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Assessing Awareness, Understanding and Adoption of Smart Buildings in Algeria: From Architects' Perspectives

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Smart Buildings, Intelligent Buildings, Awareness, Architects, Algeria.

ABSTRACT

In recent years, smart buildings have been revolutionizing the construction industry through their potential to enhance energy efficiency, improve occupant comfort and safety, and promote sustainability in the built environment. Nevertheless, despite growing adoption in developed countries, implementation in developing nations, particularly Algeria, remains limited. A major barrier is the lack of awareness among architects regarding the benefits and technical aspects of these systems. This study aims to evaluate Algerian architects' awareness and understanding of smart buildings. A mixed-methods approach was applied, beginning with a literature review to establish the theoretical framework, followed by a quantitative survey involving 134 practicing architects. Findings indicate that most participants possess limited knowledge, particularly regarding design and implementation, which constrains progress toward a smarter and more sustainable built environment. The study emphasizes the significance of educational workshops and training programs in enhancing architects' awareness and technical preparedness. By providing a contextualized understanding of smart building adoption in Algeria, this research highlights the main factors influencing awareness levels and outlines potential strategies for improvement.

الكلمات المفتاحية

المباني الذكية، الوعي، المعماريون، الجزائر.

الملخص

في السنوات الأخيرة، أحدثت المباني الذكية ثورة في قطاع البناء بفضل قدرتها على تعزيز كفاءة الطاقة، وتحسين راحة وسلامة المستخدمين، ودعم الاستدامة في البيئة المبنية. ومع ذلك، ورغم توسع اعتمادها في الدول المتقدمة، ما يزال تطبيقها في الدول النامية، لا سيما في الجزائر، محدوداً، حيث يُعَدّ غياب الوعي لدى المعماريين حول فوائدها وجوانبها التقنية أحد أبرز العوائق أمام اعتمادها. وتهدف هذه الدراسة إلى تقييم مستوى وعي وفهم المعماريين الجزائريين بالمباني الذكية، وقد اعتمد البحث منهجية متعددة بدأت بمراجعة أدبية لتأسيس الإطار النظري، تلتها دراسة كمية شملت 134 معمارياً ممارساً. وأظهرت النتائج أن معظم المشاركين يملكون معرفة محدودة، خصوصًا فيما يتعلق بالتصميم والتنفيذ، مما يعيق التقدم نحو بيئة مبنية أكثر ذكاءاً واستدامة. وتبرز الدراسة أهمية تنظيم ورش عمل وبرامج تدريبية لتعزيز وعي المعماريين وجاهزيتهم التقنية، ومن خلال تقديم فهم سياقي لواقع اعتماد المباني الذكية في الجزائر، يسلط هذا البحث الضوء على العوامل المؤثرة في مستويات الوعي ويقترح استراتيجيات محتملة لتعزيزها.

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1. Introduction

In recent years, the construction industry has undergone a rapid transformation in terms of technological advancements, prompting the evolution of the smart building concept. These buildings have gained traction over the years, owing to their potential to enhance energy efficiency, sustainability, and occupant comfort, in addition to reducing operational costs and creating more adaptive and user-friendly environments through the use of advanced technologies such as automated control systems, the Internet of Things (IoT)[1], and Big Data. In developed countries, investments in smart buildings have been strongly supported by governments and the private sector, leading to significant progress in research, implementation strategies, and the adoption of smart building technologies. However, despite the growing emphasis on adopting smart buildings, the situation in developing countries is quite different, as the smart building concept remains constrained by numerous factors. These factors encompass infrastructural challenges, financial constraints, and a lack of technical expertise (Affonso et al., 2024; Aribi & Anouche, 2025). To transition to smart buildings, developing countries must shift their construction practices to incorporate more innovative and adaptable solutions that facilitate the successful integration of advanced technologies, enhance energy efficiency, and address user needs and environmental challenges. In this regard, awareness and knowledge of smart building principles among construction professionals, including architects, is crucial for the effective implementation of the concept.

In Algeria, smart building projects are considered rare, with limited implementation of innovative technologies and smart solutions. While some efforts have been made to incorporate energy-efficient solutions to buildings, the widespread adoption of smart buildings is still hindered by multifaceted challenges, most notably the limited awareness and understanding of the concept among architects. Most architects in Algeria adhere to conventional building practices, overlooking the potential benefits of integrating smart buildings into the Algerian built environment. The level of awareness among architects about smart buildings constitutes a significant factor in their widespread implementation, as architects play a fundamental role in designing and conceptualizing buildings. Their knowledge and understanding of the concept directly influence their design choices and their willingness to adopt smart and innovative design strategies. This issue affects the decision-making of other key stakeholders, primarily developers and policymakers, further hindering the progress of smart building initiatives in the country.

This study aims to examine the level of awareness of Algerian architects regarding smart buildings and the adoption rate of these buildings in the Algerian construction industry. By assessing architects' understanding and perception of smart buildings, this study aims to identify the key factors influencing their awareness of the concept. Furthermore, the research will examine how a lack of awareness among architects impacts the broader decision-making landscape, influencing the choices of developers and clients. By shedding light on these issues, this study contributes to the ongoing body of literature regarding smart building adoption in developing countries, particularly in the Algerian context. The study's findings will provide valuable insights into the current state of awareness and inform strategies to enhance knowledge and capacity-building among architects. Ultimately, contributing to the enhancement of awareness and fostering a better understanding of smart buildings among architects could catalyze the transition towards more intelligent, sustainable, and energy-efficient buildings in Algeria.

For this purpose, the following research questions served as the framework for the design of data collection instruments in this study:

- RQ 01. How familiar are architects with smart buildings in Algeria?
- RQ 02. How well do architects in Algeria understand the concept of smart buildings?
- RQ 03. Does the level of awareness of architects affect their clients’ decision-making regarding the adoption of smart buildings?

2. Research Methodology

The present study adopted a mixed-methods approach, beginning with a comprehensive literature review to establish the necessary theoretical framework. This step was followed by a quantitative survey conducted with 134 practicing architects. The primary objective of this research is to assess the level of

[1] The Internet of Things (IoT) is an infrastructure of interconnected entities, people, systems and information resources together with intelligent services to process and react to information from the physical and virtual world.” (ISO/IEC 30141:2018).

awareness and understanding of Algerian architects regarding smart buildings, a revolutionary concept in the construction industry. The topic is critically important because architects’ awareness is a significant factor in implementing smart buildings, given their fundamental role in design and conceptualization. The lack of awareness is considered a major barrier to adoption in Algeria, a developing country where implementation remains limited. The study, therefore, seeks to identify the key factors influencing awareness and to shed light on potential strategies for improvement, providing valuable insights to the literature on adoption in the Algerian context.

The primary data collection tool was a structured questionnaire administered via the online platform Google Forms. This questionnaire, refined after expert review and a pilot test with professionals to ensure clarity and accuracy of technical terms, consisted of four sections addressing demographic information, familiarity with the concept, perceptions, and technical knowledge, as well as the current state of adoption among clients. Data were collected through closed-ended questions (yes/no and multiple-choice). Regarding the measurement tools, the data were processed using the Statistical Package for the Social Sciences (SPSS) and analyzed using descriptive statistics and frequency distributions. This choice was made to provide a clear overview of the distribution of responses and to identify general trends in levels of awareness, understanding, and perceptions of smart buildings among Algerian architects. Furthermore, cross-tabulation was used to explore disparities in technical readiness between architects who use BIM and those who do not.

3. Literature Review

3.1. Evolution And Definitions of Smart Buildings

Since the emergence of the smart building concept in the 1980s, numerous researchers and institutions have attempted to define it, but with little success. To date, there is no universal definition of smart buildings (Buckman et al., 2014). However, some of these attempts have managed to lift the ambiguity surrounding the concept. For instance, the European Intelligent Building Group (EIBG) suggested the following definition: ‘‘one that creates an environment which maximizes the effectiveness of the building’s occupants, while at the same time enabling efficient management of resources with minimum life-time costs of hardware and facilities”. While, the intelligent buildings institute (IBI) defined a smart building as “a building that provides a productive and cost-effective environment through the optimization of its four basic elements including structures, systems, services and management and the interrelationships between them” (Wigginton & Harris, 2013). Other researchers have attempted to provide a clearer understanding of the concept by focusing on its features and the services it provides. For example, Kim et al. (2022) described them as energy-efficient, high-performance buildings that enhance people's daily activities and the sustainability of the built environment.

Additionally, Buckman et al. confirmed that a smart building should be both energy-efficient and durable, while ensuring the comfort and satisfaction of its occupants (Buckman, Mayfield, and Beck, 2014). Over the years, additional features have been introduced, including the use of renewable energy, flexible spaces, and the optimization of work efficiency (Dakheel et al., 2020; Hamida, Hassanain, and Al-Hammad, 2022). On another note, Froufe et al. (2020) identified eleven key drivers of smart buildings, namely technology, integration, flexibility, longevity, health, comfort, satisfaction, security, ecology, energy efficiency, and overall efficiency. However, these drivers are only ensured if the building is equipped with the following systems: HVAC, lighting, energy, security, telecommunications, fire prevention, vertical transportation, and hydraulic systems. Similarly, Vijayan et al. (2020) noted that a smart building is a building that can control and monitor HVAC, water management, lighting systems, and health systems for older people, and respond intelligently to events.

Within the scope of this study, it is essential to adopt the most appropriate definition of smart buildings to serve as a foundational reference. Selecting the most convenient definition, particularly for developing countries, helps answer our research question about evaluating architects’ understanding of the concept. Given the variety of definitions, a well-formulated and convenient definition of smart buildings should meet several key criteria. First, it should acknowledge the concept’s roots in intelligent building principles while clearly distinguishing the unique attributes that define smart buildings (Batov, 2015). Second, the definition must emphasize advanced capabilities that surpass basic automation or reactive functions, showcasing the adaptive, predictive, and integrative nature of smart systems (Gadakari, Mushatat, & Newman, 2014). Third, it should incorporate key characteristics commonly highlighted in the literature as drivers of smart buildings, such as connectivity, user-centered design, and energy optimization. Lastly, the definition should reflect the objectives and benefits that smart buildings are intended to achieve, including improved efficiency, sustainability, and occupant well-being (Buckman et al., 2014). While other definitions highlight specific aspects like occupant-initiated versus building-initiated decisions (Batov, 2015) or self-/grid-awareness (Buckman et al., 2014), the Buckman et al. definition provides a structured framework that encompasses these features within a broader and integrated context, making it a comprehensive and useful starting point for understanding the concept of smart buildings. According to them, "Smart Buildings are buildings which integrate and account for intelligence, enterprise, control, and materials and construction as an entire building system, with adaptability, not reactivity, at the core, in order to meet the drivers for building progression: energy and efficiency, longevity, and comfort and satisfaction."

However, in the context of our survey, a simplified version of this definition is needed to ensure clarity for respondents and to prevent bias by making the more complex definition seem like the correct choice among the options provided. For this purpose, the following definition was adopted based on the definition provided by Buckman et al. (2014):

"Smart buildings integrate advanced technologies, materials, and systems to achieve adaptability, energy efficiency, durability, occupant comfort, and sustainability."

3.2. Benefits And Opportunities of Smart Buildings

Smart buildings present significant opportunities across multiple dimensions, including economic, social, and environmental. These buildings enable architects to transform architectural practices and urban environments by integrating advanced technologies that optimize the functionality and sustainability of the built environment.

Bandara et al. (Bandara et al., 2019), emphasize that smart buildings align with the three pillars of sustainability: economic growth, social well-being, and environmental preservation. These benefits include improved occupants' comfort and health, increased safety, greater efficiency in time and energy use, and the incorporation of expert systems and assistive technologies (Batov, 2015). Supporting this, Froufe et al. (2020) confirmed that the design of smart buildings should thoughtfully consider the needs of three main beneficiaries: users, owners, and the environment.

On another note, a study conducted by Clements-Croome (2011) revealed that buildings with more efficient work environments —such as prioritizing improvements in thermal and acoustic comfort, natural lighting, and more flexible workplaces —reported significant reductions in operating costs, an increased return on investment, and higher market value. These findings are further supported by Akadiri, Chinyio, and Olomolaiye (2012), who assert that consumer-oriented building designs and decentralized systems can achieve these benefits. In this regard, consumer-oriented designs are meant to enhance the user's experience. The advantage of smart buildings lies in their ability to integrate various systems, such as HVAC, lighting, and security, allowing architects to design spaces that effectively respond to users' activities, needs, and preferences (Nguyen & Aiello, 2013). Another area of opportunity that smart buildings present lies in achieving sustainability and resource efficiency. Architects can benefit from smart technologies to optimize energy efficiency by adjusting lighting and HVAC systems based on occupancy and environmental conditions, as the coordination between smart technologies and sustainable design practices can increase the potential to achieve sustainability (Wong et al., 2005; Gadakari et al., 2014). These reductions in energy consumption can reach 30.86% according to Kumar et al. (2021), with a reduction in heating energy of approximately 20%. This can result in an 8% decrease in energy consumption for buildings at the European city level (Cano et al., 2014). On another note, smart buildings are primarily designed with an emphasis on adaptability and longevity, which can be achieved through the integration of intelligence, enterprise systems, control mechanisms, and innovative materials (Buckman, Mayfield, and Beck, 2014). The integration of these components enables architects to design spaces that are not only reactive but also proactive, capable of anticipating future needs and enhancing performance throughout the building's lifecycle.

Nevertheless, this growing complexity introduces additional demands and competencies that architects must develop and incorporate into their practice. This involves both the conceptual intelligence embedded in architectural design and the intelligence required to integrate active systems and technologies. Architects are also expected to understand specific project requirements, including scope, risks, the integration of various technologies, and sustainability considerations, and effective collaboration with diverse stakeholders (Sinopoli, 2010). These include specialized knowledge for implementing new technologies, initial investment costs, and cost-benefit analyses. Additionally, they involve navigating the institutional frameworks that influence the adoption of these technologies and the technical aspects of seamless interoperability among different smart systems. These competencies are considered critical aspects of smart buildings that architects must address during the design process. As a result, architects must be aware of these considerations, as well as the potential challenges that smart buildings may present.

3.3. Exploring The Current Situation of Smart Buildings in Algeria

In addition to being the largest country in Africa, Algeria occupies a strategic geographic and political position in North Africa and is rich in natural resources. However, despite these advantages, the country's economy remains heavily dependent on hydrocarbons, which account for nearly 96% of its exports and a significant share of its government's revenue (Bouyacoub & Touami, 2016). This reliance on fossil fuels, combined with fluctuations in the oil market, has hindered the country's economic diversification. Consequently, Algeria remains underdeveloped in terms of digital advancements, particularly in the field of smart buildings, which are often deprioritized.

This contextual overview is essential for understanding the structural limitations that shape the current state of innovation in Algeria. It highlights how the country's economic reliance on hydrocarbons and limited digital development directly impact the prioritization and implementation of smart technologies in the built environment. By situating the discussion within this national framework, the study highlights the need to explore alternative, intelligent approaches to architecture that align with Algeria's broader goals of economic diversification and sustainable development.

In terms of its regulatory and technological frameworks, Algeria has not yet established formal standards or policies to support the implementation of smart buildings in the built environment. In fact, in 2012, the penetration of information and communication technologies among small and medium-sized enterprises was only 33%, reflecting the slow development of their energy and ICT infrastructure, which constitutes a major challenge to the integration of smart buildings (Messiliti et al., 2023).

As an attempt to address this challenge, the Algerian government launched the "e-Algeria 2013" strategy, aiming to enhance ICT infrastructure, promote digital skills, and modernize administration. However, the initiative failed to meet its goals due to poor administration and a lack of governmental commitment to the digital transformation agenda (Messiliti et al., 2023). On the other hand, the smart city of Algiers project was introduced in Sidi Abdellah. Established within a 2035 planning horizon, the project was designed as a model for more technology-driven urban development, focusing on key sectors such as energy, transportation, and water management. Although promising, the smart city project was largely limited to basic infrastructure and green space development, with little advancement in digital integration.

In contrast, smart buildings were never prioritized within the project's framework. This project failed to meet the government's expectations for several reasons, with the lack of professional and public engagement being one of them (Aït-Yahia et al., 2019). The lack of awareness about smart buildings and their potential opportunities is considered a contributing factor to the limited interest and slow adoption of these buildings within the built environment.

By reflecting on these attempts, we can conclude that the combination of insufficient infrastructure, unclear regulations, and limited awareness continues to slow progress towards smarter and more sustainable built environments in Algeria. Without national strategies, financial investments, and targeted efforts to educate stakeholders and raise public understanding, the benefits of smart buildings remain underappreciated by the general public.

3.4. Challenges To Smart Buildings' Implementation

Despite the growing recognition of their potential, the adoption and successful implementation of smart buildings are hindered by multiple challenges. A fundamental challenge highlighted across several sources of literature is the lack of a clear and consistent definition of smart buildings (El-Motasem et al., 2020; AlMuharraqi et al., 2022; Baharetha et al., 2023). The absence of a consensual definition affects both the design and construction of smart buildings because there are no specific frameworks or guidelines. In addition, the lack of a comprehensive action plan and well-defined fundamental characteristics of smart buildings makes it difficult to develop and evaluate them consistently. Beyond these conceptual challenges, architects may encounter technical difficulties when designing smart buildings due to the increased complexity of projects, primarily associated with integrating numerous systems and technologies (Ghansah et al., 2020; Ilesanmi et al., 2024). The complexity is not limited to the design phase, but also extends to the construction process, where good coordination between the project team, including designers, engineers, contractors, and the project owner, is essential. In addition, managing large volumes of data generated by building systems can be challenging and requires efficient data management strategies and skilled personnel to ensure the effective use and maintenance of smart buildings in the operational stage (James Sinopoli, 2010).

In addition to these technical complexities, financial constraints represent another challenge to smart buildings adoption, including higher design costs due to the complexity of designing them (El-Motasem et al., 2021; AlMuharraqi et al., 2022), in addition to higher construction costs due to skilled labor and high equipment and installation costs (El-Motasem et al., 2021; AlMuharraqi et al., 2022; Baharetha et al., 2023). Moreover, the unclear cost-benefit ratio makes it difficult to justify the initial investment in smart buildings (Gadakari et al., 2014; Ghansah et al., 2020; Baharetha et al., 2023), leading to an underestimation of the life cycle costs and an overemphasis on initial costs, further impeding adoption.

On another note, several sources have explored regulatory and organizational challenges that hinder the adoption of smart buildings, citing, for example, the lack of design standards and frameworks as the most significant barrier according to the literature (Ehrenhard et al., 2014; El-Motasem et al., 2021; AlMuharraqi et al., 2022; Baharetha et al., 2023; Affonso et al., 2024). Several sources also emphasize the absence of an action plan as a hindrance (Ehrenhard et al., 2014; Owusu-Manu et al., 2022; Baharetha et al., 2023).

3.4.1. Awareness As a Key Factor in Smart Buildings' Implementation

Among these complex challenges, a key issue consistently identified in the literature is the limited awareness and expertise of construction professionals regarding smart buildings, particularly in developing countries. It has been widely accepted that decisions to adopt or reject a technology depend on the user's acquisition of sufficient knowledge about the innovation. Parallelly, these decisions are equally influenced by the designers' and construction professionals' level of awareness about these technologies, according to Gefen (2000). Awareness, as defined by Gefen (2000), refers to an understanding that enables users to reduce uncertainty about a topic in a subjective manner.

In the context of smart buildings, several factors contribute to a certain level of ambiguity surrounding the concept, leading to misconceptions and uncertainty among construction professionals, particularly architects. Architects play a pivotal role in the initial conceptualization and design phases of building projects. Their knowledge and understanding of the concept greatly influence decision-making and its overall adoption. However, their lack of awareness of the latter manifests in several forms:

- **Misconceptions And Conceptual Confusion**

Firstly, there is a common misconception that building intelligence is merely equivalent to building automation. Since the construction industry has witnessed the widespread use of advanced technologies and control systems, many buildings that incorporate these technologies have been labeled as intelligent (Batov, 2015). In fact, Clements-Croome Derek (Clements-Croome, 2011) asserted that the concept of "smartness" transcends mere automation or technology, as it fundamentally promotes healthier and more sustainable environments that take into account occupants' comfort and satisfaction. Additionally, another widespread stereotype about smart buildings, as noted by Kua and Lee (2002), is that they are exclusive to technologically advanced countries, thereby overlooking their potential applicability and benefits in developing countries. Misconceptions persist, such as the belief that smart buildings are only applicable to large structures (Radziejowska & Sobotka, 2021), as well as the perception that smart buildings are divisive or exclusive to a specific social class (Balta-Ozkan et al., 2013; Junior et al., 2017).

This lack of clarity in terminology does not benefit designers, clients, or researchers and is more likely to confuse than provide a clear direction (Buckman et al., 2014). According to AlMuharraqi et al.

(2022), a clear definition and understanding of smart building concepts and features are fundamental prerequisites for their success, as the level of professionals' awareness plays a crucial role in enabling the implementation of smart building processes and influences the degree of resistance to change.

- **Unfamiliarity With Smart Buildings' Benefits and Opportunities**

From another perspective, many architects still lack a comprehensive understanding of the benefits of smart buildings. According to Gadakari et al. (2014) and Bandara et al. (2019), the lack of knowledge about the current and potential benefits among owners and developers presents a significant challenge to the adoption of these benefits. Similarly, Froufe et al. (2020) highlight the lack of awareness about the positive impact of smart buildings on quality of life and the environment as a key issue limiting their adoption. According to Fratu and Fratu (no date), this issue stems from the lack of research and the challenges designers face in integrating new technologies into smart buildings. The lack of evidence supporting those claimed benefits of smart technologies and construction further complicates the adoption process (Ghaffarianhoseini et al., 2016). In this regard, several studies emphasize the need to enhance public awareness about the socioeconomic and environmental benefits of smart buildings (Viana et al., 2022).

- **Limited Technical Knowledge**

The lack of such awareness extends to other crucial aspects, such as the difficulty in understanding sustainable specifications in contract details (Ghansah et al., 2022) and unfamiliarity with the whole-life costs associated with smart buildings from the perspective of practitioners (Ibrhem, Amer, and Ong, 2020). Moreover, this unfamiliarity among professionals regarding smart buildings and their design and construction process has serious consequences, as it can exacerbate technical difficulties during construction due to unfamiliarity with the technologies and their integration requirements. Professionals often lack sufficient experience and knowledge to design smart buildings. This includes the limited knowledge of smart building systems and the unfamiliarity with the correct methods and procedures for their implementation (Baharetha et al., 2023). Additionally, it can hinder effective collaboration among project teams (Zainordin & Saleh, 2017). As a result, architects become more resistant to changing traditional practices and lack the confidence to undertake new and untested technologies (Ghansah et al., 2020). In this regard, BIM knowledge is crucial in the design of smart buildings due to its ability to enhance efficiency, safety, and sustainability throughout the building's entire life cycle. BIM offers positive architectural visualization, facilitates communication among stakeholders, supports construction planning, and reduces social and financial losses associated with reliance on traditional methods (Zhao, 2023).

Furthermore, BIM supports the incorporation of smart technologies, enabling the profiling of materials and devices, which is crucial for optimizing energy management and ensuring occupant comfort in smart built environments (Zhang et al., 2015; Li, 2017). In the future of urban construction, the application of BIM promotes a more scientific approach to design, aligning with the principles of smart building development and fostering resource conservation (Chen, 2022). Thus, proficiency in BIM is vital for architects to create high-functioning, efficient smart buildings that address contemporary environmental challenges.

- **Lack Of Regulations and Frameworks**

Another significant challenge associated with smart buildings is the absence of frameworks and regulations that facilitate the interaction between buildings, energy systems, and demand-response activities (De Groote et al., 2017). At the same time, Baharetha et al. (2023) rate the lack of awareness among designers, owners, and users regarding the technical specifications of smart buildings as a "very challenging" issue. This finding aligns with previous studies (AlMuharraqi et al., 2022; Affonso et al., 2024). A study by Arditi, Mangano, and De Marco (2015) highlights a notable contradiction in professionals' understanding of smart buildings. According to the study conducted with construction managers, they seem to recognize the importance of developing smart buildings. However, there remains no widely accepted definition of what "smart" refers to in the context of building projects, which points to a lack of conceptual clarity that can hinder the cohesive planning and implementation of smart buildings. This issue has not gone unnoticed by researchers, particularly in developing countries; several studies have explored the lack of awareness among professionals regarding smart buildings. In Nigeria, for example, numerous studies investigated professionals' level of awareness about smart buildings, yet they seem to provide contrasting insights into the extent of professional awareness.

3.4.2. Case Studies from Developing Countries

A study conducted by Ejidike et al. (2024) indicated that most construction professionals have a basic understanding of the smart building concept, with no significant differences in awareness across different roles. Additionally, the researchers emphasized the need to integrate more parameters into design and policy frameworks to increase awareness of smart buildings among professionals, which plays a key role in enhancing smart practices in Nigeria. Another study from the Nigerian context (Ilesanmi et al., 2024) reported limited stakeholder familiarity with smart building features and technologies. While some individual features, such as security doors, energy-saving equipment, and solar panels, were recognized, the overall engagement with these systems remained low. The study findings reveal that a superficial understanding of the smart building concept does not necessarily equip professionals with the practical skills and ability to act effectively on it. The study also emphasizes the importance of education and policy development in enhancing awareness and promoting the adoption of smart building practices within the sector. This gap between recognition and practical awareness is also evident in Lagos State, Nigeria, where a study by Opawole et al. (2022) noted a low level of awareness of smart buildings among property stakeholders. Although many claimed familiarities with the concept, there was a notable lack of commitment to its full implementation. According to the study, 90% of construction professionals were aware of intelligent building systems, yet only about half of them had experience working on projects that integrated these features. This suggests that while awareness is important, practical experience among professionals remains limited. Similar conclusions were drawn in other developing countries. In Ghana, a study by Ghansah et al. (2022) revealed a modest level of awareness of smart building technologies among construction professionals. According to the study, although the participants were familiar with these technologies, their understanding of their practical applications and technical functions was limited. The researchers also suggested that numerous factors influence awareness, such as access to training and personal knowledge of construction professionals; legal and policy awareness is equally important. The study's findings highlight the critical role of competency and capacity-building initiatives in enhancing professionals' awareness of the smart building concept.

These findings suggest that the development of smart buildings relies on a clear definition and understanding of the concepts and features that comprise smart buildings. The level of awareness of construction professionals, particularly architects, determines the feasibility of smart buildings. The implementation of smart buildings requires both technical and practical experience. As a result, upgrading professional skills is a prerequisite for the effective implementation of these strategies. In this regard, Ram and Sutrisna (2013) stress the importance of involving individuals with adequate educational backgrounds and professional qualifications for the effective implementation of the concept. To ensure this, engaging academic and training institutions with industry stakeholders is essential to keep up with technological advancements and gain the new perspectives and practical methods required to drive the evolution of smart buildings. Figure (1) illustrates how the lack of awareness manifests in different forms.

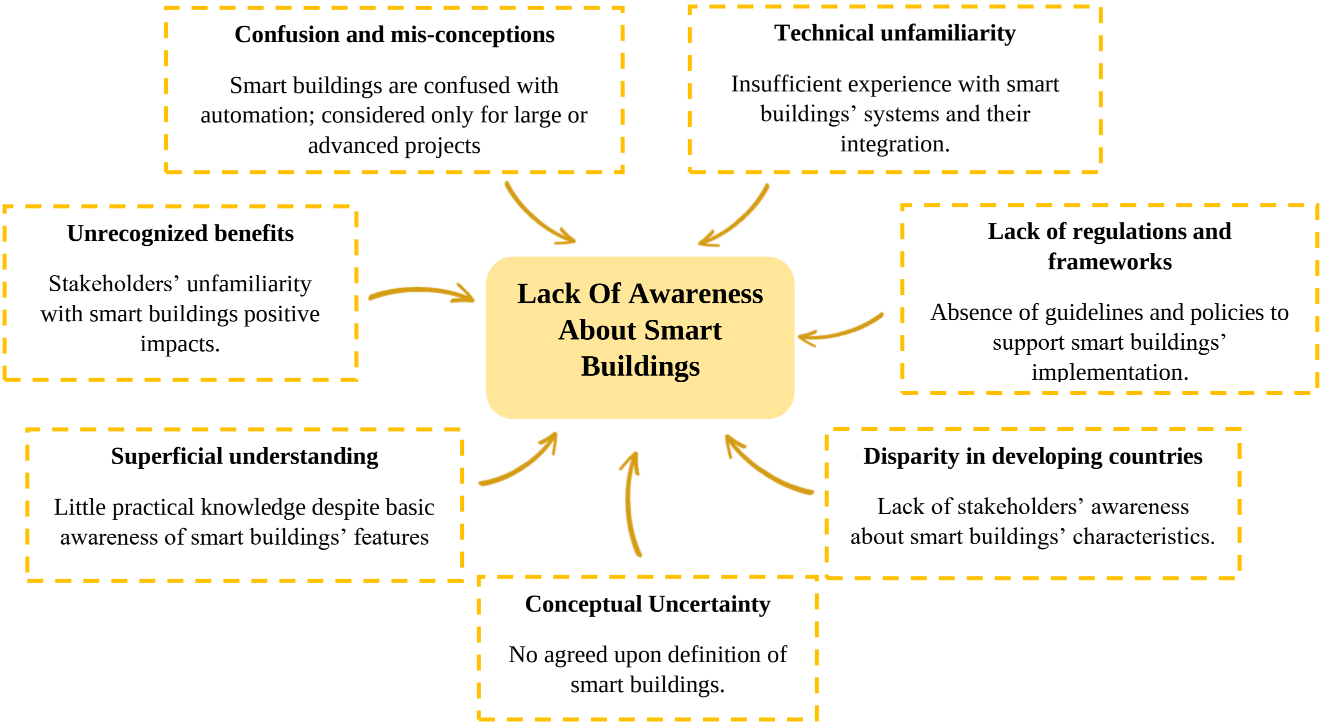

Figure 1. Forms of lack of awareness about smart buildings among professionals. Source: (Authors).

4. Research Methodology

4.1. Questionnaire Instrument

To assess the level of awareness among architects regarding smart buildings, a quantitative research study was conducted using a questionnaire, supported by a comprehensive literature review. Two procedures were used to assess the rationality of the questionnaire. The first step involved submitting the questionnaire for expert review by a professor with over 20 years of experience in the construction industry to ensure clarity in the wording of questions, the accurate use of technical terminology, and the avoidance of ambiguous expressions. The second step involved pilot testing the questionnaire on a dozen professionals, including registered architects from diverse backgrounds and roles within the industry, to assess its comprehensiveness and help identify and eliminate any ambiguities. The final version of the questionnaire was refined based on the feedback received from both the expert review and the pilot study.

4.2. Structure Of the Questionnaire

A well-structured questionnaire comprising four sections was developed and administered using the online platform Google Forms. The first section contains questions related to participants' demographic and background information, including their academic qualifications, years of professional experience, type of organization, and roles within their organizations. The second section of the questionnaire comprised questions relating to respondents' familiarity with the concept and their Source of information.

The third section examined respondents' perceptions of smart buildings, including their level of awareness, definition of the concept, and whether they possess the necessary technical knowledge to implement it. Regarding the concept, we opted for a simplified version of the definition proposed by Buckman et al. (2014). While the original definition by Buckman et al. (2014) encompasses complex and multidimensional aspects, such as enterprise-level intelligence, system integration, and adaptability, we opted for a simplified version in the context of the survey. This decision was made to enhance clarity and neutrality for respondents, and to reduce the risk of response bias associated with overly technical language. We acknowledge that this simplification does not fully capture components like data interoperability or user-centric responsiveness. However, these dimensions were indirectly explored through other survey items addressing technology integration, automation, and occupant interaction.

The fourth section explored the current state of smart buildings' adoption among clients and developers. It included questions such as whether architects propose the implementation of smart buildings to their clients, and if so, how these proposals are received, whether they are accepted, rejected, or met with concerns about potential obstacles to implementation. We used closed-ended questions to collect data, including yes/no responses and multiple-choice options, while all questions were made mandatory to ensure complete responses.

4.3. Survey Design and Sampling

A structured questionnaire survey was administered to Algerian architects from various professional sectors, including academia, the private sector, and the government sector. The inclusion criteria for the respondents required that participants be (1) architects certified by the National Council of the Order of Architects in Algeria (CNOA), which is the official regulatory body responsible for registering and licensing architects in Algeria, and (2) Architects should have at least three years of professional experience. In comparison, the exclusion criteria eliminated interns and professionals practicing outside our designated scope. This approach ensured the respondents had the basic criteria and expertise to provide informed and relevant insights for the study.

Given the difficulty in accessing the most recent and complete list of architects in Algeria, a combination of snowball and non-probability sampling methods was employed. To ensure an adequate and reliable sample size, the study employed the snowball sampling method. This involved reaching out to potential survey participants through referrals from initial participants to expand the respondent pool. Additionally, a non-probability sampling technique was used to select a representative sample for this study.

This combined sampling approach facilitated the identification and inclusion of participants based on their relevant qualifications and experience within the construction sector. We made considerable efforts to ensure diversity among respondents by using various methods to reach potential participants, including personal visits to construction firms and architecture offices, as well as sending direct invitations via email and social media platforms such as LinkedIn.

The survey distribution continued until a saturation point was reached, meaning no further participants could be recruited despite extensive outreach efforts across diverse regions and networks. This saturation reflected the practical ceiling of accessibility, given the sampling method and field conditions, as well as practical accessibility constraints (the lack of access to a centralized, up-to-date national registry of active architects in Algeria) and based on methodological expectations within similar research contexts (Mohamed et al., 2023). As a result, a total of 216 architects were successfully reached and invited to participate in the study. Among these, 134 completed the questionnaire, yielding a response rate of 62%. This rate is considered satisfactory for research conducted within the construction sector (Arusha Technical College & Mhando, 2021). However, it is crucial to acknowledge the potential bias that the snowball sampling method may present, which may limit the statistical generalizability of.

4.4. Data Analysis

The data were processed using the Statistical Package for the Social Sciences (SPSS) and analyzed using descriptive statistics and frequency distributions.

We decided to use frequency distributions to analyze our questionnaire data, providing a clear and concise overview of how responses were distributed among categories. This seems especially fitting, as our exploratory study aims to identify general tendencies and establish levels of awareness, understanding, and perception of smart buildings among Algerian architects, regarding their attitudes and approaches. Taking frequency counts and percentages provides us with precise information, especially regarding categorical variables such as years of experience, lower levels of knowledge, or perceived barriers to adoption. These frequencies and percentages facilitate the interpretation and identification of dominant themes and ideas within the sample. This approach is also consistent with other exploratory studies of this kind in architecture and social sciences (Bryman, 2016; Creswell, 2014).

5. Results

5.1. Background Information of Respondents

According to Table (1), the sample is predominantly composed of highly educated professionals, with 84.3% holding a Master's degree, while a smaller proportion possess a Doctorate (4.5%) or other qualifications (10.4%). Only 0.7% of respondents hold a Bachelor's degree, highlighting a generally high academic profile within participants. In terms of professional experience, a majority (52.2%) have between 3 and 5 years of experience. Meanwhile, 27.6% have 5 to 10 years of experience, and 20.1% report 10 to 20 years in the field. Regarding organizational affiliation, most respondents work in the private sector (59.7%), followed by the public sector (29.85%) and academia (10.45%). We also asked respondents to identify their roles based on the nature of their daily job responsibilities within the organization. Over half of the respondents (56.7%) identified as directors, while 31.3% were employees, and the remaining 12% held other roles. This suggests that the participants possessed the professional expertise and practical experience to provide their insights on the awareness and adoption of smart buildings in Algeria.

Table 1. Background information of respondents. Source: (Authors).

Variable	Characteristics	Frequency	Percentage (%)
Academic qualification	Bachelor's degree	1	0,7
	Master's degree	113	84,3
	PhD	6	4,5
	Other	14	10,4
Years of Professional Experience	3 to 5 years	70	52,2
	5 to 10 years	37	27,6
	10 to 20 years	27	20,1
Type of organization	Academic	14	10.45
	Private sector	80	59.70
	Public sector	40	29.85
	Director	76	56.7
Position within the Design Office	Employee	42	31.3
	Other	16	12

5.2. RQ01: Familiarity with The Smart Building Concept

This section explores the extent to which respondents are familiar with the concept of smart buildings, including the sources from which they have acquired their knowledge, and how they would assess their level of awareness about the concept. The aim is to determine their basic awareness and to identify the primary sources of knowledge through which they were first introduced to the concept. In this regard, respondents were asked whether they were familiar with the term "smart building," what their sources of information were (e.g., education, professional experience, or media), and how they would rate their level of awareness. These questions provide insight into architects' level of familiarity with the smart building concept and the factors contributing to its increasing awareness.

According to Table (2), the overwhelming majority of respondents (97.8%) reported being familiar with the concept of smart buildings, while only 2.2% indicated that they were not familiar with it. This suggests a high general awareness of the concept among the surveyed population.

When asked about the Source of their knowledge, 59% of the respondents attributed their understanding of smart buildings to formal education, including university courses and seminars. Media sources (such as online content, articles, and social platforms) accounted for 26.8% of the reported knowledge sources. A smaller portion reported acquiring knowledge through professional experience (11.2%) or personal networks (3%).

Despite the high familiarity rate, self-assessment of knowledge levels paints a more nuanced picture. Only 19.4% of respondents rated their level of knowledge as high. A significant majority (77.6%) considered their knowledge to be low, and 3% assessed it as moderate. This suggests that, although the concept of smart buildings is widely recognized, a comprehensive understanding remains limited for most participants.

Table 2. Architects' familiarity with smart buildings. Source: (Authors).

Statement/question	Category		Frequency	Percentage (%)
Familiarity with the concept	Yes		131	97.8
	No		3	2,2
Source of information about the smart building concept	Education	University courses and seminars	79	59,0
	Experience	Professional experience	15	11,2
		Personal experience (through networks)	4	3,0
	Media		36	26.8
How would you rate your level of knowledge about smart buildings?	High		26	19,4
	Moderate		4	3,0
	Low		104	77,6

5.3. RQ02: Assessment of Respondents' Knowledge of The Smart Building Concept

A series of targeted questions was included in this section to evaluate architects' level of understanding and perceptions regarding smart buildings. These questions aimed to capture respondents' conceptual definitions of smart buildings, their perception of the relevance and utility of such buildings, their self-assessed technical readiness to engage in smart building projects, awareness of any governmental frameworks or guidelines, and their use of Building Information Modeling (BIM) during the design phase. The goal of this section is to identify knowledge, training, and policy gaps that may hinder the broader adoption of smart building practices in Algeria. Table 3 illustrates the responses to these questions.

When asked to define what a smart building is, 74.6% of respondents indicated that a smart building is "one that integrates advanced technologies, materials, and systems to achieve adaptability, energy efficiency, durability, occupant comfort, and sustainability". While only 8.2% defined it as a building with an intelligent architectural conception, 15.7% viewed it as an automated building, and a small percentage (1.5%) associated it with smart materials.

Regarding their perceptions about the concept, 38.8% of participants considered smart buildings a luxury. In comparison, 36.5% viewed them as a convenient tool aimed at facilitating occupants' lives, and only 23.8% perceived them as a necessity. Regarding technical readiness, a large majority (80.6%) felt that their technical expertise was inadequate for executing smart building projects, with only 19.4% expressing confidence in their skills to do so. Concerning regulatory guidance, 77.6% of respondents reported that there was no government-issued action plan for smart buildings that they were required to follow, indicating a perceived lack of institutional support or direction in this area. Finally, regarding technological adoption, 60.5% of participants did not use Building Information Modeling (BIM) software in the design phase, while 39.5% reported using it. This implies that although some progress has been made toward digital integration, BIM remains underutilized among participants.

Table 3. Assessment of Respondents' Knowledge of the Smart Building Concept. Source: (Authors).

Statement/question	Category	Frequency	Percentage (%)
How would you define a smart building?	A building with an intelligent architectural conception	11	8.2
	Smart buildings integrate advanced technologies, materials, and systems to achieve adaptability, energy efficiency, durability, occupant comfort, and sustainability.	100	74.6
	An automated building	21	15.7
	A building constructed with smart materials	2	1.5
How do you perceive smart buildings?	A luxury	52	38.8
	A necessity	32	23.8
	A convenient tool aimed at facilitating occupants' lives	49	36.5
Do you consider your technical expertise adequate for executing smart buildings?	Yes	26	19.4
	No	108	80.6

Statement/question	Category	Frequency	Percentage (%)
Is there a government-issued action plan for smart buildings that you are required to follow?	Yes	30	22.4
	No	104	77.6
Do you use Building Information Modeling (BIM) software in the design phase?	Yes	53	39.5
	No	81	60.5

The Cross-tabulation of architects' technical expertise and their BIM usage is illustrated by Table 4, which reveals a clear disparity in technical readiness between architects who use BIM and those who do not. Specifically, out of the 81 architects who do not use BIM, a significant majority (69 individuals, 85.2%) reported that they lack the technical expertise needed to execute smart buildings. In contrast, among the 53 architects who use BIM, 39 (73.6%) also reported a lack of technical expertise. Still, a relatively higher proportion (26.4%) felt they possess the necessary expertise, nearly double the percentage compared to non-BIM users.

These results strongly suggest that a lack of BIM usage is associated with a pronounced gap in technical preparedness. The 69 non-BIM users who feel technically unqualified represent the largest subgroup in the entire sample, expressing low readiness. This suggests that limited exposure to BIM may be one of the key factors preventing architects from developing the confidence or capability to engage in smart building practices.

Table 4. Cross Tabulation of architects' technical expertise and their BIM usage. Source: (Authors).

	Has Expertise	Lacks Expertise	Total
Uses BIM	14	39	53
Does Not Use BIM	12	69	81
Total	26	108	134

5.4. RQ03: Architects' Perspectives on The Adoption of Smart Buildings in Algeria

This section examines the current demand for smart buildings in Algeria, based on architects' interactions with clients and their efforts to promote smart building concepts. Table (5). Illustrates the results of this section.

When asked whether they had received client requests for smart building designs, only 22.4% of respondents reported that clients had expressed interest in such designs. A significant majority (77.6%) indicated that they had not received any demand from clients regarding the concept. Despite this limited demand, over half of the respondents (56.0%) reported suggesting the idea of constructing smart buildings to their clients. Meanwhile, 44.0% indicated that they do not propose such ideas. As for client reactions, the responses are nuanced. Only 12.0% of architects noted that the idea was well received. However, the majority (65.3%) reported that while clients were receptive to the idea, practical challenges prevented its implementation. Meanwhile, 22.7% of architects reported complete rejection of the concept when they suggested it to clients.

Table 5. Adoption rate of smart buildings in Algeria, according to architects. Source: (Authors).

Statement/question	Category	Frequency	Percentage (%)
Have you received any requests from clients for the design of smart buildings?	Yes	30	22,4
	No	104	77,6
Do you suggest the idea of constructing smart buildings to your clients?	Yes	75	56,0
	No	59	44,0
	The idea is well-received	9	12,0

Statement/question	Category	Frequency	Percentage (%)
What is the typical client's reaction to your smart building suggestion?	The idea is well-received, but challenges prevent implementation	49	65,3
	The idea is completely rejected	17	22,7

6. Discussion

This study aimed to address three research questions: determining architects' familiarity and perceptions of smart buildings, assessing their level of understanding of the concept, and understanding how these factors influence clients' decision-making and the level of adoption of smart buildings. The research objectives were derived from various literature findings that highlighted common misconceptions about the smart building concept. As a result, we sought to assess the extent of their validity based on the perceptions of Algerian architects.

Regarding RQ01, the survey findings revealed a strong familiarity of architects with the concept, with 97.8% of respondents acknowledging that they have heard of it. Regarding their sources of information, the predominant Source of knowledge for architects in Algeria is formal education and media sources, in contrast to professional experience and peer networks. These findings underscore the pivotal role that academic institutions play in raising awareness about the concept. However, despite their familiarity with the smart building concept, most architects admitted to not having acquired sufficient knowledge about it. This highlights a potential gap between theoretical knowledge and the practical application of smart buildings in the Algerian construction sector. The difference between the high reported familiarity with the notion of smart buildings (97.8%) and the low self-reported understanding (77.6% with limited awareness) reveals an important nuance deserving further contemplation. This disparity may be partially due to cultural and educational factors within the Algerian architectural context. Architecture education and professional discourses often present emerging ideas at a surface level, emphasizing theoretical familiarity without necessarily cultivating a deep, applied understanding. They address unfamiliar technologies and ideas at a theoretical level without any genuine understanding. Consequently, many architects may recognize the terminology and general ideas surrounding smart architecture, yet lack the concrete skills, technical expertise, or interdisciplinary collaboration required to fully grasp and implement such approaches in practice fully. This indicates an education that prioritizes shallow, rote learning and formal definitions over critical engagement, leading to a lack of practical experience or knowledge with new technologies. In this way, the distinction is significant for professional readiness and for developing strategies to enhance living conditions.

These findings reflect a pattern observed in other developing countries such as Ghana and Nigeria, where superficial awareness does not translate into practical competency.

Regarding RQ02, most respondents (74.6%) associated smart buildings with their drivers for development, such as adaptability, energy efficiency, durability, occupant comfort, and sustainability, which reflects a good understanding of the concept. However, a considerable number of participants associate smart buildings with automation and consider them as a luxury, rather than acknowledging their utility. This gap in perceptions reveals a lack of shared understanding regarding the benefits of smart buildings. Additionally, a skill gap appears to exist among architects in their technical understanding of the concept, as 80.6% of them feel technically unprepared to execute smart building projects, and 60.5% of participants did not utilize BIM, despite it being an effective tool for the design and execution of smart buildings. Additionally, 77.6% of architects reported the absence of a government-issued action plan, which further emphasizes the systemic barriers to the adoption of smart buildings, particularly the lack of institutional guidance and regulatory frameworks. Despite architects' growing awareness and familiarity with the smart building concept, their technical understanding remains superficial, not qualifying them to execute smart buildings in Algeria, primarily due to a lack of practical capabilities and governmental support. This aligns with previous literature emphasizing the importance of both conceptual understanding and technical training for meaningful adoption. In addition, a cross-tabulation between respondents who reported using BIM and their corresponding technical readiness levels revealed a tendency toward higher readiness scores among BIM users. However, the pattern remains inconclusive, suggesting that while BIM adoption may be associated with a more advanced technical outlook, additional factors likely influence perceptions of smart buildings.

The third research question (RQ03), explored how architects' awareness influences client engagement. In this section, participants were asked about the adoption landscape of smart buildings and whether they often receive requests from clients regarding their design and execution. In response, only 22.4% of architects reported receiving these requests, which remains a very low percentage. Moreover, half of the respondents reported suggesting smart buildings to their clients. However, clients' responses were mixed. While some clients received the idea positively, others rejected it completely. Although a significant portion was receptive to it, they cited implementation challenges as a reason for their resistance. These reactions highlight the relationship between architects' awareness of the concept and the rate at which it is adopted. Suppose architects lack clarity or confidence in their technical readiness to execute smart buildings. In that case, they are unlikely to advocate for their implementation and convince clients of the opportunities it presents. This issue further hinders the adoption of smart buildings in Algeria.

Collectively, these findings suggest that the adoption of smart buildings in Algeria is still in its early stages of development. While Algerian architects' familiarity with the concept is relatively high, comprehensive knowledge and practical expertise remain limited, which aligns with the findings of the studies above conducted in developing countries, namely a study conducted in Ghana (Ghansah et al., 2022), Nigeria (Ejidike, Mewomo, and Anugwo, 2024), and Lagos state in Nigeria (Opawole et al., 2022). These studies reported a superficial understanding of the concept among professionals, despite a high level of familiarity. As a result, it is noteworthy that while architects in Algeria and other developing countries may possess a conceptual understanding of smart buildings, this has not yet translated into deep technical knowledge or professional readiness for implementation. In this regard, technical training in universities is crucial for enhancing professionals' understanding of smart buildings. In addition, collaborations between academic institutions, the government, and industry practitioners may increase architects' technical capacities and broaden their perspectives about modern and innovative construction practices.

7. Conclusion And Recommendations

This study thoroughly explored the level of awareness and understanding among Algerian architects regarding the concept of smart buildings. It examined how a lack of awareness and professional readiness can influence the adoption of smart buildings in the Algerian construction sector. Using an exploratory approach that combined an extensive literature review and a questionnaire survey targeting architects actively engaged in the field, which resulted in the selection of 134 architects. The study's findings revealed a significant gap: although nearly all surveyed architects (97.8%) reported familiarity with the term "smart building," their in-depth knowledge and technical readiness remained limited. As a result, the study highlights the critical inconsistency between architects' conceptual familiarity and practical competence regarding smart buildings. In addition to this knowledge gap, the research revealed the presence of misconceptions surrounding the concept of smart buildings among respondents. Architects primarily understand smart buildings as incorporating advanced technologies, materials, and systems to achieve adaptability, energy efficiency, sustainability, occupant comfort, and longevity. However, a significant portion still perceives them as a luxury or limits the concept to automation. A major skills gap was identified, with the vast majority declaring themselves technically unprepared to execute smart building projects.

Additionally, the adoption of key digital tools such as BIM remains low, and a clear absence of regulatory frameworks or government action plans further contributes to systemic barriers. These factors explain the low demand for smart buildings reported by architects. Despite more than half of architects proposing the idea to clients, practical implementation challenges often hinder its adoption. This highlights the interdependence between architects' knowledge and confidence, their ability to promote smart buildings, and their effective influence on client decision-making. Without efficient strategies, Algeria risks falling behind in its transition to a smart and sustainable urban environment. To address this knowledge gap and catalyze the transition to a smarter and more sustainable built environment in Algeria, targeted strategies are crucial. These strategies should focus on several key areas:

- First, it is crucial to integrate in-depth technical education on smart building systems, emerging technologies (such as IoT and Big Data), and digital tools (like BIM) into university curricula and continuing education for practicing architects. Bridging the gap between theory and practice in the education and training of smart building practices is crucial for their successful implementation in the future.

- Second, establishing a clear institutional framework through a national action plan and guidelines for implementing smart buildings, including design standards, financial incentives, and subsidies, can encourage stakeholders to take action.
- Third, promoting partnerships between academic institutions, the construction industry, developers, and policymakers can help create an ecosystem conducive to knowledge sharing, innovation, public-private partnerships, and international collaborations. These collaborations may present numerous opportunities for establishing a culture that prioritizes innovation in the construction sector.
- Finally, raising public awareness through campaigns and government-supported initiatives is key to fostering a more informed and responsive society. These campaigns should target not only architects but also developers, clients, and the general public to highlight the economic, social, and environmental benefits of smart buildings. A better-informed community can facilitate the adoption of smart buildings.

With the right investment in education and policy enforcement, along with strengthening awareness and building technical capacity, architects can drive the transition toward a smarter, more sustainable, and technologically advanced built environment in Algeria. However, despite the valuable insights it provides into the situation in Algeria, this study has certain limitations that future research could address:

- First, the study is based on a specific sample of 134 architects, using non-probability sampling methods (snowball and purposive sampling). Efforts were made to ensure a degree of diversity within the respondent pool, targeting architects engaged in various professional contexts, including those operating in urban centers, technology-oriented practices, and more conventional or rural settings. Nevertheless, the snowball sampling technique adopted in this study, being a non-probability method, presents inherent limitations. By relying on participant referrals within professional networks, this approach may have led to the overrepresentation of architects from more connected, urban, or tech-savvy environments, while potentially underrepresenting practitioners in rural or less networked areas. This imbalance could compromise the representativeness of the findings and limit the generalizability of the results to the broader Algerian architectural profession. Although this reflects, to some extent, the actual distribution of smart building discourse, which tends to be concentrated in urban and technologically active circles, it is essential to interpret the findings with caution.
- Second, the study focuses on architects’ perspectives, which, while fundamental, do not fully capture the challenges and opportunities perceived by other key stakeholders such as engineers, contractors, developers, and policymakers. The exclusive focus on architects, while justified by their central role in shaping the built environment, does not capture the full range of stakeholder perspectives involved in developing smart and responsive architecture. Future studies are therefore encouraged to broaden the scope of inquiry by incorporating insights from other key actors, including developers, policymakers, and end-users. Such triangulation would contribute to a more comprehensive understanding of the opportunities and constraints associated with implementing smart architecture in diverse contexts.
- Third, the assessment of knowledge is partly based on architects’ self-evaluation, introducing a certain level of subjectivity that may not always accurately reflect their actual technical competence.
- Lastly, the use of a simplified definition of smart buildings in the questionnaire was necessary for clarity and consistency. However, the persistence of conceptual confusion suggests that a more nuanced understanding of the different facets of "smartness" (beyond simple automation or smart materials) may require further exploration. Furthermore, although this definition was based on the definition used by Buckman et al. (2014), it was intentionally limited in complexity, omitting complex dimensions of the original framework entirely (such as system-wide data interoperability, enterprise-level intelligence, and user-centric adaptability) to allow greater clarity and access for participants with varying levels of understanding. While this was necessary to limit cognitive complexity in responses and avoid response bias, it is possible that this impacted the richness of participants' interpretations. As a result, some aspects of smart buildings may not have been fully captured in their

responses. Future research may consider using more complex definitions or multi-layered conceptual frameworks, especially if targeting an audience with a more sophisticated technical understanding.

By acknowledging these limitations and implementing the proposed strategies to raise awareness, Algeria can gradually overcome the obstacles to the adoption of smart buildings and accelerate its transition to a smarter, more sustainable, and energy-efficient built environment. The role of architects, as key actors in the design and conceptualization process, is central to this transformation.

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