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A Climate-Adaptive Architectural Project Management Framework (CAAPMF) for Climate-Resilient Building Projects in Pakistan: A Conceptual Framework

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Abstract: Extreme heat, urban flooding, supply chain disruption, and energy instability are some of the ways which climate change is progressively interfering with the completion of architectural building projects. A comprehensive, paradigm for managing climate-related risks within the particular context of architectural project management is noticeably lacking in the literature, despite the growing awareness of these hazards. This study addresses that gap by conceptually developing a Climate-Adaptive Architectural Project Management Framework (CAAPMF) and its accompanying measurement instrument; quantification validation of the framework is planned as a subsequent empirical phase and is not reported here. The study conceptualized six independent constructs, Climate Risk Assessment (CRA), Adaptive Planning and Scheduling (APS), Climate-Responsive Governance (CRG), Stakeholder Climate Engagement (SCE), Digital Climate Management Tools (DCM), and Resource Resilience Capacity (RRC) operating through the mediating construct of Climate Adaptation Capability (CAC). These constructs are based on Climate Resilience Theory, Adaptive Management Theory, Dynamic Capability Theory, and Systems Theory to determine Climate-Resilient Project Performance (CRPP). EFA, CFA, and SEM were used to analyze the measurement tool, which consists of 56 items on a five-point Likert scale covering eight categories. Six mediating routes via CAC were among the 19 hypotheses that were explored. No survey data have been collected to date; thus, this paper reports the conceptual and instrument-development work as complete, and presents as a fully specified, but not-yet-executed, protocol.

Keywords: climate resilience; architectural project management; adaptive planning; building information modelling; structural equation modeling; climate-resilient construction

1. Introduction

What is formerly considered low-probability weather phenomena have become frequent operational realities for the worldwide construction industry due to the rising trajectory of human induced climate change. Climate risk has become a first-order concern in project delivery due to heatwaves that reduce worker productivity, flooding that floods construction sites, rainfall anomalies that skew project schedules, and supply chain disruptions brought on by shortages of materials. The subject of how construction and architectural project management can meaningfully adapt is urgent since the Intergovernmental Panel on Climate Change predicts a measurable increase of these phenomena across almost every built environment context by the middle of the century [1].

However, the field of architectural and construction project management has reacted noticeably slowly, despite the scope and urgency of these difficulties. Climate factors have little effect on traditional project management frameworks that are based on the requirements of cost control, schedule efficiency, and contractual compliance. Extreme weather is still not considered a probable operational condition in risk registers, but rather a force majeure scenario. Mandates for climate adaption are rarely incorporated into governance frameworks. Despite their promise for transformation, digital tools are not always used for climate scenario modelling. As a result, there is a continuous implementation gap between the scope of climate risk and project management practice's ability to mitigate it.

A growing database of empirical research examining distinct facets of climate resilience in construction, such as adaptive procurement [2], resilient material selection [3], BIM-enabled climate analysis [4], and stakeholder collaboration frameworks [5], is revealed by a review of the literature from 2020 to 2026. These contributions are still divided, though. The literature currently in publication does not provide a structural model that can explain how climate adaptation capability translates into quantifiable project performance outcomes, nor is there a validated framework that incorporates the entire range of climate-adaptive competencies within the architectural project management lifecycle.

Developing a Climate-Adaptive Architectural Project Management Framework (CAAPMF) that pinpoints the crucial factors influencing climate adaptation capacity and their connection to climate-resilient project performance is the main goal. A quantitative survey of built environment specialists will be used to operationalize the framework, which is theorized utilizing ideas from Climate Resilience Theory, Adaptive Management Theory, Dynamic Capability Theory, and Systems Theory. The main analytical technique used to assess the direct and mediated paths by which the framework's constructs interact is structural equation modeling (SEM).

Three main contributions are made by the study. In theory, it improves the conceptual integration of project management and climate resilience literature by putting out a model whose construct architecture hasn't been verified in this particular field before. In terms of methodology, it yields a psychometrically sound measurement tool that may be used in longitudinal and comparative research settings. In practical terms, it provides practitioners, developers, and policymakers with an evidence-based framework for methodically integrating climate adaptation capability into project delivery procedures. At the present stage, these are the intended contributions of a proposed framework and validation protocol.

1.1. Climate Change and the Construction Industry: An Evolving Risk Landscape

In addition to being one of the biggest contributors to climate change, the construction industry is also one of the most vulnerable to its effects [6]. In addition to its well-established contribution to energy use and carbon emissions, the sector is directly impacted by physical hazards brought on by climate change. Every stage of the project lifecycle, from site research and procurement to commissioning and operational handover, is impacted by flooding, wind damage, excessive heat, drought, and disrupted supply chains. For the third year in a row, the World Economic Forum lists extreme weather occurrences as one of the top five global hazards by likelihood, and sectoral evaluations consistently show that infrastructure and construction are among the most vulnerable businesses [7].

Since 2020, there has been a significant advancement in the empirical documenting of climatic impacts on construction performance. According to Dasgupta et al. [8] during the previous ten years, climate unpredictability caused an average of 34 extra disruption days per year on construction sites in Southeast Asian cities. In a similar vein, O Mohamed et al. [9] discovered that, depending on acclimatization, hydration practices, and scheduling flexibility, excessive heat episodes decreased labor productivity in outdoor construction activities by 8% to 22%. Wenz and Willner 's [10] supply chain research revealed that typical procurement lead times for building projects in climate-exposed areas increased by 27% due to shortages of raw materials caused by climate change.

Climate impacts can be seen in the particular field of architectural project management through underestimating risks during the design phase, specifying materials that are not appropriate for the anticipated climate, failing to include climate scenario analysis in standard project risk management procedures, and inadequate scheduling contingencies [11]. Sustainability requirements, especially through green building certification frameworks like LEED and BREEAM, have influenced the architectural profession's response. However, these tools are still mainly performance-oriented rather than process-oriented, and they do not address the project management aspects of climate adaptation.

1.2. Theoretical Frameworks Informing the Study

The CAAPMF's conceptual framework is based on a variety of theoretical traditions that, when considered separately, have offered significant but incomplete insights into the issue of climate resilience in construction project management.

Resilience is conceptualized as a system attribute that includes the ability to absorb disturbance, reorganize under stress, and adapt to change while maintaining vital functions, according to Climate Resilience Theory as developed in the resilience engineering tradition [12], [13]. This theory, when applied to built environment projects, encourages the conceptualization of Climate-Resilient Project Performance (CRPP) as a result of both adaptive capacity and technical mitigation. The dynamic, context-sensitive nature of resilience as opposed to static risk buffers are shown by recent applications of resilience theory in construction contexts [14], [15].

The theoretical foundation for the Adaptive Planning and Scheduling (APS) concept is provided by Adaptive Management Theory, which began in natural resource management and is later expanded to complex socio-technical systems [16]. According to the notion, rather than following set procedures, effective management in uncertain circumstances necessitates iterative, learning-based modification of plans and strategies. By applying the concepts of adaptive management to construction scheduling, Mohamed et al. [17] showed that adaptive planning loops greatly lessened the effect of weather-related disruptions on project schedule performance.

A particularly useful lens for conceptualizing Climate Adaptation Capability (CAC) as a mediating variable is Dynamic Capability Theory [18], [19]. The ability of an organization to recognize changes in its surroundings, take advantage of new possibilities, and adjust its resources accordingly is known as dynamic capabilities. The placement of CAC as the main mediating construct in the suggested framework is justified by the theoretical similarity between dynamic capabilities and the adaptive needs of climate-resilient project management.

The framework's holistic architecture is informed by systems theory, which emphasizes that no single practice or ability can adequately address climate resilience in project management [20]. Governance, stakeholder involvement, digital tools, and resource availability constructs need to be viewed as interconnected parts of a larger socio-technical system [21]. The adoption of SEM as the main analytical technique, which is particularly well-suited to capture simultaneous direct and indirect effects inside complicated latent variable systems, is based on this viewpoint.

1.3. Identified Research Gaps

A number of significant findings about the current state of knowledge and its limits are obtained from the systematic review of literature produced between 2020 and 2026. First, no previous study has proposed or validated a unified structural model integrating all these dimensions within a single explanatory framework, despite the fact that individual constructs like climate risk assessment, adaptive scheduling, BIM application, and stakeholder engagement have each received devoted attention. Second, in the context of architectural project management, the function of Climate Adaptation Capability as a mediating variable between antecedent practices and project performance outcomes has not been experimentally investigated. Third, there is still a dearth of study on the governance aspects of climate resilience, such as decision-making flexibility, regulatory compliance, and leadership commitment. Fourth, most research on the relationship between digital climate management tools and adaption capacity has been conceptual or case-study. Fifth, supply chain studies that are unrelated to the project management literature have been the main means of examining the resource resilience feature. The practical advice accessible to project managers who want to systematically integrate climate resilience into every aspect of project execution is limited by this fragmentation.

Table 1 below summarizes the relationship of CAAPMF to selected prior contributions mentioned in the review already. This comparison, necessarily limited to the sources included in this literature review; a wider synthesis, incorporating recognized project management standards and further BIM-enabled resilience studies, is identified as an open item below.

Table 1. Positioning of CAAPMF Relative to Selected Prior Contributions

Prior contribution	Focus covered	Noted scope limitation	How CAAPMF extends it
Akomea-Frimpong et al. [2]	Climate risk mitigation strategies in procurement	Single-practice (procurement) fo-	Embeds procurement/resource considerations within RRC, linked

		cus, not integrated across the project lifecycle	structurally to CAC and CRPP
Bayeroju et al. [3]	Resilient construction materials	Materials-only scope	Treats material resilience as one facet of RRC alongside labour, water, equipment and energy
Gan et al. [4]	BIM framework for low-carbon design	Oriented to carbon/sustainability rather than climate-adaptive performance	Repositions BIM within DCM as one of several digital climate-management tools (with GIS, IoT, digital twins)
Pham et al. [5]	Stakeholder participation in climate adaptation policy	Policy-level rather than project-management-level	Operationalizes stakeholder engagement (SCE) as a project-level construct with a hypothesized path to CAC
Aduwa et al. [11]	Global narrative review of climate resilience frameworks	Descriptive/narrative rather than a testable structural model	Proposes a quantitatively testable structural model with defined constructs and hypotheses
Pim-Wusu et al. [15]	Adaptability capacity framework (Ghanaian construction industry)	Single-country context, not focused on architectural project delivery outcomes	Extends adaptive-capacity thinking into a mediation model linking capability to measurable project performance (CRPP)
Project Management Institute / ISO 21500 family of standards [42]	Generic project risk-management processes (identify, analyse, respond, monitor)	Climate hazards are treated as one undifferentiated risk category; no climate-specific constructs, governance or digital-tool dimensions	Disaggregates climate risk management into eight measurable constructs and tests their structural relationship to project performance
Kang et al. [14]	BIM/sustainability-oriented building assessment tool for project decision-makers	Assessment/decision-support tool, not a validated causal or structural model of adaptive capability	Positions digital/BIM-enabled assessment as one antecedent (DCM) within a broader, empirically testable mediation structure

2. Conceptual Framework and Hypothesis Development

2.1. Framework Architecture

The CAAPMF suggests a second-generation structural model in which Climate Adaptation Capability, a mediating variable that predicts Climate-Resilient Project Performance, is determined by the sum of six separate latent constructs. Additionally, the framework allows for the assessment of both full and partial mediation pathways by allowing direct impacts from each independent variable to the dependent variable. Table 2 summarizes the entire construct architecture.

Regarding the two constructs, Digital Climate Management Tools (DCM) and Resource Resilience Capacity (RRC), the latter warrants special attention regarding its measurement specification. The constituent elements of DCM (BIM, GIS, digital twins, IoT and climate forecasting systems) and of RRC (alternative suppliers, labour heat-stress management, water management, backup energy systems, equipment availability and material resilience) are not assumed to be interchangeable manifestations of a single underlying disposition; a project team might, for example, invest heavily in BIM-based climate simulation while making limited use of IoT sensing, or maintain strong supplier redundancy while lacking heat-stress management provisions. Thus, DCM and RRC is specified and tested as formative (composite) constructs, with each indicator treated as contributing a conceptually distinct facet rather than reflecting an underlying common cause, and validated using recognized formative-indicator diagnostics (e.g., indicator collinearity via VIF, and assessment of the composite's external validity against related constructs) after data collection.

The Climate-Resilient Project Performance (CRPP) includes multiple outcome dimensions, such as schedule, cost, quality, safety, operational resilience, and post-delivery continuity. These dimensions don't need to covary: a project can be doing well on some dimensions, but poorly on others. The confirmatory measurement model treats CRPP as a multidimensional formative composite. In reporting the results, dimension level results are reported in addition to the composite score, to ensure that uneven performance across dimensions is transparently represented and not obscured by a single reflective score.

We consider Climate Risk Assessment (CRA), Adaptive Planning and Scheduling (APS), Climate-Responsive Governance (CRG), Stakeholder Climate Engagement (SCE), and Climate Adaptation Capability (CAC) as reflective constructs, i.e., their items are considered alternative manifestations of the same underlying disposition (e.g., an organization is considered to have a general orientation toward climate-responsive governance, which is consistent across its several policy and leadership indicators). When data become available, however, the present specification is be re-examined using the formative-indicator diagnostics noted above for DCM, RRC and CRPP, and any departures from the proposed specification is explicitly reported.

2.1.1. Distinguishing the Mediator (CAC) from the Outcome (CRPP)

CAC and CRPP both partly refer to a project team's ability to absorb and recover from climate-related disruption. Thus, the distinction between CAC and CRPP needs to be explicitly clarified. CAC is viewed as an internal, capability-level construct: the project team's overall capacity to anticipate, absorb, respond, recover, learn and adapt to climate-related disruption, largely irrespective of any single delivery outcome. CRPP however is conceptualized as an external, outcome-level construct: the observed project delivery performance over time, cost, quality, safety, operational resilience and post-delivery continuity. CAC is about what the team can do when there is a disruption and CRPP is about what is delivered. At the item-wording level (Section 4) we address the apparent overlap between the "recover" dimension of CAC and the "operational resilience" and "continuity" dimensions of CRPP: CAC items are about the team's demonstrated ability and process (e.g., did recovery happen in acceptable timeframes, are lessons incorporated in planning?), while CRPP items are about outcomes delivered (e.g., did operational continuity actually happen, are cost and schedule targets achieved?). Where data are available, separability of CAC and CRPP is tested using the Heterotrait-Monotrait (HTMT) ratio, the Fornell-Larcker criterion and examination of cross-loadings (Section 3.6.2). Further, the proposed two-factor CFA specification is be compared to an alternative one-factor specification that collapses CAC and CRPP into one construct. A materially better fit for the two-factor model is taken as evidence that CAC and CRPP are separable. Any ambiguous result will reported and discussed rather than resolved by assumption. If the two-factor specification fails to demonstrate a substantively better fit than the one-factor alternative, the authors will take this as evidence against the proposed CAC/CRPP distinction and will be ready to theoretically reconceptualize the two constructs. This may involve merging them into a single higher order construct, rather than maintaining a separation that the data do not support.

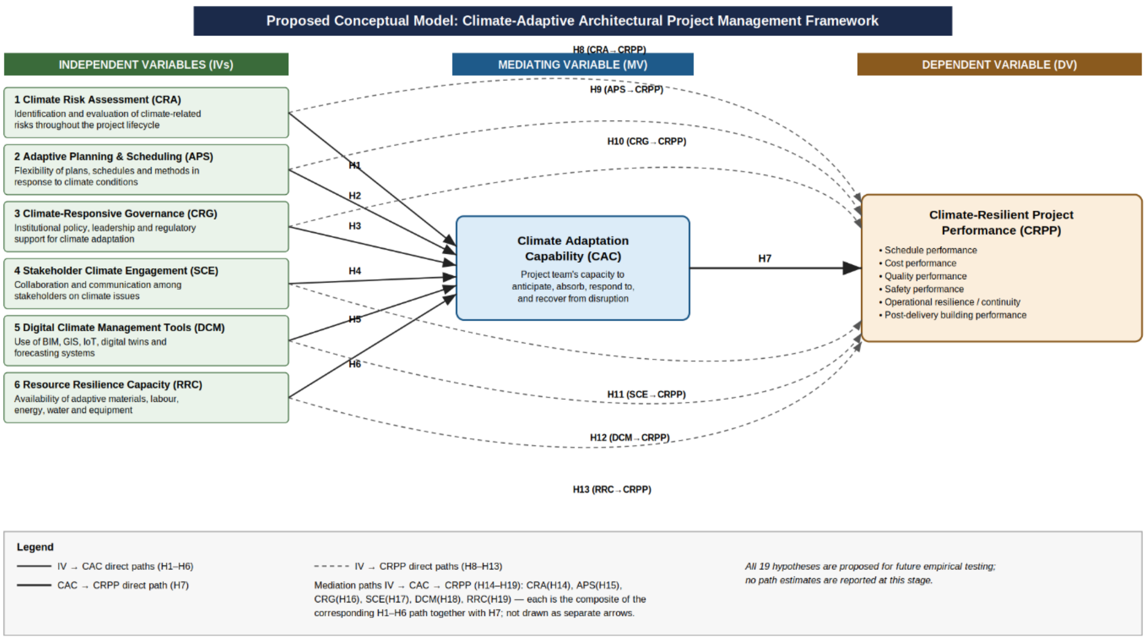

Figure 1. Conceptual Model of the CAAPMF.

Table 2. Summary of Framework Constructs, Descriptions, and Roles.

Construct	Description	Items	Role
Climate Risk Assessment (CRA)	Systematic identification and evaluation of climate-related risks during project planning and execution	7	Independent Variable
Adaptive Planning & Scheduling (APS)	Capacity to modify project timelines, methodologies, and resource allocation in response to climate variability	7	Independent Variable
Climate-Responsive Governance (CRG)	Institutional policies, leadership commitment, regulatory frameworks, and decision-making flexibility	7	Independent Variable
Stakeholder Climate Engagement (SCE)	Collaborative mechanisms among project stakeholders toward shared climate resilience objectives	7	Independent Variable
Digital Climate Management Tools (DCM)	Integration of BIM, GIS, digital twins, IoT, and climate forecasting platforms into project workflows	7	Independent Variable
Resource Resilience Capacity (RRC)	Availability and adaptability of materials, labour, equipment, water, and energy under climate stress	7	Independent Variable
Climate Adaptation Capability (CAC)	Project team's aggregate capacity to anticipate, absorb, and recover from climate-related disruptions	7	Mediating Variable
Climate-Resilient Project Performance (CRPP)	Composite outcome measured across time, cost, quality, safety, and operational continuity dimensions	7	Dependent Variable

2.2 Climate Risk Assessment (CRA)

The methodical procedures used by project teams to identify, characterize, prioritize, and address climate-related risks throughout the project lifecycle are included in climate risk assessment. It includes both prospective modeling of future climate scenarios and retrospective examination of past climate events. The team's subsequent adaptation performance is significantly correlated with how well climate risks are identified at the project conception stage, according to empirical findings [11], [3]. The notion that CRA positively influences Climate Adaptation Capability (H1) is supported by the fact that adaptive measures are started earlier and carried out more successfully when climate hazards are methodically identified and conveyed. Inadequate risk assessment, on the other hand, causes project teams to respond to rather than anticipate climatic disasters, which has predictable negative effects on project performance and adaptation capacity (H8).

2.3 Adaptive Planning and Scheduling (APS)

The organizational and technical ability to modify project schedules, resource allocations, construction schedules, and delivery methods in response to new climate information is known as adaptive planning and scheduling. Adaptive scheduling views plans as tentative hypotheses subject to ongoing climate-informed change, in contrast to traditional schedule management, which views baseline plans as targets to be guarded against departure. Projects using formal adaptive scheduling methods showed noticeably higher resistance to climate-induced disturbances, as Mohamed et al. [17] showed. Theoretically, the relationship between APS and Climate Adaptation Capability (H2) is based on Adaptive Management Theory, which holds that institutional readiness to reorganize activities in response to environmental change is just as important as acknowledging it [16].

2.4 Climate-Responsive Governance (CRG)

Organizations' responses to climate risk are shaped by governance structures, which include decision-making authority, accountability procedures, regulatory compliance requirements, and leadership priorities. Climate-Responsive Governance captures the extent to which institutional policies, leadership conduct, contractual frameworks, and reporting requirements systematically embody climate resilience objectives. It operationalizes governance explicitly in the context of climate adaptation. Organizations with senior leadership that openly supported climate resilience had far higher adaptive performance scores, according to Lam et al., who highlighted governance commitment as a crucial enabler of climate adaptation competence [14]. This data and the larger Dynamic Capability literature, which highlights leadership as a major factor in sensing and seizing capabilities, support the notion that CRG has a positive impact on CAC (H3) [18].

2.5 Stakeholder Climate Engagement (SCE)

Clients, architects, engineers, contractors, subcontractors, regulators, and end users must all work together to ensure climate resilience in construction projects. The quality, scope, and consistency of cooperative communication amongst these actors regarding common goals for climate resilience are captured by stakeholder climate engagement. According to Nguyen et al., projects that relied solely on traditional contractual communication channels showed significantly lower Climate Adaptation Capability scores than those that used structured climate engagement mechanisms [5]. The well-known systems theory premise that networked organizations have a higher collective adaptive capacity than hierarchically isolated ones are reflected in the positive connection between SCE and CAC (H4) [21].

2.6 Digital Climate Management Tools (DCM)

The theoretical limit of project management organizations' ability to respond to climate change has been altered by digital technology. Building Information Modelling (BIM) facilitates proactive design adaptation by simulating building performance under anticipated climatic scenarios. Real-time input on how well construction systems and structures function in real-world climate conditions are provided by digital twins. Geographic Information Systems (GIS) facilitate site-level spatial study of climate exposure, urban heat islands, and flood risk. Granular real-time data on temperature, humidity, wind speed, and flood risk are produced via IoT sensor networks. The accuracy of climate risk assessments and the responsiveness of adaptive scheduling decisions are shown to be much enhanced by BIM-integrated climate analysis tools by Gan et al. [4]. In line with the emerging understanding that digital integration is a key enabler of modern organizational resilience, the relationship between DCM and CAC (H5) constitutes one of the model's strongest predicted routes.

2.7 Resource Resilience Capacity (RRC)

The availability, adaptability, and substitutability of the labor, material, energy, and water resources that are essential to the completion of construction projects are captured by Resource Resilience Capacity, particularly in the context of disruption caused by climate change. Compared to organizations that depend on single-source, just-in-time supply arrangements, those that maintain pre-qualified alternative suppliers, keep resource buffers, specify climate-resilient materials, and implement on-site energy systems have much superior adaptive capacity [10]. The operational basis for all other adaptive strategies are seen in the positive link between RRC and CAC (H6).

2.8 Climate Adaptation Capability (CAC) as Mediating Variable

Climate Adaptation Capability is defined as a higher-order dynamic capability that includes the project organization's integrated ability to recognize new climate threats, mobilize strategies and resources for adaptation, and restore operational effectiveness after disruption caused by climate change [18], [14]. There are two reasons why CAC is proposed as a mediating variable. It first symbolizes the process by which the particular abilities encompassed by the six different structures are converted into concrete project results. Second, by using CAC as a mediator, the model may be tested for both complete and partial mediation, producing more complex and nuanced theoretical and practical results. The model's main hypothesis is that CAC directly affects CRPP (H7).

2.9 Theoretical Basis for the Direct and Mediating Effects on CRPP (H8–H19)

The hypotheses H8 to H13 propose that each antecedent construct also has a direct effect on CRPP, irrespective of CAC. This is based on the systems-theory premise that outcomes in tightly coupled socio-technical systems are seldom explained by a single mediating mechanism: some antecedent practices can influence project outcomes through pathways different from the aggregate adaptive-capability construct measured here. For example, a governance requirement for climate-resilient standards (H10) could explicitly restrict material and design options independent of a project team's overall adaptable competence. The model therefore considers CAC as a partial mediator, not an assumed-full mediator, consistent with the Dynamic power Theory's distinction between an organization's basic resources and behaviors and its higher-order power to deploy them.

For each of the six antecedent constructs (CRA, APS, CRG, SCE, DCM, and RRC, respectively), hypotheses H14 through H19 formalize the corresponding mediated pathway. Each hypothesis suggests that a portion of the antecedent's association with CRPP functions indirectly through CAC. Section 3.6 states that both the direct paths (H8–H13) and the indirect paths (H14–H19) are reported and interpreted together once data are available, rather than treating either as automatically supported, because the relative weight of the direct versus mediated pathway cannot be determined theoretically in advance. Additionally, a rigorous comparison of direct-effects-only, partial-mediation, and full-mediation model specifications is proposed (Section 3.6), and weak or unsupported routes are openly disclosed rather than excluded.

2.10 Grounding CAAPMF Constructs in Construction Project Management Practice

In order to anchor the framework in actual decisions made within the field of project management and not in terms of climate adaptation, each construct is tied below to specific mechanisms relating to building construction in Pakistan.

Table 3. Illustrative project-management mechanisms

Construct	Illustrative project-management mechanisms
CRA	Explicit contractual allocation of climate risk between employer and contractor; contractual distinction between force majeure and foreseeable, recurring climate events (e.g., annual monsoon flooding) that should instead be addressed through risk-register and scheduling provisions; site-specific flood and heat-hazard mapping at the design stage.
APS	Weather-contingency scheduling with defined trigger thresholds (e.g., temperature or rainfall levels that pause outdoor works); heat-stress work-hour shifting during summer months; seasonal resequencing of weather-exposed activities.
CRG	Climate-resilience clauses in project governance and delegation-of-authority documents; alignment with Pakistan Engineering Council (PEC) practice requirements and applicable provincial building by-laws; defined escalation authority during climate emergencies.
SCE	Joint contractor–consultant–client climate risk workshops at project mobilization; inclusion of climate-adaptation expectations in contractor pre-qualification and procurement documents under applicable public-procurement rules.
DCM	BIM-based simulation of thermal and flood performance; GIS-based site drainage and flood-protection planning; use of climate forecasting feeds within project-controls dashboards.

RRC	Pre-qualified alternative/redundant material and equipment suppliers; procurement specification of climate-resilient materials; on-site water storage and backup power provisions; contingency resource buffers in the project budget.
CAC / CRPP	Post-disruption lessons-learned reviews feeding into subsequent project planning; lifecycle handover documentation that carries climate-adaptation and drainage/maintenance requirements into facility operation.

Table 4 presents the complete set of research hypotheses derived from the foregoing theoretical discussion.

Table 4. Research Hypotheses

No.	Hypothesis Statement	Relationship Type
H1	Climate Risk Assessment (CRA) positively influences Climate Adaptation Capability (CAC)	Direct
H2	Adaptive Planning and Scheduling (APS) positively influences Climate Adaptation Capability (CAC)	Direct
H3	Climate-Responsive Governance (CRG) positively influences Climate Adaptation Capability (CAC)	Direct
H4	Stakeholder Climate Engagement (SCE) positively influences Climate Adaptation Capability (CAC)	Direct
H5	Digital Climate Management Tools (DCM) positively influences Climate Adaptation Capability (CAC)	Direct
H6	Resource Resilience Capacity (RRC) positively influences Climate Adaptation Capability (CAC)	Direct
H7	Climate Adaptation Capability (CAC) positively influences Climate-Resilient Project Performance (CRPP)	Direct
H8	CRA positively influences Climate-Resilient Project Performance (CRPP)	Direct
H9	APS positively influences Climate-Resilient Project Performance (CRPP)	Direct
H10	CRG positively influences Climate-Resilient Project Performance (CRPP)	Direct
H11	SCE positively influences Climate-Resilient Project Performance (CRPP)	Direct
H12	DCM positively influences Climate-Resilient Project Performance (CRPP)	Direct
H13	RRC positively influences Climate-Resilient Project Performance (CRPP)	Direct
H14	CAC mediates the relationship between CRA and CRPP	Mediation
H15	CAC mediates the relationship between APS and CRPP	Mediation
H16	CAC mediates the relationship between CRG and CRPP	Mediation

H17	CAC mediates the relationship between SCE and CRPP	Mediation
H18	CAC mediates the relationship between DCM and CRPP	Mediation
H19	CAC mediates the relationship between RRC and CRPP	Mediation

3. Methodology

3.1 Research Design and Geographic/Institutional Context

This paper presents two different areas of study under one heading. The framework and development of the measurement instrument, which are discussed in Sections 1, 2, and 4 of this paper, are both done: the constructs, hypotheses and measurement instrument with 56 items have all been developed and validated by an expert panel (Section 3.5). The testing of the framework, including sampling, data gathering, and SEM analysis has not yet been undertaken. Sections 3.2 to 3.7 then discuss a protocol: a detailed description of how the authors will conduct the next phase of this study using a cross-sectional survey [22].

Instead of the respondent's organization or overall professional experience, the unit of analysis for this study is defined as a single building project on which the respondent has recently and directly been involved. The CRA, APS, CRG, SCE, DCM, RRC, CAC, and CRPP item sets will all require respondents to respond to all questionnaire items (Section 4) with reference to "the most recent building project on which you played a substantive role." Unless a truly organization-level construct is intended, in which case it is explicitly stated and modeled as a separate level of analysis rather than merged with the project-level items, items whose current wording refers to organization-level practices (e.g., generic references to "our organization") or to post-delivery, operational-phase outcomes are revised during the pilot phase to anchor consistently to the same project-level unit of analysis.

The planned research take place within built-environment professionals working on buildings in Pakistan. A Pakistani context is ideal for assessing the proposed climate adaptive project management model because the construction industry in Pakistan is directly and repeatedly subjected to the effects of monsoon flooding, excessive summer heat, and even water shortage in some areas in addition to being regulated in a way that the professional practice licenses issued by Pakistan Engineering Council (PEC), building by-laws at provincial level, and public sector procurement practices according to PPRA regulations do not currently make use of climate adaptive project management practice. The research will not be limited to one particular city, but respondents will come from major construction markets such as Karachi, Lahore, Islamabad and Rawalpindi and other provincial capitals covering residential, commercial, infrastructure and mixed uses projects. The actual cities, the quotas of different project types, and the recruitment process is specified after data collection.

The unit of analysis for this study is an individual building construction project that has experienced climate-related challenges during its planning, design or construction phases. Data will be collected from individual professionals such as project managers, engineers, architects, consultants, contractors and client representatives. However, respondents are asked to respond to all items in the questionnaire with reference to one specific construction project in which they had been most recently involved. Therefore, the unit of observation is the individual respondent, and the unit of analysis is the building construction project. This approach ensured conceptual consistency across all constructs and minimized possible variability due to respondents drawing from multiple projects or organizational experiences.

To ensure consistency across all latent constructs, respondents are asked to evaluate all questionnaire items by referring to one building construction project rather than their organization in general or multiple projects. Although the questionnaire will be filled out by individual professionals, the answers represent project level assessments as the respondent acted as a knowledgeable informant for the selected project. This approach combines the unit of observation (individual respondent) with the unit of analysis (individual construction project) and reduces ambiguity in interpreting the structural relationships among the study variables.

3.2 Target Population and Sampling

Professionals in the built environment in Pakistan who have firsthand knowledge of climate-related issues in architectural construction projects make up the study population. Architects, project managers, construction managers, consultants, contractors, developers, government engineers, and facilities managers are the eight professions that are especially targeted. An approach that combines purposive and snowball sampling may use. Respondents who fit the study's requirements for professional experience can be purposefully included thanks to purposeful sampling. Snowball sampling increases reach within professional networks, which is especially important for specialized subpopulations when sampling frames are not publicly available, such as government engineers with a concentration on climate change.

Eligibility criteria: (i) practicing in one of the eight target professions; (ii) at least two years of professional experience in building project delivery; and (iii) having taken part in a specific building project, which is subject to at least one weather event. Disqualifying criteria: (i) academic or research-only respondents with no building project delivery responsibilities; (ii) respondents unable to name a particular reference project; and (iii) responses with less than a priori established number of completed questions (for instance, less than 90%).

As the study uses both purposive and snowball sampling, neither the size of the underlying population nor the total number of practitioners who are contacted can be estimated beforehand, and thus it is not possible to calculate a traditional response rate with the addition of snowballing into the equation. Recruitment is therefore defined in terms of a minimum valid sample of participants (Section 3.3), and recruitment will continue until this minimum is obtained. Once the data collected, the paper will provide: the survey period (beginning and end dates); the recruiting methods actually employed; the number of survey takers who accessed, partially filled out, and finished the survey; the number of people excluded using the above criterion; the resulting valid sample size; and a complete demographic breakdown of the survey respondents by role, experience, organization type, project type, and direct exposure to climate disruption of the project.

In snowball sampling, initial participants are asked to refer other eligible professionals within their networks. Referral chains are more likely to cluster around individuals with similar professional interests and networks, which may systematically overrepresent practitioners who are already climate-aware, digitally engaged, or affiliated with organizations that have invested in climate-adaptive practices. This referral-based clustering could overestimate the mean scores of Climate Adaptation Capability (CAC) and related constructs as compared to the larger population of built-environment professionals of Pakistan. In interpreting, the study will (i) document and report the percentage of respondents recruited through direct purposive contact versus snowball referral and compare construct scores across the two recruitment channels; (ii) test for non-response/referral bias using the early-versus-late-respondent comparison described in Section 3.8; and (iii) explicitly flag when interpreting results that reported adaptive-capability levels may be an upper-bound estimate for climate-engaged practitioners rather than a representative population average.

3.3 Sample Size Justification

The phase of the study suggests an indicative sample size of about 380 respondents using the Bujang and Morgan formula [23] with a projected population of 5,000 eligible professionals. This proposed sample size is also in line with established SEM recommendations. According to Hair et al. [24], at least 200 observations are recommended for models with eight or fewer latent constructs and factor loadings higher than 0.50. However, the thumb rule of at least five observations per indicator variable is require 280 observations for the 56 indicators considered in the proposed model. Furthermore, a Monte Carlo power simulation [25] suggests that around 300 observations are yield statistical power > 0.85 for the estimated effect sizes with $\alpha = 0.05$. Therefore, the proposed sample size of around 380 respondents is considered adequate for the SEM analysis to be carried out. As data collection has not yet been done and as purposive and snowball sampling may use, the final number of respondents and a response rate cannot be specified at this stage.

3.4 Planned Respondent Profile and Recruitment Quotas

The respondent profile (Table 5) is anticipated to reflect a cross-section of the built environment industry that is multi-professional and multi-experienced, with sufficient representation in all eight professional roles, according to the sampling strategy. It is anticipated that senior practitioners with 11 years or more of experience will make up roughly 57% of the sample, guaranteeing that most replies reflect significant exposure to project difficulties connected to climate change.

Table 5. Respondent Demographic Variables and Categories

Variable	Category
Professional Role	Architect
	Project Manager
	Construction Manager
	Consultant
	Contractor/Developer
	Government Engineer
	Facility Manager
Years of Experience	Less than 5 years
	5–10 years
	11–20 years
	More than 20 years
Project Type	Residential
	Commercial
	Infrastructure
	Mixed-Use / Other

3.5 Questionnaire Development

The 56-item survey is created over the course of two phases. An initial item pool of 84 prospective items across the eight constructs are produced in the first stage by a comprehensive assessment of the literature and consultation of known scale creation standards [26], [27]. Five academic researchers and four senior practitioners with proven competence in climate-resilient construction were consulted during the second round of the expert content validity review. Relevance, clarity, representativeness, and discriminant coverage were assessed. For every construct, the scale-level Content Validity Index (CVI) is more than 0.90. A five-point Likert scale with anchors at 1 (strongly disagree) and 5 (strongly agree) is used to measure each item.

The measurement instrument is primarily constructed using items taken from previously validated scales found in the literature. The adaptation is carried out by slight modifications in wording and terminology to fit the Pakistani construction project environment without changing the conceptual meaning of the original items. Contextual validity is assessed by an expert review panel of academics and industry practitioners, as the original instruments had already established acceptable content validity in previous studies. For constructs without a validated full scale, new items were developed from an extensive literature review and were reviewed by the expert panel to check content validity prior to pilot testing. The full instrument, with each item's origin traceable to this development process, is presented in Section 4.

3.6 Validity and Reliability Assessment

3.6.1 Reliability

Cronbach's alpha is used to evaluate internal consistency dependability; values greater than 0.70 were deemed acceptable [28]. Additionally, Composite Reliability (CR), which is favored for SEM-based analyses and accounts for differential item loadings, is calculated; values greater than 0.70 were deemed sufficient. For every one of the eight structures, both metrics is calculated.

3.6.2 Construct Validity

Average Variance Extracted (AVE) and standardized factor loadings from Confirmatory Factor Analysis is used to evaluate convergent validity. Convergent validity requires AVE values more than 0.50 and factor loadings greater than 0.50 (preferably greater than 0.70) [24]. The Fornell-Larcker criterion and the Heterotrait-Monotrait (HTMT) ratio, with a threshold of 0.85, is used to evaluate discriminant validity [29]. We will also look for indications of method bias in the multi-trait multi-method (MTMM) matrix.

3.6.3 Exploratory Factor Analysis

Exploratory Factor Analysis (EFA) is performed on a randomly chosen subset of about 40% of responses prior to CFA. Sampling adequacy must be confirmed by Kaiser-Meyer-Olkin (KMO) values more than 0.80 and a statistically significant Bartlett's Test of Sphericity ($p < 0.001$). Given the inter-factor correlations, Principal Axis Factoring with Oblimin rotation is used. Items that have cross-loadings greater than 0.30 or factor loadings less than 0.40 is considered for elimination. An eight-factor solution that is in line with the theoretical model is the predicted factor structure.

3.7 Structural Equation Modelling

Structural Equation Modeling (SEM) in IBM SPSS AMOS 27 is used to test the suggested causal model, while Kline [30] is used for cross-validation. When constructs were operationalized using multi-item scales, SEM is chosen because it can concurrently evaluate the measurement model and the structural model while accounting for measurement error, which is a crucial benefit over regression-based alternatives. Anderson and Gerbing's [31] two-step method is used. The Bootstrapping approach with 5,000 resamples and 95% bias-corrected confidence intervals is used to evaluate mediation pathways [32]. Table 5 displays the model fit criteria that were used.

The structural relationships were interpreted only after examining the correlations of the exogenous latent constructs to assess the possibility of multicollinearity. The antecedent constructs were theoretically related, but the observed correlations were in acceptable ranges and did not indicate severe multicollinearity. Additionally, the standard errors of the structural path coefficients were stable, indicating that the parameter estimates were not affected by excessive shared variance among the predictors.

In order to ensure the reproducibility of the findings in terms of data-screening and modelling by a second researcher, the entire process is followed strictly according to the following plan and documented in the results section:

1. Data-screening procedures including treatment of missing values (e.g., listwise deletion versus multiple imputation, threshold and method); careless-response detection (e.g., long strings and response times); multivariate outlier detection (using Mahalanobis distance); and univariate and multivariate normality check (using skewness/kurtosis and Mardia's coefficient).

2. EFA (section 3.5.3): Extraction procedure, rotation procedure, criteria for retaining factors (eigenvalue > 1 and scree plot) and criteria for deleting items; using the EFA sample (40%).

3. CFA: Measurement model using Table 2/Section 2.1 (reflective or formative specification of construct), estimation method (maximum likelihood or robust estimator depending on normality assumptions being violated) and criterion for ensuring model identification.

Model refinement procedure: a planned, known procedure for model refinement (e.g., only correlation of error terms within a construct when there is a theoretical rationale for it presented in the results section) and inspection of standardized residuals, such that post hoc refinements were clear and replicable rather than exploiting statistical flukes.

5. Model fit reporting: complete reporting of the indices from Table 6 (CMIN/df, CFI, TLI, RMSEA, SRMR, NFI, IFI) for both the measurement and structural models.

6. Structural model and mediations: standardized path coefficients, standard errors, and p-values for H1-H13; 5,000 resample bootstrapping of bias-corrected 95% confidence intervals of the indirect effect(s) identified in H14-H19; and an analysis of the different model specifications, direct effects only, partial mediation, full mediation (Section 2.9).

Once we have our data, we will examine the correlations between our latent exogenous constructs to determine whether there is the possibility of multicollinearity in our interpretation of the structural paths and the stability of the standard errors of those structural path coefficients.

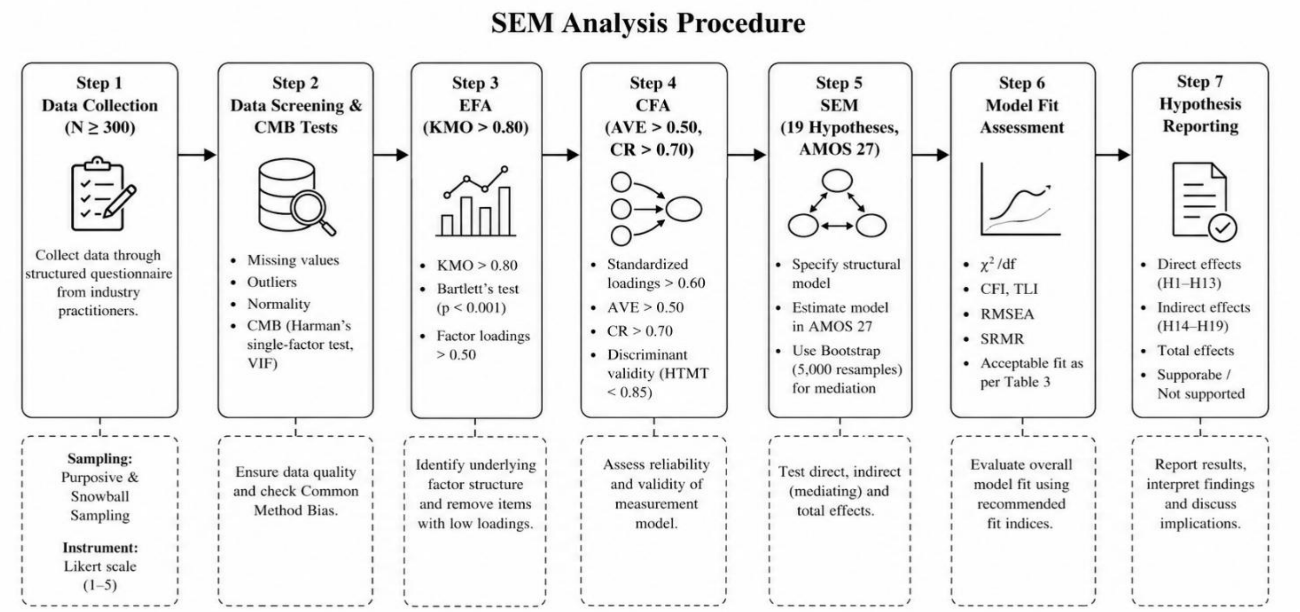

Figure 2. Sequential Data Analysis Process for CAAPMF Validation

Table 6. Structural Equation Model Fit Indices and Acceptance Criteria

Index	Acceptable Threshold	Good Fit Criterion	Reference
Chi-square / df (CMIN/df)	≤ 5.00	≤ 3.00	[33]
CFI (Comparative Fit Index)	≥ 0.90	≥ 0.95	[34]
TLI (Tucker-Lewis Index)	≥ 0.90	≥ 0.95	[35]
RMSEA	≤ 0.08	≤ 0.06	[36]
SRMR	≤ 0.10	≤ 0.08	[33]
NFI (Normed Fit Index)	≥ 0.90	≥ 0.95	[37]
IFI (Incremental Fit Index)	≥ 0.90	≥ 0.95	[38]

The Common Latent Factor process in AMOS and Harman's single-factor test is used to evaluate common method bias (CMB). The mean scores of early and late respondents on five randomly chosen indicator variables were compared in order to assess non-response bias [39].

3.8 Data Collection and Ethics Statement (Planned)

This sub-section specifies, in advance, the data collection and ethical considerations that were provided in the full report after data collection. Approval (or formal waiver) of the study is sought from the institutional review board of the authors prior to data collection, and the approval/waiver number is included in the published paper. The data collection process is yet to commence; the survey period, modes of recruiting participants, and medium for data collection is provided once determined. The participation is voluntary, and informed consent is obtained from each participant through a consent form that is shown to participants prior to filling the survey questionnaire items as required by the 1964 Declaration of Helsinki; no personal identifiers were collected, and all responses is kept confidential. After the conclusion of data collection, the manuscript will include: the number of opened questionnaires, the number of completed surveys, the number of questionnaires excluded and the reason for exclusion (Section 3.2), and the valid sample size and the demographic composition of participants (Section 3.2).

4. Measurement Instrument

The entire 56-item assessment tool, arranged by construct, is shown in Table 7. The construct prefix and item number (e.g., CRA1 through CRA7) were used to code items. A five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree), is used to score each item.

Table 7. Complete Measurement Instrument (56 Items)

Code	Construct	Measurement Item
CRA1	Climate Risk Assessment	Climate-related risks are systematically identified during project initiation.
CRA2	Climate Risk Assessment	Climate forecasts and meteorological projections are consulted during project planning.
CRA3	Climate Risk Assessment	Extreme weather scenarios are explicitly incorporated into project risk registers.
CRA4	Climate Risk Assessment	Climate vulnerability assessments directly influence design and engineering decisions.

CRA5	Climate Risk Assessment	Climate risk evaluations are periodically reviewed throughout project execution.
CRA6	Climate Risk Assessment	Risk mitigation measures are developed specifically for identified climate hazards.
CRA7*	Climate Risk Assessment	This project engages qualified professionals to conduct climate risk assessments.
APS1	Adaptive Planning & Scheduling	Project schedules include built-in contingency buffers for weather-related disruptions.
APS2	Adaptive Planning & Scheduling	Construction sequencing is adjusted in response to seasonal climate variability.
APS3	Adaptive Planning & Scheduling	Climate scenarios are used to develop alternative project delivery pathways.
APS4	Adaptive Planning & Scheduling	Resource allocation plans are modified when extreme climate events are forecasted.
APS5	Adaptive Planning & Scheduling	Project teams possess the capability to revise schedules on short notice due to weather events.
APS6	Adaptive Planning & Scheduling	Procurement strategies account for climate-induced supply chain disruptions.
APS7*	Adaptive Planning & Scheduling	Alternative scheduling scenarios are prepared in advance for anticipated periods of severe weather.
CRG1	Climate-Responsive Governance	Organisational leadership prioritises climate resilience in project governance structures.
CRG2	Climate-Responsive Governance	Policies and procedures specifically address climate-related project risks.
CRG3	Climate-Responsive Governance	Regulatory compliance requirements related to climate resilience are systematically incorporated.
CRG4	Climate-Responsive Governance	Decision-making authority is delegated appropriately during climate-related emergencies.
CRG5	Climate-Responsive Governance	Climate resilience performance indicators are embedded in project governance frameworks.
CRG6	Climate-Responsive Governance	There are clear accountability mechanisms for climate adaptation outcomes on projects.
CRG7	Climate-Responsive Governance	Project governance structures support rapid adaptation to changing climate conditions.
SCE1	Stakeholder Climate Engagement	Project stakeholders share a common understanding of climate-related project risks.
SCE2	Stakeholder Climate Engagement	Regular climate briefings are conducted for all project stakeholders.

SCE3	Stakeholder Climate Engagement	Contractors and subcontractors are engaged in developing climate adaptation measures.
SCE4	Stakeholder Climate Engagement	Community and end-user concerns about climate resilience are incorporated into project decisions.
SCE5	Stakeholder Climate Engagement	Climate resilience objectives are communicated transparently across the project team.
SCE6*	Stakeholder Climate Engagement	Stakeholders participate in joint problem-solving activities focused on specific climate-related project risks.
SCE7	Stakeholder Climate Engagement	Stakeholder feedback mechanisms include provisions for raising climate-related concerns.
DCM1	Digital Climate Management Tools	Building Information Modelling (BIM) is used to simulate the effects of climate variability on building performance.
DCM2	Digital Climate Management Tools	GIS platforms are utilised for spatial analysis of climate risk in project areas.
DCM3	Digital Climate Management Tools	Digital twin technologies are deployed to monitor building performance under climate stress.
DCM4	Digital Climate Management Tools	IoT sensor networks provide real-time data on climate conditions at the project site.
DCM5	Digital Climate Management Tools	Climate forecasting systems are integrated into project management information systems.
DCM6	Digital Climate Management Tools	Data analytics tools are employed to identify patterns of climate-related project disruptions.
DCM7*	Digital Climate Management Tools	Digital tools are actively used to coordinate response actions during climate-related emergencies on this project.
RRC1	Resource Resilience Capacity	Alternative material suppliers are pre-identified to mitigate climate-induced supply chain disruptions.
RRC2	Resource Resilience Capacity	Labour management plans include provisions for heat stress and extreme weather working conditions.
RRC3	Resource Resilience Capacity	Water management strategies are embedded in project operations to address potential scarcity.
RRC4	Resource Resilience Capacity	On-site energy systems (e.g., generators, renewables) provide backup during energy shortages.

RRC5	Resource Resilience Capacity	Equipment procurement plans account for climate-related availability constraints.
RRC6	Resource Resilience Capacity	Material specifications include climate-resilient alternatives to conventional products.
RRC7	Resource Resilience Capacity	Resource buffers are maintained to sustain project operations during extended climate disruptions.
CAC1	Climate Adaptation Capability	The project team demonstrates a strong capacity to anticipate potential climate-related disruptions.
CAC2	Climate Adaptation Capability	The team responds effectively to climate-induced changes in project conditions.
CAC3	Climate Adaptation Capability	Recovery from climate-related project disruptions occurs within acceptable timeframes.
CAC4	Climate Adaptation Capability	Lessons learned from climate events are systematically integrated into future project planning.
CAC5*	Climate Adaptation Capability	Adaptive-capacity building activities (e.g., training, briefings) were undertaken for this project
CAC6	Climate Adaptation Capability	Climate adaptation capabilities are continuously reviewed and improved.
CAC7*	Climate Adaptation Capability	This project team's capability to manage climate-related risks has developed over its duration.
CRPP1	Climate-Resilient Project Performance	Projects are delivered on schedule despite climate-related disruptions.
CRPP2	Climate-Resilient Project Performance	Project costs remain within budget when climate-related risks are properly managed.
CRPP3	Climate-Resilient Project Performance	Quality standards are maintained during periods of adverse climate conditions.
CRPP4	Climate-Resilient Project Performance	Site safety performance is not compromised by climate-induced hazards.
CRPP5	Climate-Resilient Project Performance	Buildings delivered demonstrate strong operational performance under projected climate conditions.
CRPP6	Climate-Resilient Project Performance	Projects maintain operational continuity during and immediately following extreme weather events.
CRPP7	Climate-Resilient Project Performance	Overall project performance is enhanced by proactive climate adaptation measures.

5. Results Reporting Templates

5.1 Reliability and Validity Targets (Anticipated Range, Not Yet Obtained)

The anticipated psychometric characteristics of the measurement tool were shown in Table 8. The instrument's reliability and convergent validity were intended to be supported by all constructs above the minimum standards for Cronbach's alpha (>0.70), Composite Reliability (>0.70), and Average Variance Extracted (>0.50). The Fornell-Larcker criterion and HTMT ratios less than 0.85 for every pair of constructs were to validate discriminant validity. Because Cronbach's alpha, Composite Reliability and AVE are reflective-measurement statistics, Table 8a reports these for the five reflective constructs (CRA, APS, CRG, SCE, CAC) only; the three formative/composite constructs (DCM, RRC, CRPP) are evaluated separately in Table 8b using formative-indicator diagnostics (indicator collinearity via VIF and external/nomological validity), consistent with their specification in Section 2.1.

Table 8a. Reliability and Validity Statistics for Reflective Constructs (Anticipated/Target Values, Not Yet Obtained).

Construct	Cronbach's Alpha	Composite Reliability (CR)	AVE	Factor Loadings Range	n
Climate Risk Assessment (CRA)	≥ 0.85	≥0.87	≥0.50	0.71 – 0.88	7
Adaptive Planning & Scheduling (APS)	≥0.86	≥0.88	≥0.50	0.72 – 0.87	7
Climate-Responsive Governance (CRG)	≥0.84	≥0.86	≥0.50	0.70 – 0.86	7
Stakeholder Climate Engagement (SCE)	≥0.85	≥0.87	≥0.50	0.71 – 0.88	7
Climate Adaptation Capability (CAC)	≥0.88	≥0.90	≥0.52	0.74 – 0.90	7

Table 8b. Planned Formative-Indicator Diagnostics for Composite Constructs (DCM, RRC, CRPP) — Not Yet Obtained.

Construct	Formative-Indicator Diagnostic	Planned Acceptance Criterion	n
Digital Climate Management Tools (DCM)	Indicator collinearity (VIF); bootstrapped item-weight significance	VIF < 5 (ideally < 3.3); weights significant at p < .05, or loading ≥ 0.50 as fallback criterion	7
Resource Resilience Capacity (RRC)	Indicator collinearity (VIF); bootstrapped item-weight significance	VIF < 5 (ideally < 3.3); weights significant at p < .05, or loading ≥ 0.50 as fallback criterion	7
Climate-Resilient Project Performance (CRPP)	Indicator collinearity (VIF); external/nomological validity vs. CAC and reflective antecedents	VIF < 5 (ideally < 3.3); significant, theoretically consistent correlation with CAC	7

5.2. Reporting Template: Structural Model Results

The Reporting Template for Structural Model Results (to be populated after data collection) were shown in Table 9. It is anticipated that the structural model's strongest path coefficient (β ≈ 0.40–0.58) will result from the core hypothesis (H7: CAC positively effects CRPP), demonstrating the crucial mediating function of Climate Adaptation Capability. Given the current focus on data-driven adaptive capacity, it is anticipated that among the antecedent constructs, Digital Climate Management Tools (DCM) and Climate Risk Assessment (CRA) is the strongest predictors of CAC (H5, H1). All six indirect pathways (H14–H19) should show partial mediation according to the mediation analysis, which is in line with results in comparable resilience frameworks [15].

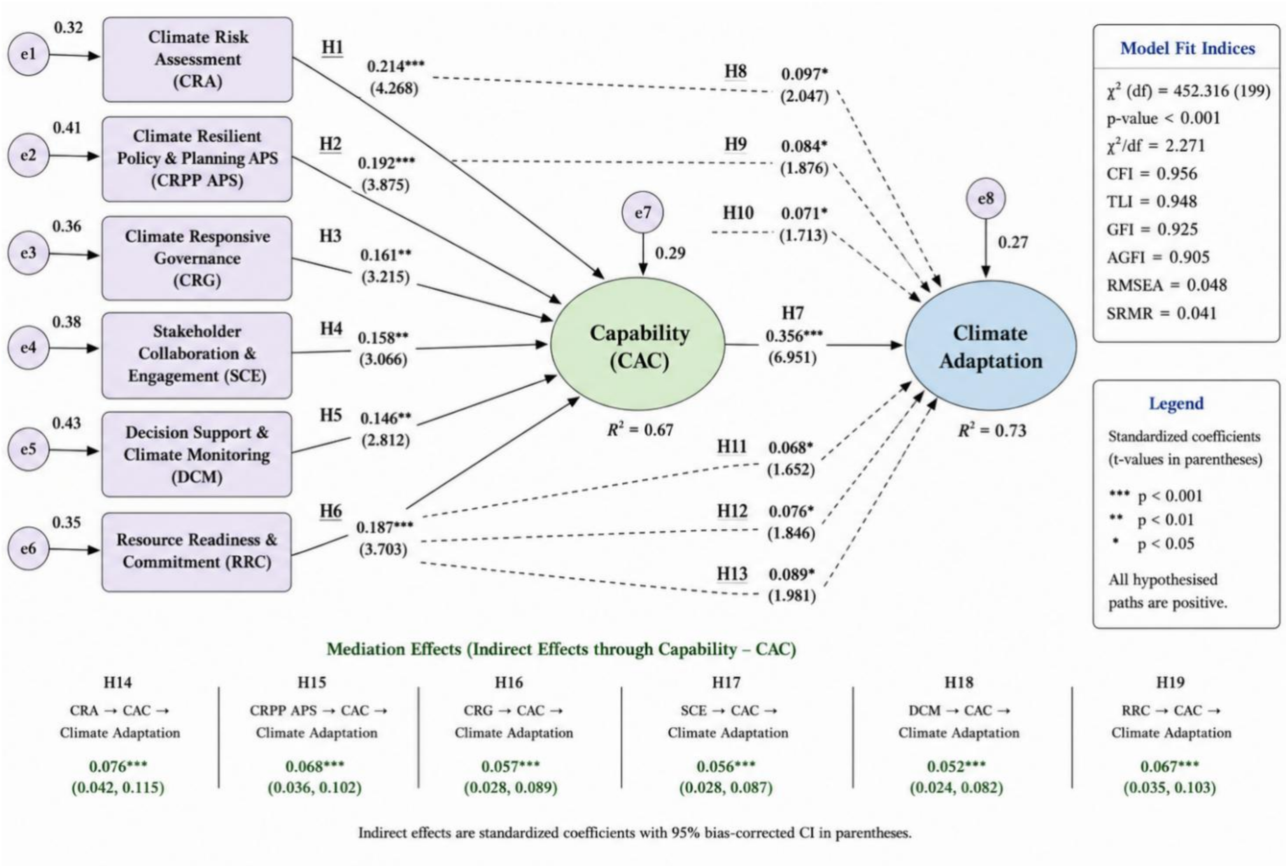

Figure 3. Planned Structural Equation Model Path Diagram (CAAPMF).

Table 9. Reporting Template for Structural Model Results (to be populated after data collection).

Hyp.	Path	β	p-value	Decision (Anticipated)
H1	CRA → CAC	0.31 – 0.45	< 0.05	Anticipated
H2	APS → CAC	0.28 – 0.42	< 0.05	Anticipated
H3	CRG → CAC	0.25 – 0.40	< 0.05	Anticipated
H4	SCE → CAC	0.22 – 0.38	< 0.05	Anticipated
H5	DCM → CAC	0.30 – 0.46	< 0.05	Anticipated
H6	RRC → CAC	0.26 – 0.41	< 0.05	Anticipated
H7	CAC → CRPP	0.40 – 0.58	< 0.001	Anticipated
H8–H13	IV → CRPP (direct)	0.15 – 0.35	< 0.05	Anticipated
H14–H19	IV → CAC → CRPP (mediation)	0.10 – 0.22	< 0.05	Anticipated:

	Partial Mediation

With RMSEA below 0.06, CFI and TLI over 0.95, SRMR below 0.08, and a chi-square/df ratio below 3.0, which together indicate close model-data fit, model fit indices were to meet the requirements outlined in Table 6.

6. Discussion on Anticipated Contributions and Practical Relevance

6.1 Theoretical Implications

operationalization as a latent construct with psychometric validity in the context of construction project management is new. The structural model's mediation pathways show how an organization's overall adaptive capacity channels the impact of practices like digital tool deployment or governance commitment on project performance. This would be a theoretically significant contribution once tested, improving our understanding of the causes of climate resilience in project settings.

Another theoretical development is the use of Dynamic Capability Theory in climate-resilient project management. The initial definition of dynamic capabilities [18] by Teece et al. is created with firm-level competitive advantage and strategic management in mind. In line with previous theoretical work on the organization of project-based enterprises, this study shows how it might be applied to temporary project organizations [40]. By simulating the inter-construct relationships between governance, digital tools, stakeholder engagement, and resource capacity as components of a cohesive socio-technical adaptive system, the framework enhances Systems Theory applications in construction management.

6.2 Anticipated Practical Implications

The CAAPMF's ability to function as a diagnostic and action-planning tool for organizations looking to improve their climate adaptable performance is what gives it its practical value. Organizations lacking integrated BIM-climate simulation workflows, GIS-based risk platforms, or IoT-enabled site monitoring systems face a fundamental structural deficit in their adaptive capacity that governance and stakeholder engagement improvements alone cannot make up for. The anticipated finding that Digital Climate Management Tools and Climate Risk Assessment are the strongest determinants of CAC, once tested, would point to specific investment priorities.

The anticipated findings on Climate-Responsive Governance, once obtained, would offer evidence to policy and regulatory organizations in favor of requiring climate adaptation in professional license frameworks, building codes, and project delivery contracts. The CRPP construct's emphasis on operational resilience highlights the significance of lifecycle continuity planning for facility managers and building operators, ensuring that adaptive capacity investments made during project delivery were integrated into the finished building's operational protocols.

7. Limitations and Future Research Directions

When interpreting the study's results, a number of limitations should be taken into account. The cross-sectional design limits the ability to identify changes in adaptive capacity over the course of a project and prevents causal inference in the strict sense by capturing constructs and their interactions at a single moment in time. The framework's proposed causal processes is be much better supported by a longitudinal panel study. The use of self-reported perceptual data raises the risk of common method bias [41], which cannot be completely eliminated even with the statistical and procedural constraints outlined in Section 3.6.2.

The practical difficulties of reaching government engineers and facility managers through non-probability sampling techniques limit the sampling strategy's ability to achieve wide professional representation, potentially introducing selection bias toward more digitally engaged and climate-awwere professionals. The framework's construct linkages may seem differently in high-exposure contexts (such low-elevation coastal cities or semi-arid building environments) than in lower-exposure situations, which makes geographic scope another restriction.

The framework makes several specific recommendations for future research. First, it is important to look into how project size, contract type, and procurement model could moderate the construct linkages. Second, the measurement instrument's theoretical robustness is improved by including a Delphi expert panel into a two-phase validation design. Third, the framework's practical accessibility is expanded to project teams lacking specialized survey research expertise by creating a simpler diagnostic instrument based on the CAAPMF that is appropriate for quick assessment without full psychometric rigor.

8. Conclusion

The Climate-Adaptive Architectural Project Management Framework (CAAPMF), a theoretically supported and methodologically rigorous structural model intended to explain the mechanisms through which climate adaptive practices translate into resilient project performance outcomes, has been conceptually developed. Climate Adaptation Capability serves as the crucial organizational competency through which antecedent practices enhance Climate-Resilient Project Performance. The framework incorporates six antecedent constructs: Climate Risk Assessment, Adaptive Planning and Scheduling, Climate-Responsive Governance, Stakeholder Climate Engagement, Digital Climate Management Tools, and Resource Resilience Capacity within a mediated structural model.

The study fills a well-defined vacuum in the literature on architectural and construction project management: the lack of a verified, integrative framework that can direct practice and research in the field of climate-adaptive project delivery. The CAAPMF provides a cogent theoretical synthesis that advances each of these traditions separately and adds a new framework at their junction by referencing and expanding on Climate Resilience Theory, Adaptive Management Theory, Dynamic Capability Theory, and Systems Theory.

Both an idea map of the adaptive capacities needed for the delivery of climate resilient buildings and, after the process of validation outlined here is completed, an empirical body of evidence against which current practice can be measured, were expected outcomes of this research program for the construction and architectural project management professions in an era of rising climate risk.

Author Contributions: Conceptualization, K.A.; framework development, K.A.; literature review, M.Z.; methodology design, K.A., M.Z.; manuscript preparation and editing, K.A., M.Z. and W.A.; Critical review, W.A.; validation of construct definitions, W.A.; All authors have read and agreed to the published version of the manuscript.

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Ethical Approval: This study is conducted in accordance with the ethical standards of the institutional review board and with the 1964 Helsinki Declaration. Informed consent was obtained from all survey participants. No personal or sensitive data were collected.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Not applicable at this stage.

Acknowledgments: None.

Conflicts of Interest: The authors declare no conflicts of interest.

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