

Examining Barriers to the Application of Modern Construction Technologies in Historic Building Treatments in Metro Detroit

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ABSTRACT

Modern construction technologies can offer significant potential for historic building treatments by addressing structural deterioration, enhancing safety, improving energy performance, and supporting long-term sustainability. However, integrating these modern construction technologies into historic construction requires a careful balance between preserving historic integrity, complying with contemporary construction standards and advancing technological capabilities. This tension often results in complex managerial and technical challenges for project stakeholders when considering, selecting, and implementing modern construction technologies into historic building treatments. Understanding the perspective and decision-making considerations of key stakeholders is critical to the effective development, utilization, and application of modern construction technologies in the historic construction field. However, there is a lack of empirical understanding of how project stakeholders, including construction engineers and managers, experience, interpret, and address the managerial and technical challenges in practice. In addition, little is known about how such challenges influence technology adoption decisions during historic building treatments. Therefore, it is essential to investigate the lived experiences and perspectives of the project stakeholders to identify the key drivers and challenges shaping modern technology adoption during historic building treatments. To address this research gap and capture nuanced, context-dependent perspectives, the current study employed an in-depth qualitative approach, drawing on detailed interviews with subject matter experts who participated in historic building treatment projects in the Metro Detroit area. Qualitative data were collected and analyzed to examine the lived experiences, interpretations, and professional judgments of stakeholders, which are often shaped by project-specific constraints, regulatory environments, and organizational contexts that cannot be adequately captured through purely quantitative measures. The findings of this research indicate that major barriers to the application of modern construction technologies in Detroit's historic building treatment projects include limited knowledge, technology reluctance, and high costs. The findings of this research advance empirical understanding of how project stakeholders and decision-makers determine the appropriate technologies in historic building treatments. The results identify key factors that contribute to practitioners' and contractors' reluctance to adopt these technologies, including financial constraints, limited technical knowledge, and training gaps among contractors. By revealing the practical considerations that influence technology adoption and implementation, this study provides evidence-based guidance for construction firms, owners, consultants, and historic-building preservation professionals. The findings also inform preservation policy and regulatory decision-making by clarifying the barriers and decision processes associated with modern technology adoption, supporting the more consistent, cost-effective, and context-sensitive application of modern construction technologies in historic building treatments.

KEYWORDS

Historic Integrity; Historic Property; Historic Building Treatments; Preservation; Rehabilitation; Restoration; Reconstruction

INTRODUCTION

The treatment of historic properties includes a range of professional interventions applied to structures in order to conserve, repair, adapt, or rehabilitate them while respecting their cultural, architectural, and historical significance.^{1,2} The treatment of historic buildings has long been shaped by the balance between modern construction demands and the imperative objective of preserving cultural and historic integrity.³ While advances in construction technologies offer opportunities to improve efficiency, sustainability, and affordability, they can often pose the risk of diminishing the historical character of built heritage.^{4,5} There is a persistent risk that construction technologies aimed at improving historic buildings may inadvertently impact their cultural value by compromising their historic integrity.⁴ Many historic properties were built centuries ago and the construction industry has undergone transformative changes in methods and technologies since then. As a result, the gap between historic construction techniques used for historic buildings and modern technologies applied in modern construction projects has continued to widen.⁶

⁷ In addition, historic buildings are often used in ways that differ significantly from their original purpose, creating new occupant needs.⁵ For example, contemporary HVAC requirements are often far more demanding than those in place when historic buildings were originally constructed.⁸ If this gap is not carefully managed, historic properties risk losing their integrity through neglect or hasty modernization, while insufficient adaptation may ultimately render them obsolete.⁹

Historically significant buildings are governed by extensive and complex regulations designed to balance the practical demands of economic use with the preservation of historic integrity and cultural significance.¹⁰ The National Historic Preservation Act (NHPA) requires federal agencies to consider impacts on historic properties, fostering harmony between modern use and preservation.^{11, 12} Historic building treatments are often expensive, time-consuming, and typically require specialized artisanal skills and technical expertise.^{13–15} Hasty or inadequately planned work on historic properties without proper expertise can result in severe, long-term, and often irreversible damage to the properties.^{14, 16} Historic building treatment projects should balance modern construction demands such as functional use, sustainability, environmental performance, energy efficiency and affordability, with the preservation of historic authenticity, aesthetic character, and cultural value of the property.^{17, 18} However, in practice, achieving this balance remains highly challenging.^{19, 20}

Modern construction demands can be addressed through the adoption of modern construction technologies, such as energy-efficient retrofitting methods, smart building materials, and digital building information modeling (BIM) techniques.^{21–24} Historic building treatment projects can similarly leverage such technological interventions to enhance overall project performance. For example, the heritage BIM-based energy retrofit of a historic public building achieved approximately 32% to nearly 100% (up to a net-zero energy balance) annual operational energy savings while preserving the building’s heritage values.²⁵ Identifying a reasonable balance between the application of modern technologies and the preservation of historic integrity is critical in historic building treatment projects, as technological intervention decisions can directly influence both conservation and performance outcomes.^{26–28} In addressing this balance, many Western European countries have adopted more progressive technological interventions in historic buildings, while many Eastern European countries tend to favor more conservative, preservation-oriented approaches to historic building treatments.²⁹ In the United States, this balance manifests differently across regions, reflecting variations in regulatory frameworks, economic conditions, and local construction practices.^{30–32} In legacy post-industrial U.S. cities, such as Detroit, historic building treatments have been particularly challenging. Detroit experienced rapid industrial growth in the early 20th century, followed by significant economic decline and urban transformation.^{33, 34} Detroit’s prolonged economic decline relegated the maintenance and rehabilitation of many historic properties to a lower priority, resulting in widespread abandonment and deterioration.³⁵ At the same time, the city faces pressing economic and social demands that require cost-effective and sustainable renovation solutions.³⁶ As a result, the city of Detroit has recently launched initiatives to promote the restoration and adaptive reuse of historic buildings.³⁶

Despite Detroit’s extensive portfolio of approximately 292 historic properties and districts listed on the National Register of Historic Places, little research has examined the challenges and barriers to integrating modern construction technologies and methods into local historic preservation and rehabilitation practices from an end-user perspective.³⁷ Existing literature tends to focus on general discussions of heritage conservation,^{38, 39} or on the wide variety of modern construction techniques and technologies currently applicable to projects concerning historic properties,⁴⁰ with a lack of grounding in local expert input. It is crucial to understand the context and motivations that lead local contractors and clients to adopt emerging construction technologies for cultural and historic regional heritages. The current research aims to investigate the challenges, perspectives, and key considerations influencing modern technology adoption in historic building treatments. This study employs in-depth qualitative interviews with construction practitioners who participated in Detroit’s historic building projects. The findings of this research are expected to provide empirical evidence and practical insights on balancing modern construction technologies with historic integrity preservation and address the gap in knowledge about the decision-making processes for applying modern construction technologies to historic building treatments.

LITERATURE REVIEW

The literature review is conducted to synthesize the current state of modern construction technologies and techniques applicable to historic building treatments. Important terms are defined based on the literature review in **Table 1** to ensure conceptual clarity, promote consistency across qualitative interviews, and support the validity and transparency of this study.

Term	Definition
Property Preservation	Historic building and property preservation is the process of maintaining, repairing, and restoring historic properties in a manner that preserves them in a state as close as possible to the one in which the building was initially built while still keeping up to as many modern safety, accessibility, and environmental standards as possible. ⁴¹

Historic Property	As stated by (NHPA [54 U.S.C. § 300308]) “Historic property” will be defined as any prehistoric or historic district, site, building, structure, or object included on, or eligible for inclusion on, the National Register, including artifacts, records, and material remains relating to the district, site, building, structure, or object. ⁴²
Historic Building Treatments	When working with historic properties, it is important to understand and remember the four historic building treatments: preservation, rehabilitation, restoration, and reconstruction. ⁴¹
Preservation	Preservation is defined as applying the necessary measures to stabilize a historic property and maintain it in its current state. ⁴¹
Rehabilitation	Rehabilitation is defined as repairs, additions, or alterations to a property while still keeping the features of the property that convey its cultural, architectural, or historic values. ⁴¹
Restoration	Restoration consists of depicting the form and character of a property as it used to be at a specific point in time. This may include reconstruction of missing features or the removal of added features that do not fit the intended time period. ⁴¹
Reconstruction	Reconstruction is applicable in situations where there is little existing material left. In such cases, a total rebuilding of the property is required. This treatment has a substantial risk due to the potential for historic inaccuracies. ⁴¹

Table 1. Definitions of terms.

A summary of the literature review is presented in **Table 2**. Previous studies explore the applications of modern technologies in historic building treatments, such as the utilization of a deep learning AI algorithm to classify Athenian architecture into appropriate categories.⁴³

Study	Modern Technology	Findings
Prokop <i>et al.</i> 2021 ⁴⁴	Laser scanner Faro Focus 3D modeling	A 3D Historic Building Information Model (HBIM) provides reliable documentation and finite element analysis of historic structures, supporting visualization, diagnosis, and conservation of architectural heritage such as St. Hubert's Chapel in Rzeszów.
Garbett <i>et al.</i> 2021 ⁴⁵	The combination of building information modeling (BIM) and augmented reality (AR) into a unified product	A framework has been designed for the use of BIM and AR together. This resulted in a prototype system (BIM-AR) being developed that allows geographically split teams to work together in the AR space.
Siountri & Anagnostopoulos 2023 ⁴³	AI deep learning classification of historic buildings	By utilizing a You Only Look Once (YOLO) algorithm and deep learning AI, the classification of Athenian architecture since 1830 into its various categories can be accomplished automatically.
Perret 2025 ³	The coherent acceptable low emission cultural heritage efficient renovation (CALECHE) project	This literature review legitimizes and backs the continued utilization of the CALECHE project to pioneer sustainable energy and renovation projects for historic buildings, demonstrating its effectiveness through four demonstration sites, for example, the former Musée-Bibliothèque de Grenoble in France.
Cabeza <i>et al.</i> 2018 ²⁹	The deployment of modern energy efficiency solutions to historic buildings	Using a variety of modern renewable technology solutions, such as high-efficiency heating, ventilation, and air conditioning (HVAC) systems, solar energy, and geothermal energy to raise the energy efficiency of historic buildings, helping mitigate their impact on the environment.
Xu <i>et al.</i> 2017 ⁴⁶	The use of 3D scanning and 3D printing to recreate historic building ornamental components	By combining the usage of three-dimensional scans and mortar-based cement, 3D printing reproduction of certain ornamental components of historic buildings is possible when such components are difficult to achieve through historic methods. For a feasibility demonstration, a cup-shaped plinth was recreated at the Huazhong University of Science and Technology in China.
Krajnikova <i>et al.</i> 2025 ⁴⁷	Using AI for digital diagnostics and predictive modeling in historic monuments.	AI can greatly benefit the prediction of the condition of historic monuments and can reduce the need for interventions by providing automated damage detection and degradation analysis.
Cascone <i>et al.</i> 2016 ²⁰	Fiber-reinforced polymer nets	Fiber-reinforced polymers (FRPs) are greatly effective at providing reinforcement to masonry structures: they are compatible with lime mortars and suitable for integration into existing buildings and can thus be used to great effect in historic buildings. An example provided is their use in a prominent historic building in Catania, Spain, originally built in 1883.
Orlenko <i>et al.</i> 2020 ⁴⁸	Hydrodynamic methods for the treatment of walls in historic buildings	By utilizing new-to-the-industry hydrodynamic methods and special abrasives historic walls can be cleaned and prepared for restoration. Chemical methods like ammonium fluoride preparations and hydrofluoric acids can also be used.
Khaleghi & Governa 2025 ⁴⁹	Smart city application to historic buildings	The interaction of interconnected smart building systems such as digital heritage tools, data-driven urban management tools, BIM, etc. are in a delicate relationship with the cultural and historic value of many buildings. This relationship must be balanced carefully to preserve collective memory in a swiftly changing world.
Tejani 2021 ¹⁹	Integration of modern HVAC systems into historic buildings	By retrofitting HVAC systems that are energy-efficient into historic properties they are able to continue functioning as important

		buildings that serve not only a cultural function but a practical one. However, the implementation of these systems presents a large number of challenges in preserving the historic sanctity of the building.
Grinzato 2012 ⁵⁵	Use of infrared (IR) thermography for historic building analysis	Thermal non-destructive testing can be effectively applied for historic building treatments. IR thermography can inspect large surfaces with no physical contact or damage. The use of IR thermography allows for the detection of structural cracks, fresco detachment sizing, and understanding the moisture content of structures.

Table 2. Description of the applications of modern construction technologies in historic building treatments that have been documented in previous studies.

When technologies concern material replacement, it is critical to maintain a careful balance between the perceived practicality of the replacement material and understanding if the material is realistically applicable as a replacement for the original material, avoiding the common misconception that new material is always better.⁵⁰ An example of such technological balance is the utilization of externally bonded composite material in masonry structures,⁵¹ such as fiber-reinforced polymer.⁵² The visual impact of these composite materials can be minimal in certain applications, particularly when they are carefully designed and strategically placed on less visible areas such as the extrados of an arch.⁵¹ However, their visual integration is application-dependent and may vary based on geometry, exposure, and design constraints. Despite this variability, these materials can significantly enhance the safety and structural stability of historic buildings. This is especially important in earthquake-prone regions where additional reinforcement is critical.^{20, 51} When preparing historic walls for other treatments and restoration efforts, hydrodynamic and chemical methods such as ammonium fluoride or hydrofluoric acids may be used.⁴⁸

The use of 3D scanning and 3D printing are two emerging technologies in construction that are beginning to see more frequent use.⁵³ There are two primary reasons for the utilization of these 3D techniques in historic building treatments. Many decorative flourishes in historic buildings have substantial amounts of detail, of which there may be limited existing drawings and blueprints. Due to the fragile nature of certain building components and the possibility of their corrosion and erosion from contact with measuring equipment or oils from human skin, it may, as a result, become impossible to effectively measure and survey them without employing 3D laser scanning.⁴⁶ The second major reason is the scope of work involved in manually copying certain elements. As the quantity of artisanal craftsmen goes down, and prices skyrocket for some projects, it becomes increasingly difficult to use entirely manual labor to recreate complex work such as decorative masonry, frescoes, and wood carvings.¹⁴ Utilization of 3D scanning to obtain a highly detailed 3D image of the work can allow recreation with far more accurate results, especially if this is done preemptively before severe damage or deterioration takes place.⁵⁴ Evaluation of historic buildings can also be conducted using thermal non-destructive testing. IR thermography can allow for the effective investigation of material weakness and its causes, as well as identify structural cracks.⁵⁵

An overarching technology that has become of pressing importance in the construction management industry as a whole is BIM.⁵⁶ BIM allows for significantly easier project management and limits waste.⁵⁷ As historic building treatments in particular involve so many fine details, as well as environmental constraints when adapting to modern standards,⁵⁸ the usage of BIM has been imperative in maintaining control of every element of a project.⁵⁹ During retrofitting projects, energy-efficient HVAC system implementation can be beneficial to historic buildings as they often rely on older HVAC systems leading to significant energy usage.⁶⁰ As the modern world continues evolving, it becomes increasingly necessary for historic buildings to remain usable and compliant in modern circumstances. Modern HVAC systems can achieve that while maintaining the historic value of the properties.¹⁹

A crucial factor necessary for successful projects in the context of construction management is customer involvement.⁶¹ The employment of virtual reality (VR) allows companies to clearly demonstrate to their clientele and other high-importance stakeholders concepts that may be difficult for them to grasp without seeing an image-based representation.⁶² In addition, VR employment during the construction phase can significantly increase safety awareness of contractors.⁶³ Usage of VR also allows for the minimization of paper usage in the planning process of projects, which allows easier visualization of concepts and leads to increased accessibility and cohesion of efforts.^{64, 65} Many of these technologies can be applied at the same time, often leading to an even further streamlined and optimized process. For example, BIM and augmented reality (AR) can be integrated to deliver a seamless viewing process for both contractors and clients.⁴⁵ A full bundle of modern technologies can lead to smart-city solutions, with integration of BIM, digital heritage tools, data-driven urban management tools, and other innovations.⁴⁹ As artificial intelligence (AI) technology has risen to prominence in recent years, it has become increasingly relevant and commonplace in the historic construction industry.⁴⁷ AI has broad practical and theoretical applications, from the utilization of deep learning techniques to classify buildings,⁴³ to improving worker safety during high-risk tasks.⁶⁶

Approval from the historical discourse community and other stakeholders is critical to the success of modern technology applications for historic building treatments and is often difficult to secure.³⁸ Historians are often cautious about attempting new preservation strategies.⁶⁷ This difficulty is especially pronounced with technologies that can be seen by the surrounding community as minimizing the historic integrity of the property.^{39, 68} For example, 3D printing technology can reproduce certain decorative elements of buildings; however, it can rarely do it with the original material and must be done with a replacement, such as a cement mixture or plastic.⁴⁶ Use of certain modern technologies is only considered in severe cases of dilapidation.⁵⁸ In addition, the deployment of certain smart systems often aligns with speculative redevelopment and the transformation of historic spaces into commodities, separating them from their function as spaces communities see as their cultural heritage and identity.⁴⁹ Despite the significant amount of research devoted to the topic of the application of modern technology to historic treatment projects, the majority of the research that has been done is either quantitative in nature, resulting in less detailed professional opinions or is focused on an individual case study, often in Europe, resulting in a narrow scope of study. Prior research generally gives little attention to how clients and contractors evaluate whether to integrate modern technology into their projects or not. This research strives to address the existing research gap of the application of modern construction techniques, methods, and technologies for historic building treatments by utilizing qualitative research methods to provide a more in-depth understanding of how industry professionals and owners of historic properties decide what techniques and technologies are appropriate for their circumstances, as well as what prior knowledge they have of modern construction technology.

METHODS AND PROCEDURES

This research seeks to answer the following questions: (1) What are the factors that can assist in understanding whether a client or contractor is willing and likely to employ modern and emerging construction technologies for a historic building treatment project? (2) What often prevents individuals from deciding to use these technologies? (3) What incentives or methods can be used to motivate and encourage the appropriate usage of modern construction technologies for historic building treatments?

This research focused on identifying common challenges, strategies, and considerations in the selection process of applying modern construction technologies and techniques to historic building treatments in Detroit, Michigan. Five semi-structured expert interviews were conducted with professionals directly engaged in historic building treatments in Detroit, including virtual design construction (VDC) specialists, construction project managers, engineers, and historic preservation specialists. Four of the interviewees worked as contractors.

In qualitative research, expert interviews are a widely accepted technique for eliciting in-depth knowledge about specialized practices, unresolved issues, or gaps in existing literature.³⁷ In the context of historic building treatments, many of the most relevant insights about historic building preservation requirements and modern construction technologies are not readily accessible through formal documents or published studies. Semi-structured expert interviews address this limitation by offering a systematic yet flexible way to capture practitioners' reasoning, decisions, and implicit professional judgments. Semi-structured interviews differ from explanatory interviews in that they rely on a carefully designed question set to ensure consistency and comparability across responses, while still allowing space for clarification and elaboration. This approach makes it possible to capture both the breadth and depth of challenges encountered in Detroit's historic renovation projects. Reliability in qualitative interviews refers to the consistency of data collection and interpretation processes.⁶⁹ To enhance reliability, a semi-structured interview protocol was developed and applied across all participants, reducing variation in question framing and sequencing. Additionally, conducting multiple interviews with professionals from different roles improved the robustness of findings by triangulating perspectives.⁷⁰ Validity is defined as the extent to which the research captures what it intends to capture.⁶⁹ The validity of expert interviews in this study was strengthened through deliberate interviewee selection. The approach provides both an empirical contribution to preservation literature and practical guidance for professionals engaged in balancing heritage values with modern construction demands and technologies.

To ensure ethical standards, the Institutional Review Board (IRB) at Wayne State University was contacted. It was determined that this study was exempt from being considered as human participant research as it constituted an evaluative study and did not require IRB review. Interviewees were selected from a variety of companies and universities and were contacted either by e-mail, telephone, or in-person conversations.

This interview process employs non-random selection of interviewees as presented in **Table 3**, focusing on a variety of historic building treatments in the Detroit area done by a multitude of companies and contractors. The purpose of these interviews was to understand the decision process of contractors and clients as to whether they choose to use certain emerging technologies or not in the scope of historic building treatment projects, to present to the reader a brief summary of some modern technologies used in building restoration in Detroit and surrounding suburbs, as well as to gain insight into the thought process of industry professionals and how they perceived the existing issues in the industry. For the satisfaction of this purpose, semi-structured interviews were used with five subject matter specialists who were involved in a variety of projects in various roles such as project managers, project engineers, or members of historical boards. Care was taken to ideally select interviewees who were close to the

project and had a familiar relationship with contractors and sub-contractors involved. Historic properties important to the historic building landscape of Detroit, such as Central Michigan Station, shown in **Figure 1**, were discussed as part of the interviews.

Interview Number	Title	Years of Experience	Relevant Projects
Interviewee #1	Electrical Engineer, Contractor	30+	Packard Proving Grounds
Interviewee #2	Project Manager, Contractor	8	Central Michigan Station, Buhl Building
Interviewee #3	VDC Coordinator, Contractor	7	Central Michigan Station
Interviewee #4	Vice-Chair of Historical Committee	11	More Than 42 Residential Properties
Interviewee #5	Project Manager, Contractor	37	Freer House

Table 3. Interviewee information



Figure 1. View on Central Michigan Station from below.

RESULTS

Five interviews were conducted with experts representing a combined total of over 93 years of experience in construction and pre-construction project phases. The interview responses generally aligned with insights identified in the literature review, including the risks and benefits of material replacement, the advantages of adopting modern technologies during the pre-construction phase, and the importance of evaluating project-specific needs prior to implementing such technologies. The inclusion of practitioner and end-user perspectives provides contextual support for the literature findings and offers applied insights that help ground the discussion in real-world construction practice. At the same time, the interviews revealed novel findings and provided nuanced perspectives, particularly regarding the sparse application of modern technologies, which warrant further elaboration in this section. Two major categories of reasons for the lack of modern construction technology deployment were pointed out during the interviews.

Financial Barriers

The most obvious barrier to the adoption of modern construction technologies is financial concern. Many of the recently emerging technologies are still in the experimental phase and thus quite expensive. This issue is especially relevant to smaller construction firms as well as clients possessing residential properties. For them, the risk of utilizing a costly technology that may not necessarily “pay itself off” is not worth the risk.

Knowledge Barriers: Lack of Knowledge and Awareness

However, even when prices are reasonable, the second major barrier corroborated by interviewees was the simple lack of knowledge and awareness of the technology in question. An example of this lack of knowledge and awareness is the use of infrared (IR) scanning in the pre-construction phase. Using an IR scan can aid in diagnosing the condition of the historic building, allowing the contractor to be prepared for the scope of work instead of being surprised by the poor condition of certain elements, such as severe leakage, structural cracks, or insulation issues.⁵⁵ Being aware of these conditions before building treatments begin

can allow for proper methodologies to be applied for these issues, thus resulting in minimized further damage to the building and reduced costs. IR scanners are quite affordable to use, with a scan generally costing as little as 200-300 dollars. However, one of the major barriers to IR scanner application is that clients or contractors are simply unaware of it as an option for identifying issues with the building. The concern of clients being unaware of approaches was noted by an interviewee, mentioning how often he encounters owners of historic residential properties that are unaware of some of the modern construction technologies that could be available and fit the needs of their property. According to interviews, contractors often fail to provide adequate information to the client in this regard, despite being aware of the technology. A suggested solution was to utilize information pamphlets to distribute to potential clients, ensuring that they would be aware of all options regarding their property. A summary of interviewee suggestions is provided in **Table 4**.

Recommendation	Reasoning
Produce media involving the usage of modern construction techniques and technologies.	Spread knowledge of a variety of modern construction techniques and technologies to lay people, resulting in a higher rate of them asking for such technology to be used on projects.
Distribute information slips describing modern construction techniques and technologies to potential clients and owners of historic properties.	Raise awareness of such technologies, resulting in increased interest and knowledge among people not directly involved in the field.
Improve the user interface (UI) of products and reduce the amount of necessary equipment for utilization.	Many products remain underutilized due to how complicated they are to gain competence with. If companies lowered the knowledge level required to use modern solutions through improvements to the user experience, these technologies would see more use.

Table 4. Interviewee recommendations

Knowledge Barriers: Technology Reluctance

Even when contractors are aware of certain new technologies, they can often be reluctant to employ them. Construction as an industry is a field that evolves slowly, particularly in comparison with others.⁷¹ Construction managers can be very doubtful about the use of new technologies due to a lack of understanding and exposure to them, and thus, have a lack of trust towards them.⁷² This absence of trust and willingness to adopt new things is particularly noticeable with smaller construction firms for whom the risk of a poor financial decision is greater.⁷³ Smaller construction companies are often concerned about employing new construction techniques and technologies on projects.⁷³

A method of disseminating knowledge of modern construction techniques and technologies noted by an interviewee was the production of media involving the implementation of modern construction technologies in the context of historic building treatments.

Also, improving the user-friendliness and UI of software and digital tools could significantly increase the frequency of use of modern technologies in historic building treatments.

Deciding what level of modern technological intrusion is acceptable is a challenging task. Interviewees agree that as many modern methods as possible should be used in the pre-construction phase. One of the biggest general factors in historic building work is unknown problems that are hidden by the building until work begins. Emerging technologies may be utilized to expose some of these potential faults, saving both money for the client and time for the contractor, and preventing decisions that may lead to further damage to the property. For example, an interviewee mentioned the need to detect water leaks as early as possible. When such issues are detected early in the planning phase, further damage can be prevented, and existing damage can be repaired more easily. In addition, careful pre-construction efforts and planning utilizing technology can help to understand the building's history and thus lead to accurate and historically appropriate choices in later phases of the construction process. For example, layers of paint may be analyzed, thus providing a better picture of what time period additions and renovations occurred in the building. Similar techniques can be used to analyze the mortar used on brick and masonry. However, once construction begins, knowing where it is acceptable to use modern methods becomes a lot more challenging. Most interviewees were quite opposed to any ahistorical material replacement. However, to quote an interviewee: "There is a place for it [modern construction methods and materials] to a point".

One of the most frequently cited factors influencing the successful application of modern construction technologies in historic preservation projects was the knowledge and training of contractors. Interview participants emphasized that modern technologies and materials are merely tools whose effectiveness depends on how appropriately they are applied. As one participant explained, using an unsuitable technology in a historic building is "like using a hammer to drive in a screw." While modern materials can improve efficiency and performance, their misuse can compromise both the historic integrity and structural condition of a building.

The Freer House restoration project provides a clear example of these risks. **Figure 2** shows the Freer House, which is currently undergoing restoration work that includes the replacement of the incompatible mortar with historically appropriate lime mortar. The Freer House, a historic masonry structure, was originally constructed using lime mortar, which is flexible enough to accommodate natural building movement. Because such historic structures typically lack modern expansion joints, compatible lime mortar is essential for preventing cracking and deterioration. During previous repair efforts, however, a modern cement-based mortar was used instead of lime mortar. Although the cement mortar was perceived as stronger and more durable, its rigidity prevented the masonry from flexing as intended. As a result, the building experienced significant cracking, mortar joint failure, and masonry spalling, creating additional deterioration that continues to require remediation today. This example illustrates how inadequate knowledge of historic construction methods can lead to the inappropriate application of modern materials, ultimately causing greater damage and increasing long-term repair costs.



Figure 2. A view of the Freer House undergoing rehabilitation

DISCUSSION

Despite the limited interview sample size and the geographic focus on the Detroit metropolitan area, this research provides insight into how project stakeholders and decision-makers determine the appropriate technologies in historic building treatments. The major barriers to applying modern construction techniques and technologies to historic building treatments can be grouped into two categories: financial barriers and knowledge barriers, which are often interrelated.

Financial barriers emerged as a primary constraint, indicating that the high cost of adopting modern technologies frequently discourages implementation, particularly for smaller firms or projects with limited budgets. In such contexts, cost considerations tend to dominate decision-making processes and reduce the likelihood of adopting innovative approaches. Smaller companies and clients are effectively restricted to letting large companies bear upon them the brunt of experimentation with modern techniques and technologies and must wait until the new technology becomes tested and readily available on the market for a lesser price.

Knowledge barriers represent a broader range of knowledge-based challenges, including the lack of knowledge and awareness and technology reluctance. The findings indicate that clients and contractors are often unfamiliar with available technologies, which limits consideration of their use in practice. Even when contractors are aware of emerging technologies, they may still be reluctant to adopt them, reflecting the generally slow rate of technological evolution in the construction industry compared to other sectors.⁷⁰

This hesitancy is often associated with limited understanding and exposure, which can contribute to reduced trust in new technologies among construction managers.⁷¹ In some cases, stakeholders may also be unaware of the potential benefits these new technologies could offer compared to traditional approaches.

One key intersection between financial and knowledge barriers is risk-aversion. When technologies are perceived as both costly and unfamiliar, stakeholders are more likely to favor established construction practices that are perceived as lower risk. This interaction reinforces conservative decision-making patterns in the adoption of new technologies in historic building contexts. This absence of trust and conservative adoption behavior is particularly evident among smaller construction firms, where the perceived risk of poor financial decisions is greater.⁷² Smaller firms are therefore more likely to be cautious in adopting new construction techniques and technologies.⁷² The interview findings suggest that financial constraints and perceived risk play a central role in shaping adoption decisions, particularly in contexts where project budgets are limited.

The most commonly proposed solution to alleviate these challenges, mentioned in almost every interview, is to increase industry-wide awareness of these technologies among both potential clients and contractors. Contractors and clients should be as aware as reasonably possible of all potential technologies available during a historic building treatment. This could be achieved through structured training programs, informational resources, as well as gradual exposure to emerging technologies as they become more widely adopted in practice. A potential strategy is to bring these modern technologies into common knowledge via the use of various media entertainment programs, such as television programs or online channels. Television programs, such as *Houses With History*, focus on historic building treatments. However, these existing programs usually focus on the aesthetic decisions during the historic building treatments, rather than discussing the potential use of modern technologies. Highlighting modern technologies and techniques that can be used to achieve the desired aesthetic outcome could significantly increase public awareness of these possibilities.

Increasing the user-friendliness of software and digital tools could significantly improve the frequency of use of modern technologies in historic building treatments. Construction projects have an inherently complex and unpredictable nature.⁷⁴ This inherent complexity makes the usability and ease of implementation of modern technology critical considerations in historic building projects.

An important point to emphasize is that before the application of modern technologies, methods, or materials is considered, the contractor must be highly familiar with the historic methods, and more importantly, understand the rationale of why they were used. By doing so, contractors can more accurately decide where the use of modern technologies in historic building treatments is appropriate, and where it is not. This understanding of historic methods, or lack thereof, is the most important factor to consider when applying modern construction techniques and technologies in the context of historic building treatments.

The research found that financial barriers, knowledge barriers, and usability limitations collectively reinforce risk-averse behavior of practitioners, hindering their adoption of modern technologies. This dynamic is particularly important in historic building treatments, where decision-making must balance innovation with preservation requirements. The successful integration of modern technologies, therefore, requires emphasis on both technological accessibility and historical competency. While interviewees highlight that these emerging technologies should become accessible to end-users as quickly as possible and that access to the technologies should be democratized, they also emphasize the need for coordinated efforts to strengthen training in historic construction methods. In combination, these approaches may enable the benefits of modern innovation to be realized without compromising the cultural and historical integrity of heritage structures.

CONCLUSIONS

This research was undertaken to address the research gap in the decision process of key project stakeholders when deciding whether to utilize modern construction technologies in historic building treatments and factors impacting this decision-making process. The findings of this research provide qualitative empirical insight into the opportunities and challenges associated with the applications of modern construction technologies in historic building treatment projects. Drawing on in-depth expert interviews with industry professionals involved in historic building projects in Detroit, Michigan, the study identifies several key concerns influencing adoption decisions, including the high cost of implementing modern technologies, lack of knowledge and awareness, and technology reluctance among project stakeholders.

Among these, financial constraints emerged as a primary and recurring concern, particularly given the perceived expense of emerging technologies and the budget limitations often faced by smaller firms and projects. These financial considerations frequently interact with knowledge-related constraints, reinforcing cautious and risk-averse decision-making. At the same time, the results also underscore the potential benefits of modern construction technologies in historic building treatments, particularly in mitigating

long-term deterioration and enabling more effective intervention strategies, especially in cases where historic methods are infeasible or impractical.

A key contribution of this research lies in its identification of knowledge gaps as a central constraint on the responsible adoption of modern technologies in historic building treatments. The findings of this research show that uncertainty, limited familiarity, and lack of knowledge about modern construction technologies, among both project owners and contractors, often drive overly conservative decision-making or, conversely, inappropriate technological applications. By foregrounding practitioner perspectives, this study advances existing literature by linking technology adoption in historic building treatments not only to material or regulatory considerations, but also to workforce training, professional education, and communication practices. Workforce training programs, targeted professional education, and the strategic documentation and dissemination of successful case studies can be utilized to address existing knowledge gaps and improve knowledge transfer across project teams, thereby supporting the effective application of modern technologies in historic building projects.

This research provides empirical insights for project stakeholders in the historic construction industry by illuminating the complexities of technology-related decision-making, discussing financial and knowledge-based constraints, and identifying actionable strategies to support more effective application of modern technologies in historic building projects. This research opens several avenues for future research. The interview sample size was limited, which may constrain the breadth of perspectives represented. Moreover, the geographic focus on the Detroit metropolitan area restricts the generalizability of the findings. Future research would benefit from a larger and more geographically diverse sample of expert interviews, enabling analysis across different climatic conditions, regulatory frameworks, and regional preservation practices. Expanding the research scope in this manner would further refine the understanding of how modern technologies can be responsibly adapted to diverse historic building contexts.

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PRESS SUMMARY

Modern construction technologies have notable potential in their application to historic properties important to the cultural heritage of Detroit by addressing structural deterioration, enhancing safety, improving energy performance, and supporting long-term sustainability. However, integrating these modern construction technologies into historic construction requires a careful balance between preserving historic integrity and complying with contemporary construction standards and advancing technological capabilities. Understanding the perspective and decision-making considerations of key stakeholders is critical to the effective development, utilization, and application of modern construction technologies in the historic construction field. Therefore, it is essential to investigate the lived experiences and perspectives of key project stakeholders to identify the primary drivers and challenges shaping the adoption of modern technology used during historic building treatments.