

Drivers and enablers of dampness mitigation intervention adoption: Evidence from construction practitioners

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ABSTRACT

Dampness remains one of the most prevalent and costly issues affecting both residential and public buildings in Ghana. This problem reduces structural integrity, worsens building appearance, and increases health risks for occupants. Despite its widespread nature, empirical evidence on the specific factors that construction stakeholders consider essential for addressing dampness remains limited. This research draws upon the Diffusion of Innovation Theory as the underpinning theory for the study. This study identified and ranked nine potential factors that contribute to effective dampness control using a descriptive, cross-sectional survey design. It employed a convergent mixed-methods approach targeting building construction practitioners involved in the design, construction and maintenance of buildings. A total of 366 sample was utilised, consisting of 352 for quantitative analysis (Descriptive statistics) and 14 for qualitative analysis (Thematic). Stratified and convenience sampling technique was employed for the quantitative component and purposive sampling technique was employed for the qualitative component. The factors examined included adequate training and capacity building (88.92%), enforcement of building codes (83.24%), and availability of affordable quality materials (82.95%), which emerged as the most strongly supported factors and form a foundational level considered essential for sustainable improvement. Conversely, implementation of policy guidelines received the least support (1.14%), despite positive qualitative feedback. This discrepancy suggests stakeholders see Ghana's regulatory framework as sufficient in principle but poorly enforced in practice, rather than viewing policy itself as unimportant. Qualitative findings reinforced and expanded upon the quantitative rankings, revealing an interdependent relationship: training enhances awareness, which influences clients' investment decisions, and client investment sustains demand for affordable materials and professional collaboration. The study concludes that reducing dampness in Ghana's built environment requires a coordinated, multi-faceted strategy that simultaneously improves human capacity, regulatory enforcement, material affordability, and public awareness, rather than isolated interventions. This study provides specific recommendations for policymakers, professional and training institutions, industry practitioners, and researchers. These findings contribute to the limited empirical literature on drivers of dampness mitigation in construction settings in developing countries and present a prioritised, evidence-based framework to guide future interventions and resource allocation.

Keywords: Building Defect, Construction Industry, Dampness, Enabling & Driving Factors, Mitigation Practices

I. INTRODUCTION

Dampness in buildings remains a major, complex challenge (Sousa, 2024). According to Ako-Adjei et al. (2025), this phenomenon affects building performance and durability and also impacts building occupants (Guarnieri et al., 2023). Generally, building components accumulate excessive moisture. According to Tetteh et al. (2025), it can show up as condensation, water ingress, rising damp, or mould growth in building materials and indoor spaces. Moisture is unavoidable in building construction and operation; however, when it becomes excessive and uncontrolled, it can cause structural damage and other health risks for occupants. Dampness in buildings, typically evident as excessive moisture accumulation, capillary rise, condensation, or water infiltration (Kamel et al., 2024), remains a significant issue in the built environment. According to Brambilla & Sangiorgio (2020), excessive moisture in building components typically arises from inadequate architectural specifications, substandard construction and maintenance procedures, and improper occupant behaviour. This phenomenon can lead to structural deterioration and mould proliferation (Cai et al., 2024), reduced thermal efficiency, adverse health effects (Blay et al., 2019), and higher maintenance or energy costs (Mudarri, 2016). Agyekum et al. (2018), for instance, found that many structures lacked adequate damp-proof courses, leading to rising wall moisture, mould growth, flaking paint, and health issues among residents. Bornehag et al. (2001) review indicated that moisture in buildings increases the incidence of respiratory problems and concluded that adequate

evidence supports preventive action. Accordingly, Tuumien (2020) emphasised that dampness poses health risks by facilitating the proliferation of mould and fungi, which can trigger allergic reactions and respiratory issues among inhabitants. Kong et al. (2021) contend that dampness increases energy consumption by enhancing the thermal conductivity of walls. Dampness has been conceptualised only as a maintenance issue; however, it is also an economic externality that can affect public health systems and national housing resilience.

Prescribed measures to mitigate dampness are numerous and diverse, ranging from early identification and diagnosis of moisture sources to structural interventions (Ako-Adjei et al., 2025). Bernardo et al. (2024) recommend measures such as chemical injection, electro-osmosis treatment, and innovative damp-proofing materials to address dampness in buildings. Seidu et al. (2019) argue that mitigating dampness requires a systematic approach involving appropriate construction methods, routine maintenance, and innovative damp-mitigation measures. Nonetheless, despite viable solutions, applying damp-mitigation measures remains challenging. According to Franzoni and Bassi (2022), existing solutions are often only partially effective because dependable, suitable techniques are lacking. Franzoni (2018) notes that the actual success and failure rates of these methods in real buildings remain poorly understood. These challenges call for the industry to transition from corrective dampness remediation toward preventive moisture resilience management (Ayarkwa et al., 2026). In many cases, other constraints such as limited resources, low awareness, inadequate regulatory enforcement, social norms, and a lack of maintenance culture impede the effectiveness of dampness mitigation measures (Asamoah et al., 2017).

Mitigation measures often include early diagnosis and detection to identify risk and prevent early onset (Alkadri et al., 2024), as well as treatment measures to address and remedy damage. While research explains the causes, impacts, and treatments of dampness (Battersby & Ezratty, 2025; Franzoni, 2018), few studies examine the rationale for adopting mitigation measures and the factors that enable their effective application. Dampness affecting buildings is not purely a moisture defect. It is also a socio-technical pathology that emerges from interactions among climate, building characteristics, occupant behaviour, and institutional, regulatory, and maintenance systems. This study fills this gap by systematically identifying and analysing the enabling and driving factors that influence the effectiveness of dampness mitigation in buildings.

1.1 Research Objective

To identify the driving and enabling factors that influence effective dampness mitigation in buildings.

II. LITERATURE REVIEW

2.1 Theoretical Review

2.1.1 Diffusion of Innovation Theory

This research draws upon the Diffusion of Innovation Theory, developed by Everett M. Rogers (1962) as mentioned by Orr (2003). This theory explains how new ideas, practices, or technologies spread within a social system. Rogers defines diffusion as the process through which an innovation is communicated via specific channels over time among members of a social group. Furthermore, the theory posits that adoption is a gradual decision-making process influenced by individuals' perceptions of the innovation, the characteristics of the social system, the methods of information dissemination, and the attributes of potential adopters. For this study, innovation refers to any dampness mitigation strategy that building construction practitioners perceive as new, regardless of its actual novelty. This theory is appropriate because adopting dampness mitigation strategies requires technical learning, behavioural change, and economic decision-making among practitioners who influence one another.

2.2 Empirical Review

2.2.1 Dampness Overview

Dampness is increasingly seen as a complex threat to structural integrity, indoor environmental quality, and occupant health (Aziz, 2025). Dampness in buildings refers to unwanted moisture, which may result from air moisture manifesting as condensation, penetration, or rising dampness (Asamoah et al., 2017)). Asamoah et al. (2017), further concluded that dampness negatively impacts occupants' health and accelerates structural decay. Brambilla and Sangiorgio (2020) defined dampness as water penetration through walls and other building elements, noting that it is the most prevalent and severe issue in buildings and is responsible for over half of all documented structural collapses. Guimarães and Delgado (2015) state that although dampness occurs frequently, it remains a complex phenomenon characterised by unpredictable behaviour. Moisture rising through masonry walls can result in high-tide-like staining on wall surfaces, including wallpaper and other interior finishes. In severe cases, paint may blister, and plaster may deteriorate (Franzoni, 2014; Lstiburek, 2004). Damp walls also promote the growth of mold, mildew, and other harmful microorganisms, which pose significant health risks, particularly for individuals with respiratory conditions (Franzoni et al., 2014; Rirsch and Zhang, 2010). Furthermore, dampness compromises wall structural integrity and accelerates the degradation of building materials (Guolo et al., 2025). The literature consistently shows that moisture accelerates

material degradation, reduces mechanical performance, and undermines thermal insulation efficiency, increasing energy consumption and long-term maintenance costs (Cai et al., 2024; Blay et al., 2019; Franzoni, 2018). The concurrent problems of mould growth, indoor air quality degradation, and associated public health ramifications intensify the need for more reliable diagnostic, preventive, and treatment strategies (Bernardo et al., 2024). However, selecting any of these strategies may come with several challenges (Ayarkwa et al., 2026). Nonetheless, some factors can equally facilitate their effective adoption and application.

2.2.2 Driving Factors for Dampness Mitigation in Buildings

The adoption and effective application of dampness mitigating measures are primarily driven by the need to preserve and protect the building and its occupants. Hörhammer et al. (2025) highlighted technological breakthroughs as a key driver of adopting and applying dampness mitigation measures. According to Hörhammer et al. (2025), advances in infrared thermography, electrical impedance tomography, microwave/radar moisture sensing, and cost-effective embedded sensors have improved the resolution, precision, and practicality of moisture detection in various situations. Improvements in materials and monitoring technologies have increased the effectiveness and reliability of damp-proofing measures, thereby bolstering confidence in their implementation. Technological improvements in moisture control, including classifying vapour and air barriers by quantifiable parameters such as permeability, enable more accurate and efficient regulation of moisture transfer within building envelopes (Lstiburek, 2002). Contextual elements associated with buildings and the environment significantly influence the choice of dampness mitigation measures. The building's age, construction type, masonry variability, and moisture exposure conditions influence the appropriateness and reliability of different procedures

The performance and evidence-based drivers serve as crucial mediators between context and technology. Bernardo et al. (2024) note a substantial gap in the scientific and technical literature on the long-term monitoring and durability of dampness remedies. Torres (2014), for instance, noted that the adoption and application of wall-base ventilation is mainly driven by the shortcomings of traditional moisture control methods, especially their inefficacy and unsuitability for some building types. Its simplicity, ease of use, and demonstrated efficacy has helped it gain acceptance as a potential remedy for rising damp in heritage structures (Annala & Lahdensivu, 2020; Martínez-Garrido et al., 2018; Torres, 2014). Similarly, Lstiburek (2002) argued that moisture control strategies are implemented mainly to improve building performance and ensure long-term durability. Lubelli et al. (2011) noted that dampness treatment technologies, especially chemical injection techniques, are primarily adopted for their simplicity and broad practical acceptance compared with more invasive mechanical alternatives. The application of damp-proofing systems in masonry is often driven by the necessity to preserve historically and culturally significant structures, enhance indoor comfort, and mitigate material degradation (Torres & de Freitas, 2007; Franzoni, 2018). Bernardo et al. (2024) noted that addressing structural and aesthetic integrity issues in masonry requires thorough and effective mitigation measures.

According to Di Tullio and Proietti (2024) and Wang et al. (2025), mitigation techniques in cultural heritage conservation are driven by the need for non-destructive, non-invasive examination of important and often immobile artifacts. Rymarczyk et al. (2018) mentioned that the pressing demand for non-invasive and non-destructive moisture evaluation, especially in culturally significant structures where destructive testing is forbidden, drives the adoption of dampness mitigation measures. Torres (2018) argued that scientific evidence, practical simplicity, non-invasive characteristics, and demonstrated efficacy in real-world applications support adopting and applying a wall-based ventilation system. Similarly, Pease et al. (2012) noted that X-ray attenuation methods for tracking moisture migration in construction materials are driven by their ability to provide precise, non-invasive, high-resolution assessments of internal moisture variations. For de Freitas et al. (2015), adoption is based on the system's proven efficacy in long-term, real-world case studies, where moisture-related pathologies were noticeably diminished or eradicated, and on a system that offers robust empirical confirmation and assurance, facilitating its implementation for building preservation. Harmati et al. (2014) established optimisation criteria for dampness analysis in buildings based on effectiveness, duration of the handling method, and cost considerations. The increasing investment in building rehabilitation in the construction industry to improve market value has increased the demand for dependable, economical, and technically substantiated damp treatment methodologies, hence promoting the adoption of established and proven techniques and strategies (Delgado et al., 2016; Guimarães & Delgado, 2015; Guimarães et al., 2014; Guimarães & Delgado, 2013).

Similarly, Alfano et al. (2023) stated that adopting a dampness mitigation measure, especially a diagnosis technique, is driven by moisture's significant impact on structural degradation and the need to precisely identify moisture sources before intervention. The desire to maximise buildings' value, performance, and utility also drives the adoption of strategies (Asphaug et al., 2020). The urgent need to protect invaluable cultural heritage promotes the adoption of dampness mitigation technique (Proietti et al., 2021; Franzoni (2014), also, the detrimental characteristics and intrinsic constraints of traditional moisture management techniques Wan and Lei (2015); Rymarczyk and Tchórzewski (2019), are the principal motivators for implementing a multidisciplinary, non-invasive diagnostic approach employing advanced methods such as Infrared Thermography, Unilateral Nuclear Magnetic Resonance, Acoustic Imaging, Acoustic Tomography, and Laser-Induced Fluorescence (Proietti et al., 2021; Suchorab et al., 2018). According to Franzoni et al.

(2020), the pervasive and persistent issue of damp in buildings, along with the lack of standardised, dependable, and practical assessment methods, necessitates developing and implementing laboratory-based approaches and techniques. According to López-Arce et al. (2011), an intervention at the El Poular monastery cloister in Madrid was driven by the need to prevent further deterioration. Mounting moisture threats drive the use of any moisture-control strategy for habitable buildings. Ensuring occupant health and comfort is a key driver for adopting dampness mitigation strategies, as moisture-related issues can lead to material deterioration, heat loss, and microbiological proliferation (Asphaug et al., 2020). The prevalence and significant repercussions of moisture accumulation in buildings drive the implementation of dampness mitigation measures, particularly monitoring and diagnostic techniques. Increased humidity reduces home comfort and energy efficiency by increasing thermal conductivity and heating requirements. A primary driver is the need to identify moisture issues early, before visible damage appears, to reduce costs (Melada et al., 2018; Edis et al., 2015). The considerable health effects of mould exposure, alongside the understanding that dampness and mould are largely controllable, strongly encourage proactive moisture management and remediation initiatives (Major & Boese, 2017).

From a practitioner's viewpoint, user-friendliness, measurement efficiency, and ease of on-site application are significant drivers. Dampness mitigation strategies are driven by the need for efficient, dependable, and long-lasting solutions that reduce harm to both contemporary and historic structures (Lubelli et al., 2018). Practical factors, including cost, time efficiency, tenant interruption, and the need for reproducible results, influence technique selection (Hörhammer et al., 2025). Cost is a major factor considered by prospective homeowners making decision on any major component installation the building (Huang et al., 2021). These characteristics jointly drive trade-offs among accuracy, invasiveness, feasibility, effectiveness, and durability. Stakeholders must implement design-phase interventions to reduce lifecycle costs and prevent costly corrective maintenance (Elinwa et al., 2018). Furthermore, Hacquebord et al. (2013) stated that comparative simplicity and cost-effectiveness determine the choice of treatment option. Elinwa et al. (2018) and Dafico et al. (2022), however, linked moisture and mould to negative health effects, such as respiratory complaints, asthma exacerbation, and an overall decline in indoor air quality, and concluded that these factors drive the choice and application of dampness mitigation techniques.

2.2.3 Enabling Factors for Effective Dampness Mitigation in Buildings

Certain factors affect the selection and usage of dampness mitigation measures. These factors influence the selection and application of diagnosis, prevention, and treatment techniques in practice. These factors directly facilitate adoption via the attributes of accessible technologies and methods. Accuracy, reliability, depth sensitivity, spatial coverage, and long-term monitoring capability are essential factors. For instance, Elinwa et al. (2018) found that advances in tools and techniques such as Computational Fluid Dynamics (CFD), Building Information Modeling (BIM), and statistical optimisation tools allow designers to simulate airflow, humidity distribution, and material performance before construction. The availability and reliability of these analytical tools reduce uncertainty and support evidence-based moisture-prevention policies. Franzoni (2014) noted that a diverse array of commercially available technologies, including chemical injections, ventilation systems, restoration plasters, and electro-osmotic devices, supports practical adoption. The author further argued that despite the lack of thorough scientific proof, market availability and contractor familiarity still promotes their utilisation. According to Guimarães and Delgado (2015), integrating technological refinements such as hygro-regulated control facilitates adoption by ensuring consistent performance and mitigating condensation-related problems, thereby improving the system's long-term reliability. Alkadri et al. (2024) also argued that advances in technologies such as 3D laser scanning and thermal imaging have improved the rapid diagnosis and detection of humidity-related challenges in buildings. Zendri et al. (2017) also noted that advances in infrared thermography, electrical, electromagnetic, ultrasonic, and tomographic techniques have improved measurement precision, spatial resolution, and data interpretation, making these approaches more feasible and reliable for field use. These technological developments have overcome previous geometric and mechanical constraints of conventional probes, making these techniques predominant in civil engineering and building diagnosis (Suchorab et al., 2018).

The inadequacy of current methods to deliver non-destructive, comprehensive data (Hoła et al., 2012), the considerable impracticality of on-site application, and the consequences of precise moisture evaluation in buildings are key enabling factors for adopting and applying dampness mitigation measures. The accessibility of measuring sites, permissible disturbance levels, and environmental variability, such as seasonal moisture variations, also influence method selection. According to Lubelli et al. (2011), environmental conditions have shaped dampness mitigation practices, driving a market shift toward water-based injection products in liquid, gel, cream, or emulsion formats. Dampness causes material deterioration, reduced mechanical strength, poor indoor air quality, and increased energy use. These consequences put significant pressure on homeowners and practitioners to implement appropriate mitigation solutions. Different areas within buildings are vulnerable to accidental moisture damage from bathtub or kitchen sink overflows. Sensors and moisture indicators promptly notify building occupants. When such events occur, residents or occupants act quickly to prevent further damage to flooring and walls (Kamel et al., 2024). Panico et al. (2023) argue that the need for precision and non-invasiveness shapes the choice of techniques for diagnosing and detecting moisture in masonry. Similarly, Guimarães and Delgado (2015) stated that a key factor driving the adoption of dampness

mitigation techniques is the substantial deterioration dampness causes in buildings, especially in antiquated edifices and heritage constructions.

According to Panico et al. (2023), microwave devices and infrared thermography for moisture diagnosis and detection appeal because of their speed, repeatability, and adaptability to field settings. Professionals increasingly recognise that misdiagnosis leads to ineffective or harmful interventions. This risk encourages systematic analytical approaches and integrated monitoring methods to support more informed decision-making in repair and conservation practices. According to Hörhammer et al. (2025), the availability of expertise and established mitigation techniques and strategies strongly support adoption and application. Increased awareness of the risk of misdiagnosis, particularly the common misattribution of wetness to growing damp, promotes more prudent, evidence-based analytical approaches. A major contributing factor, according to Asamoah et al. (2017), is artisans' inadequate knowledge of construction techniques and the proper application of damp-proof materials. Noncompliance of building regulations has also been attributed to one of the major challenges to the construction industry (Offei-Nketiah et al., 2020). Regulation enforcement and compliance ensure effective use of damp-proofing materials. The authors argue that this deficit leads to non-compliance with standards and specifications and requires education, training, and rigorous enforcement of appropriate dampness mitigation measures. López-Arce et al. (2011) note that strong scientific expertise supports applying these procedures, including comprehensive material characterisation, recognition of chemical incompatibilities between stones and mortars, and an understanding of moisture and salt transport mechanisms.

Furthermore, Guolo et al. (2025) noted that the literature documents a variety of non-invasive techniques. These include visual observation, infrared thermography, and probes that measure electrical resistance, capacitance, impedance, and microwave signals. These are the most prevalent because they are user-friendly and can assess all masonry surfaces (Guolo et al., 2025). Institutional and regulatory elements serve as a fundamental enabling function. Building codes and regulations, technical standards, and guidance documents confer legitimacy and formal endorsement for a particular mitigation measure. Monczynski et al. (2019) stated that standardised technical specifications and guidelines provide a foundation for properly implementing dampness mitigation techniques and strategies. Advances in scientific understanding of environmental factors, including hygro-thermal conditions (Delgado et al., 2013), rain exposure, and interior climate, allow designers to select and implement suitable moisture-control solutions (Dafico et al., 2022; Guimarães & Delgado, 2015; Lstiburek, 2002). Scientific evidence, knowledge of previous interventions' shortcomings, and technological advances also shape confidence in adoption (Li et al., 2023; Lubelli et al., 2018).

Institutional learning and the development of best practices also facilitate the adoption of these strategies in both practice and policy (Elinwa et al., 2018). Inaccurate selection of treatment methods frequently results in ineffective interventions and exacerbates deterioration. According to Guimarães and Delgado (2015), a data-driven approach will facilitate the comparison of techniques and their limitations. This will reduce failure rates and increase confidence in expected outcomes, thereby promoting adoption. Asamoah et al. (2017) also suggested that promoting rigorous enforcement of damp-proof material installation, thorough plumbing testing, and the rejection of superficial cosmetic solutions will drive widespread industry implementation of these strategies. Accordingly, Franzoni (2014) argues that adherence to heritage conservation criteria strongly influences technique selection. López-Arce et al. (2011) noted that institutional support strengthened practical feasibility. Strict, enhanced building codes, energy-efficiency mandates, and sustainability objectives require superior moisture-control strategies (Zendri et al., 2017). Enforcement supports reliable monitoring, prevention, and treatment systems that ensure compliance and validate performance. Collaboration among multiple stakeholders promotes the adoption of dampness mitigation measures (Major & Boese, 2017). These groups, comprising advocacy groups, occupants, organisations, professional entities, and government agencies, facilitate the creation of legislation that is clear, widely endorsed, and actionable by explicitly categorising dampness and mould as public health issues.

III. METHODOLOGY

3.1 Research Design

This study employed a descriptive, cross sectional survey design utilising a mixed-methods approach, integrating quantitative and qualitative research, to examine the factors influencing the adoption of dampness mitigation measures. Quantitative research often addresses questions of "how much," whereas qualitative research explores "how." A mixed-methods approach allows comparison of findings from both quantitative and qualitative methods, enriching the evidence base and yielding deeper insights (Creswell & Creswell, 2018). In Convergent, or concurrent, mixed methods (also called "parallel") projects, researchers gather quantitative and qualitative data separately, or in parallel. In convergent designs, unlike sequential mixed methods, data design, collection, and analysis do not influence later stages of data collection (Katz-Buonincontro, 2024). This study uses a convergent mixed method design.

3.2 Study Area

This study systematically identifies and analyses the enabling and driving factors that influence the effectiveness of dampness mitigation in buildings within Ghana's construction industry, focusing on the Bono Region. Sunyani serves as the regional capital, and the region comprises eleven additional districts: Sunyani West, Dormaa, Dormaa East, Dormaa West, Wenchi, Berekum, Berekum West, Jaman North, Jaman South, Tain, and Banda. The Bono Region has an estimated population of 1.209 million (Ghana Statistical Service, 2021). It covers a land area of 11,481 square kilometres and shares boundaries with the Savannah, Bono East, Ahafo, and Western North Regions. The Bono region was selected for two primary reasons. First, its transitional climate, characterised by high humidity and double-peak rainfall, provides an effective setting for studying moisture-related building defects. Additionally, the region has experienced rapid urbanisation, which has resulted in accelerated building construction with limited enforcement of the Ghana Building Code, leading to observable cases of dampness.

3.3 Target Population

This study's target population consisted of building construction practitioners engaged in designing, executing, and maintaining buildings in the Bono Region of Ghana. For this research, a practitioner is defined as an individual with formal training, professional certification, or significant practical experience in building construction whose activities directly affect the initiation, completion, or maintenance of residential and commercial buildings. Because the building delivery process in Ghana is fragmented and largely informal, the target population was stratified into three broad categories to represent the full building life cycle and ensure diverse perspectives on dampness and related coping mechanisms. The categories comprise design professionals, execution and construction professionals, and maintenance and facility management professionals.

3.4 Sampling, Sample size and Data Collection Instrument

This study conducted a quantitative and qualitative analysis of 352 (91 percent response rate) and fourteen (14) (saturation point) respectively. The survey used stratified random sampling and convenience sampling and employed structured questionnaires for the quantitative data. Similarly, interviews with purposively selected practitioners from the same demographic background as the quantitative participants form the respondents for the qualitative data. The criteria for selection include the following: (1) The individual must have a minimum of ten (10) years of professional experience in the construction industry, (2) The individual should have been directly involved in building design, construction, or maintenance and (3) The individual must have been directly involved in dampness mitigation practices in either new building construction or existing building refurbishment.

3.5 Data Analysis

The quantitative data was analysed using descriptive statistics to investigate factors influencing the adoption of dampness mitigation measures/practices. The qualitative analysis identified major themes and ended with an in-depth description of the results. In other words, this study used thematic analysis for the qualitative component and descriptive statistics for the quantitative component. Direct quotations of key expressions from respondents were also used, but respondents' names and locations were not disclosed for ethical reasons.

3.6 Ethical Consideration

The study adhered to rigorous ethical standards throughout the study. All participants, received a Participant Information Sheet and provided informed consent. Written consent was obtained for interviews, and questionnaire completion was considered implied consent. Participants were informed that their involvement was voluntary, that they could withdraw at any time, and that interviews could be audio-recorded. To ensure privacy, we used coded questionnaires, assigned pseudonyms, and removed identifying information. Access to the data was restricted only to the research team. The study did not result in any physical or psychological harm. Academic integrity was maintained through proper citation of sources, objective data analysis, and member checking. No conflicts of interest or external sponsorship were present.

IV. FINDINGS & DISCUSSION

4.1 Findings

This section presents the findings from questionnaire and interviews with construction practitioners involved in designing, executing, and maintaining buildings in the Bono Region of Ghana. The structure aligns with the research objective and the adopted mixed-methods approach. This section first presents the quantitative results from the descriptive analysis, followed by the qualitative findings derived from interview themes. To show how these results align, we also provide a combined display of the findings. A total of 385 questionnaires were distributed to practitioners in the twelve Metropolitan, Municipal and District Assemblies (MMDAs) in the Bono Region. Of these, 352 were

returned and included in the analysis, resulting in a response rate of 91.0%. For the qualitative component, interviews were conducted with 14 key informants until data saturation was achieved.

Figure 1 shows that adequate training and capacity building for construction workers is the most determining factor in adopting and implementing dampness mitigation techniques and strategies in both new and existing buildings, as indicated by 88.92% of respondents ($n = 313$). This shows that technical competence is essential to applying dampness mitigation techniques effectively. Practitioners with sufficient training are more likely to understand how moisture intrusion works and the appropriate strategies needed to prevent it. Enhanced enforcement of building regulations also ranked highly, with 83.24% ($n = 293$) indicating that regulatory monitoring ensures compliance with damp-proofing standards. Similarly, respondents chose affordable, high-quality materials in 82.95% of cases ($n = 292$), indicating that access to reliable, high-quality materials supports the practical implementation of mitigation measures. Awareness programmes and knowledge sharing also accounted for a significant share (77.56%; $n = 273$). The results show that financial and collaborative variables moderately affect dampness mitigation measures in buildings. The willingness of clients to invest in quality construction materials and practices was pegged at 65.06% of respondents ($n = 229$). This underscores the role of financial commitment in strengthening dampness mitigation measures. Professional collaboration and sharing of best practices were also acknowledged by 59.38% of cases ($n = 209$). This implies that cooperation among industry actors and improved knowledge transfer will support effective dampness mitigation implementation. Financial incentives in the form of subsidies and tax reliefs were recognised by 54.55% of respondents ($n=192$), whereas research and innovation in materials were chosen by 52.56% ($n=185$). However, policy guideline implementation attracted minimal attention, at just 1.14% ($n=4$), even though it is a fundamental driver.

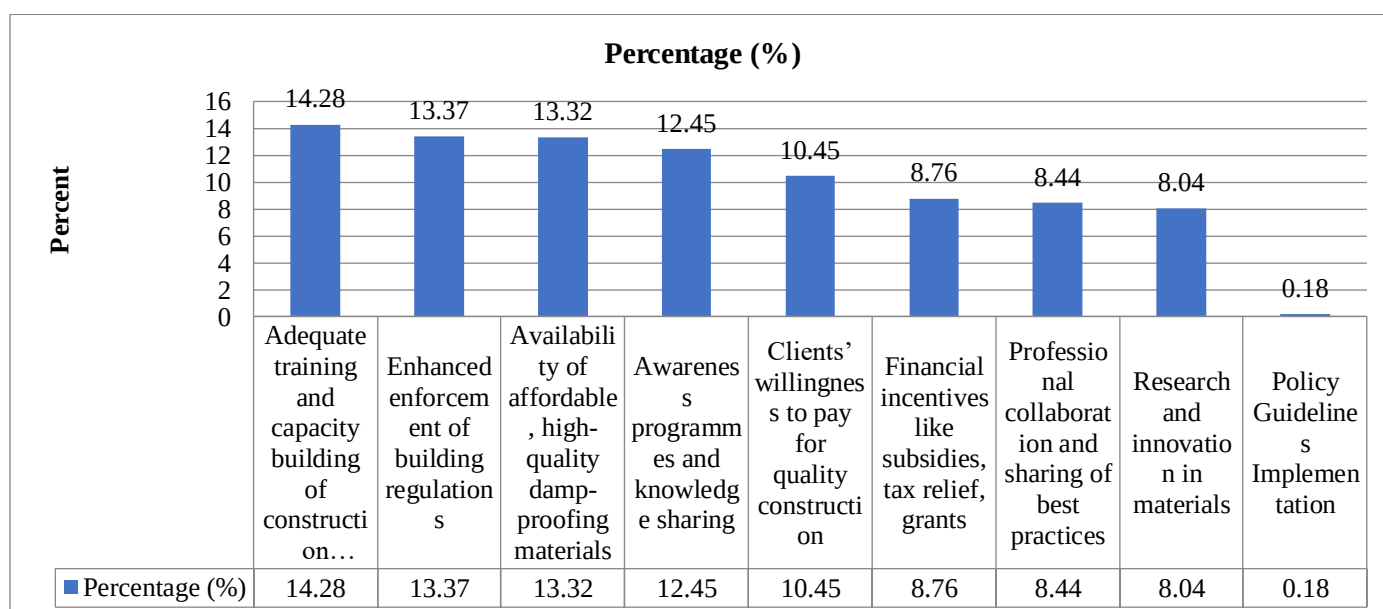


Figure 1
Dampness mitigation measures application drivers and enablers

4.2 Quantitative and qualitative findings Convergence

According to Table 1, the strongest variables cluster around knowledge of dampness mitigation techniques and strategies, as well as practitioners' technical capacities. The highest value recorded was 88.92% for adequate training, indicating that dampness mitigation relies heavily on practitioner competence. The interviews help explain this, as respondents consistently linked poor dampness mitigation practices to knowledge gaps. Respondents lacked knowledge of effective diagnostic tools and materials for prevention in new buildings, or for treating existing buildings affected by dampness. A respondent claimed that

"Practitioners need more training on dampness mitigation practices. A lot of these builders are doing it the wrong way. They employ several ways which are not effective" (P4, 14/6/2026).

In contrast, other participants emphasised that

"training of the artisans is very key as most of them lack adequate skills in fighting dampness" (P8, 16/6/2026).

As a result, mitigation strategies may be present, but without technical understanding, they are not applied consistently and are often done incorrectly. The high percentage mirrors a practical reality in construction practice. Knowledge affects whether damp-proofing measures are executed correctly. An identical interpretation applies to building construction regulatory enforcement, which was documented at 83.24%. This suggests that compliance is

usually driven by institutional pressure rather than voluntary practice. The respondents who participated in the interview affirmed this dynamic, observing that

“Okay, so because it is not a requirement from the design perspective, because it is not a requirement, that must be checked during the submission of drawings to the planning authorities. Most people will want to skip the proper detailing in these sections. But if you must provide detailed, damp-proof drawings, and it becomes a requirement checked as part of the building permit process, then architects and designers will not shed their responsibility for providing these details. Another participant also said, “Unless the law enforces it, builders are always in a hurry to complete their work, so anything to delay them will be skipped, but if the code or regulation stipulates it, we will do it” (P1, 13/6/2026).

Put simply, regulations influence practitioners’ behaviour on construction sites.

High-quality material accessibility also touches on this same point. 82.95% reported availability of affordable, high-quality materials, suggesting that even when practitioners understand mitigation methods, implementation depends on access to appropriate materials and technologies. A participant explained that reducing costs would “motivate people to adopt certain mitigation measures as the cost of the high-quality materials deters us”; another participant also noted,

“Things like government incentives on the materials and tech tools and equipment would encourage people to do most of these things.” (P3, 13/6/2026).

Altogether, these results indicate that dampness mitigation is not influenced by a single variable. Rather, it rises from the relationship between technical knowledge, regulatory enforcement, and practical resource availability. The moderate factors show a slightly distinct trend. Participants (65.06%) noted that some clients’ willingness to pay extra for certain preventive and treatment measures supports mitigation efforts, while professional collaboration between architects and builders stood at 59.38%. These determinants relate to decision-making rather than technical capacity. The interviews suggest that when clients understand the effects of dampness, they are more willing to invest. As one participant observed, clients with knowledge

“make financial provisions for prevention techniques to be applied during the design and construction of the building” (P5, 14/6/2026).

This suggests that financial commitment is usually linked to awareness. Financial incentives and research innovation, polled at 54.55% and 52.56%, respectively, appear less influential. These results imply that technological advancement alone may not transform practice unless knowledge, regulation, and resources are in place.

Table 1

Convergence between the quantitative findings and the qualitative evidence

Quantitative results		Qualitative results	
Driver	%	Theme	Direct Qualitative Evidence
Adequate training and capacity building	88.92%)	Practitioner training	<i>“Professionals in the industry need more training and giving more knowledge... Professionals or skilled labour capacity building.” (P10, 16/6/2026).</i> <i>“Training of the artisans is very key... If artisans know what dampness can cause, they will take good measures in dealing with dampness.” (P1, 13/6/2026).</i>
Stronger enforcement of building codes	83.24%	Regulatory enforcement	<i>“Unless the law enforcers enforce it on the contractors and the owners, the regulation has to be one of the first things that we have to do.” (P6, 15/6/2026).</i> <i>“If it becomes a requirement that you must provide detailed damp-proof drawings... architects and designers will not shed their responsibility of providing these details.”</i>
Availability of affordable quality materials	82.95%	Affordable materials	<i>“Materials that actually function or actually work... technologies are also key.” (P7, 15/6/2026).</i> <i>“If there will be any intervention that will lead to a reduction in the price of some of those interventions, I think it will be a motivation for people to adopt it.” (P10, 16/6/2026).</i>
Awareness programs and knowledge sharing	77.56%	Awareness creation	<i>“Awareness, general awareness creation and knowledge about these issues sharing from the perspective of clients and building owners and even professionals.” (P11, 16/6/2026).</i> <i>“We need to go a step beyond just publishing but disseminating it... going on radio stations, CPDs and so on to really get this information out there.” (P2, 13/6/2026).</i>

Clients' willingness to pay for quality construction	65.06%	Client investment	<i>"When you are dealing with knowledgeable clients... they make financial provisions that will cater for those things."</i> <i>"When people are well educated about it, they will see the need for going in for it."</i> (P13, 17/6/2026).
Professional collaboration	59.38%	Professional collaboration	<i>"Professionals should be able to get out there and inform clients and homeowners of the effects of not preventing dampness."</i> (P4, 14/6/2026). <i>"Consultants can also get themselves equipped with these different methods and also be involved in their projects."</i>
Financial incentives	54.55%	Government incentives	<i>"Government incentives on these materials... tax reduction on this material would also help."</i> (P5, 14/6/2026). <i>"Government should remove taxes on some of these things... it will be helpful if the government removes taxes."</i> (P7, 15/6/2026).
Research and innovation	52.56%	Research and innovation	<i>"Government supporting research and then innovations on materials that will combat dampness in buildings."</i> (P9, 16/6/2026). <i>"New products are coming... we have to learn a lot of those."</i>
Policy guideline implementation	1.14%	Policy guidelines	<i>"If you have a comprehensive guide... that will outline the effective and efficient way of mitigating the effect of rising damp."</i> (P14, 18/6/2026). <i>"Guidelines and policies... will enforce us to do the right thing."</i> (P12, 17/6/2026).

4.2 Discussion

This study aimed to identify which factors construction stakeholders in Ghana consider necessary to address the ongoing problem of dampness in buildings. The quantitative rankings, supported by evidence from the qualitative interviews, point to a clear and understandable pattern. Rather than all being accepted equally, the nine factors divide into three broad categories. The top categories include adequate training and capacity building (88.92%), stronger enforcement of building codes (83.24%), and the availability of affordable, quality materials (82.95%), supported by more than four in five respondents. The middle categories, consisting of awareness programmes and knowledge sharing (77.56%), clients' willingness to pay for quality construction (65.06%), and professional collaboration (59.38%), include factors relating to demand and coordination. The lowest category is made up of financial incentives (54.55%), research and innovation (52.56%), and, most notably, the implementation of policy guidelines (1.14%), which consists of structural and systemic measures that the respondents seem to see as either already provided in principle or as being too far removed from everyday practice to be important. Each finding is then examined in more detail in the context of the existing literature on dampness, building defects, and reform in Ghana's construction sector and similar developing countries.

Training and capacity building are the most widely supported interventions, reflecting the well-documented skills shortage in Ghana's construction workforce. This aligns with Elinwa et al. (2018) which found that advances in tools and techniques enhances dampness mitigation however implementers will require some training to use these techniques effectively. Studies on artisan availability in Ghana indicate that most tradespeople acquire their skills through informal apprenticeships rather than formal vocational or technical education (Aryeetey et al., 2013). While this approach imparts practical knowledge, it seldom includes instruction in the technical principles of moisture control and damp-proofing. The lack of formal training is directly linked to poor workmanship, as master craftsmen often pass on traditional practices rather than current technical standards to apprentices. This corroborates Asamoah et al. (2017), that artisans in Ghana have inadequate knowledge of construction techniques and the proper application of damp-proof materials. A sector-wide assessment identified a national deficit of approximately 60,000 skilled artisans, a gap projected to widen significantly by 2020. The same assessment noted that artisans typically do not pursue further professional development after their apprenticeship, limiting their exposure to new techniques, materials, and codes of practice (Darvas & Palmer, 2014). The findings are consistent with existing literature, as respondents attributed artisans' lack of awareness of the causes and consequences of dampness to inadequate site practices as discussed by (Li et al., 2023; Lubelli et al., 2018). Capacity building for skilled labour was identified as a primary intervention. This perspective is corroborated by observational research on rising damp in the Kumasi Metropolitan and Ejisu Municipal Assemblies, which revealed that sandcrete block walls were often constructed continuously from the foundation to the superstructure lintel without incorporating a floor-bed concrete course or a damp-proof course. This practice resulted from insufficient technical knowledge among site workers, rather than a lack of materials (Asamoah, 2017). Collectively, these findings strongly support training, not only for its general benefits but also because it directly addresses a well-documented cause of the defect under investigation.

Regulatory enforcement emerged as the second most frequently cited concern, reflecting a persistent and widespread issue in Ghanaian construction research. This aligns with Franzoni (2014) which argues that adherence to

heritage conservation regulations strongly influences a technique selection. Ghanaian architects identified inadequate and inefficient staffing, corruption, and the absence of effective public-private partnerships as primary institutional weaknesses undermining regulatory compliance (Offei-Nketiah et al., 2020). Building inspectors in Kumasi also attributed non-compliance to the public's limited awareness of regulations, delays in permit processing, developers' disregard for permit conditions, and persistent shortages of vehicles, cameras, and other logistical resources needed for site inspections at each construction stage (Asante & Sasu, 2018). These institutional deficiencies have tangible consequences as Zendri et al. (2017) posited that institutional support is critical to adoption of strategies. The qualitative findings align with these issues. Participants asserted that enforcement actions against contractors and property owners should precede, or at least accompany, other interventions. They specifically recommended making detailed damp-proofing drawings a mandatory component of the permitting process, ensuring that architects and designers are held accountable for specifying protective measures. This recommendation aligns with broader literature, which emphasises enhanced documentation and inspection requirements as a cost-effective alternative to increasing the number of inspectors (Offei-Nketiah et al., 2020).

The tension between material costs and construction standards in Ghana's housing industry is exemplified by the third-ranked driver: the availability of affordable quality materials is a key driver identified, aligning with Hacquebord et al. (2013). Building materials account for 50% to 70% of total construction costs in Ghana, making them the biggest factor affecting affordability. Interview respondents distinguished between materials that were simply available and those that performed effectively. They identified lower prices as a key factor in adopting these materials. This indicates that the challenge extends beyond increasing the supply of damp-proofing materials to ensuring that materials with verified technical performance are affordable for typical clients and contractors. This perspective is also emphasised in reviews of environmentally friendly and sustainable building materials in the Ghanaian market (Anzagira et al., 2022).

Awareness creation, endorsed by 77.56% of respondents, ranks as an intermediate driver and is theoretically significant as a prerequisite for adopting all other factors corroborating Dafico et al. (2022) assertion that health effect awareness of dampness to occupants drives mitigation measures. According to Rogers' diffusion of innovation theory, awareness constitutes the initial stage in the adoption process, followed by persuasion, decision, implementation, and confirmation. This framework has been applied to sustainable building practices among architects, where awareness was prevalent but remained largely theoretical, with limited translation into site practice. Similarly, a study on knowledge-sharing in sustainable building construction identified public awareness, integrating awareness content into professional training and certification, and establishing accessible information repositories as the most influential factors in changing practices within the built environment (Santos-Hermosa & Atenas, 2022). The qualitative findings extend existing literature by showing that respondents differentiated between knowledge generation and dissemination. They criticised the tendency to halt at publication rather than utilising broadcast media, ongoing professional development sessions, and other outreach methods to engage clients and building owners beyond professional circles. This observation aligns with diffusion-of-innovation research, which indicates that mass-media channels are effective for raising awareness, while interpersonal channels are more effective in persuading individuals to adopt new practices.

Similarly, 65.06% of respondents supported client investment behaviour, indicating its role as a demand-side constraint on construction quality. Similar findings appear in the literature, which shows that more experienced and knowledgeable clients value professional expertise more and are consequently more willing to pay for it, particularly when long-term operational and durability benefits are evident (Chih et al., 2019). Additionally, research on homeowners' willingness to invest in building performance improvements in other contexts reveals that, although willingness to pay exists, it often falls short of covering the full cost of interventions and is influenced by the client's education level, prior experience, and the manner in which professionals present the value proposition (Huang et al., 2021). Interview data further corroborate this relationship, as respondents explicitly linked clients' knowledge levels to their investment decisions. Knowledgeable clients were perceived as routinely allocating funds for damp-proofing, whereas uninformed clients often failed to recognise its necessity in consonance with Bernardo et al. (2024). This finding reinforces the interdependence between awareness and client investment, suggesting that the willingness-to-pay gap is attributable at least in part to differences in awareness rather than solely to financial constraints.

Also, professional collaboration, rated lowest among the middle-tier drivers by 59.38% of respondents, is notable given the emphasis on multidisciplinary coordination in construction management literature. Industry guidance underscores the importance of involving all disciplines from the outset, rather than sequentially transferring designs from architect to engineer to contractor. This integrated approach helps prevent costly redesigns, delays, and quality issues associated with isolated work (Rezvani et al., 2026). In the context of damp-proofing, qualitative responses suggest that collaboration is valued mainly for sharing information with clients. Participants noted the importance of consultants becoming familiar with damp-proofing methods and joining projects early, as well as professionals educating clients and homeowners about the consequences of untreated dampness. Thus, collaboration is closely linked to client awareness and investment drivers, rather than functioning as an independent factor.

More than half of respondents (54.55%) supported financial incentives, placing them in the highest group among the lowest-ranked categories. This finding aligns with international research on promoting sustainable construction, which indicates that tax reductions, subsidies, and other fiscal measures are effective in principle. However, in developing countries, limited institutional capacity often constrains the design, implementation, and monitoring of such incentives (Yeboah, 2024). Interview findings corroborate this, as respondents specifically requested tax reductions on damp-proofing materials and measures, viewing these incentives as supplementary rather than as substitutes for more fundamental factors such as training, enforcement, and material affordability. The relatively low ranking of financial incentives may reflect the perception that fiscal measures provide only marginal benefits, with technical knowledge and regulatory compliance identified as the primary determinants of quality.

The most notable finding in the dataset is the minimal support for implementing policy guidelines (1.14%), which contrasts sharply with the other eight factors and with the qualitative data, where respondents expressed a favourable view of comprehensive guides for addressing rising damp. This apparent contradiction; positive qualitative evidence alongside negligible quantitative endorsement requires careful interpretation and should not be viewed as a straightforward rejection of policy as a solution.

4.2.1 Integrating the drivers: a layered model of change

Taken together, the nine drivers do not represent a simple, equally ranked list of interventions but form a layered system. Foundational and proximate drivers, such as training and enforcement, are prioritised over enabling and mediating drivers, including awareness, client investment, and collaboration, which in turn take precedence over more distant, structural drivers like incentives, research, and policy. This hierarchy aligns with diffusion-of-innovation and implementation-science literature, which distinguishes between a solution's technical adequacy, stakeholders' awareness and acceptance, and the institutional and financial context for adoption. Qualitative evidence suggests these levels are causally interconnected: training imparts technical knowledge that underpins awareness; awareness influences clients' willingness to pay; and client demand shapes the market conditions necessary for affordable materials, financial incentives, and further research. Consequently, interventions that focus exclusively on the most prominent drivers, such as artisan training programmes without concurrent enforcement and awareness initiatives, are likely to have limited impact, as the literature indicates that each driver both supports and depends on the others.

V. CONCLUSION & RECOMENDATIONS

5.1 Conclusion

This study examined the factors construction stakeholders in Ghana consider essential to addressing the persistent issue of dampness in residential and public buildings. By quantitatively ranking nine potential factors and supporting them with qualitative interview evidence, the research provides an evidence-based account of practitioners' perspectives on effective solutions to this longstanding problem. Three principal conclusions emerge from the analysis. The findings indicate that dampness in Ghanaian buildings stems primarily from insufficient knowledge and non-compliance, rather than a lack of suitable building materials. The three most strongly supported factors were adequate training and capacity building (88.92%), stronger enforcement of building regulations (83.24%), and the availability of affordable quality materials (82.95%). Respondents identified these as essential preconditions for lasting improvement. This hierarchy aligns with existing construction literature in Ghana, which frequently attributes defects such as rising damp to informal apprenticeship training that omits technical principles for moisture control and to weak enforcement of an otherwise comprehensive regulatory framework, rather than to a lack of available technologies or materials. Secondly, the analysis shows that the factors driving change in this context are interdependent rather than isolated. Qualitative evidence consistently showed that raising awareness is associated with increased client investment, which in turn fosters greater professional collaboration. This collaboration, in turn, strengthens training efforts, suggesting a multi-layered, mutually reinforcing system. Consequently, interventions that address only a single factor in isolation are unlikely to achieve sustained progress. Fragmented initiatives, such as training programmes implemented without enforcement or public-awareness campaigns conducted without ensuring affordable materials, are likely to yield only partial or temporary improvements. Implementation of policy guidelines (1.14%), even though there has been positive qualitative feedback on this issue, should not be taken as proof that policy is unimportant but rather as indicating that practitioners view Ghana's current legal and regulatory framework, mainly the National Building Regulations (L.I. 1630) and the Ghana Building Code (2018), as being sufficient in principle. Taken together, the study concludes that achieving a sustainable reduction in dampness in Ghanaian buildings requires simultaneous, coordinated investments in human capacity, regulatory enforcement, and material affordability. These efforts must be underpinned by continuous awareness-raising to ensure that demand-side actors, including clients and homeowners, recognise the value of and are willing to invest in quality construction. Interventions focused solely on the supply side, such as training and materials, are unlikely to produce lasting change without addressing demand and governance aspects like awareness, enforcement, and client investment.

5.2 Recommendations

This study recommends prioritising the strengthening of enforcement capacity over introducing new regulations. Because Ghana's existing building regulations already address materials, foundations, and moisture protection, rather efforts should focus on increasing the number of inspectors, improving logistics (such as vehicles, digital monitoring tools, and GPS-enabled inspection records), and increasing the frequency of site inspections, rather than developing additional guidance documents. Also, it is recommended for sanctions and accountability measures to be extended beyond developers to non-compliant design professionals and contractors to address the documented accountability gap. Measures such as relief from import duties or reduced taxes on certified damp-proofing membranes and additives could lower the effective cost of compliance without requiring large public spending. Furthermore, it is recommended for the establishment of a formal system for artisans' continuing professional development. Because most artisans in Ghana receive training through informal apprenticeships and lack opportunities for further professional development, professional organisations and technical or vocational institutions should create accredited, periodically renewable certification schemes focused on damp-proofing techniques, building on existing Competency-Based Training programmes. Actively disseminate information beyond traditional publication. Because research limited to journal or report publication alone is insufficient, awareness campaigns should use radio, television, and other mass-media outlets to build public knowledge, complemented by targeted continuing professional development sessions and briefings for trade associations to secure professional support. Finally, the study recommends the promotion of early formation of integrated project teams, ensuring that architects, engineers, and contractors collaborate from the outset. This approach helps include damp-proofing measures in the design brief, reducing the risk of omission due to time or cost pressures.

Declaration of Interest

The authors declare that they do not have any known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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