coefficient was the indicator with the variable "Application of sustainable principles in projects execution" (ACO2) with a parameter coefficient of 0.738.

The SIV, the perceived need for implementation (PNI), successful implementation factors (SUI) and financial requirement (FUR) all explained 28.7% of the variance in Adaptive Capacity Outcomes (ACO). Also, critical transformation factors (CRT), social factors (SOC), potential barriers (PBA) and implementation awareness (IPA) explained 41.5% of the variance in ACO. In contrast, potential barriers factors (POB), implementation drivers and enablers factors (IDE), implementation drivers and enablers (IMD) and innovation trends drivers (ITD) explained 47.2% of the variance in ACO.

The SEM results suggest that PNI, SUI and FUR significantly influence ACO. However, SIV insignificantly influence ACO. Again, CRT, SOC and IPA significantly influence ACO, while PBA insignificantly influence ACO. Moreover, POB, IDE and ITD significantly influence ACO. On the other hand, IMD insignificantly influence ACO.

Thus, the PNI, SUI and FUR have a relationship with ACO. In contrast, SIV have no relationship with ACO. Also, CRT, SOC and IPA have a relationship with ACO. In contrast, PBA have no relationship with ACO. Furthermore, POB, IDE and ITD have a relationship with ACO. Still, IMD have no relationship with ACO. The findings supported previous studies which informed that the components that measure adaptive capacity implementation are a multidimensional construct (Van Breda, 2001, p. 5; Du Plessis, 2007; Li *et al.*, 2012; Akadiri and Fadiya, 2013; Aktas, 2013, pp. 57–67; Cummings *et al.*, 2015; Dearing and Cox, 2018). The relationships among the variables were found to be statistically significant. The result also suggested that all the latent factors adequately measured the overall ACO.

6. Conclusion

This study aims to develop an integrated framework for Ghana's medium-sized (SME) firms to implement adaptive capacity. Because of the peculiarity of developing countries, the application and relevance of the studies piloted in developed countries will not be consistent with those of developing countries. This section of the study identifies the gaps in adaptive capacity. Since the conceptual framework provides the points of view from which problems are addressed, some adaptive capacity implementation factors in Ghana and other developing countries are most likely not captured by certain gaps in the existing conceptual framework. However, identified gaps in the literature include education and training, government support and a centralised information hub to implement adaptive capacity among SME construction firms. The empirical findings from this research study are consistent with the theoretical review. This is noteworthy from the empirical findings that revealed the six-construct indigenous components framework that measures adaptive capacity implementation. The study is also significant because it addresses the lack of theoretical information about the most important factors predicting Ghana's ACO. The results also indicated that the components such as the PNI, SUI, the FUR *and* CRT are a significant influence on ACO in Ghana. Also, IDE and ITD, SOC, IPA and POB. The findings enforced the theory that adaptive capacity implementation is complicated. The findings also show that the latent variables lead to effective adaptive capacity implementation in Ghana.

6.1 Practical implications and recommendations

The literature review did not reveal a similar study to the current one. Therefore, this suggests that this type of research has not yet been conducted to identify factors of adaptive capacity implementation studies, especially in Ghana. Therefore, this study may offer other researchers a base for further follow-up studies.

The current study framework for measuring adaptive capacity implementation has a three-factor construct with the inclusion of three new variables: *education and training* (EAT), *government support* (GVS) and *centralised information hub* (CIH). Previous studies have tried integrating a framework for adaptive capacity implementation using other variables without adding these additional constructs. This study has shown that more than one factor influences ACO.

Apart from the study contributing to theoretical knowledge, it also contributed to the methodological advance in the approach used in conducting this research. The value and contribution of the current research are described at four levels. This integrated framework enables SME firms in Ghana to implement adaptive capacity at the theoretical, methodological and practical research findings. However, it is appropriate to note that the study's outstanding contribution will enlighten SME firms in the construction industry on implementing adaptive capacity and encourage sector actors to have an open dialogue to inform planning across the sector.

This study's novelty also lies in developing a framework that drives and enables SME firms in Ghana to implement adaptive capacity. The literature findings concerning adaptive capacity implementation studies in the Ghanaian construction industry revealed a lack of studies that developed a framework to foster ESC delivery among SME construction firms in Ghana. Thus, this current study's integrated framework for adaptive capacity implementation has contributed to knowledge.

It addresses the lack of a framework to foster and drive ESC delivery among SME construction firms in Ghana. This is to influence firms to deliver construction projects in an environmentally sustainable manner to achieve the global agenda of SD to improve Ghanaians' lives, the regions of Africa and globally.

Further, the framework informs the components that measure adaptive capacity implementation in Ghana. Similarly, the latent variables identify an adaptive capacity framework for SME construction firms in Ghana. The finding was that nine out of thirteen identified variables which are PNI, SUI, the FUR, *and* CRT are the key ingredients to the implementation. Also, SOC, IPA, POB, IDE and ITD.

It is recommended that the adaptive capacity implementation framework developed in this study be considered to guide construction professionals, the government and other stakeholders desirous of preserving the ecosystem (which faces a threat from non-environmentally-friendly anthropogenic activities). Also, the framework is recommended for construction industry-based researchers seeking to study adaptive capacity implementation, especially in the construction industries in developing countries. The framework is recommended for use by non-governmental organisations (NGOs), government agencies, donors and funding partners like the World Bank Group, who fund activities that ensure the achievement of the global goals of SD and seek to promote environmentally-friendly anthropogenic activities in developing countries like Ghana.

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