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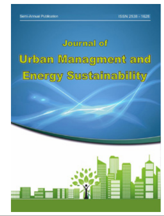

ORGINAL RESEARCH PAPER

# Explaination of the Impact Assessment Process for Energy Consumption Optimization Interventions in Historic Buildings**

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ABSTRACT

Improving energy performance in historic buildings has become a critical challenge due to the need to balance environmental sustainability with the conservation of heritage values. Although numerous guidelines and decision-support tools have been developed, many existing approaches rely on qualitative judgments and lack transparent, quantitative procedures for evaluating the impacts of energy optimization interventions. This gap often leads to uncertainty in prioritizing measures and achieving consensus among multidisciplinary stakeholders. The present study aims to develop a structured Impact Assessment Process that enables integrated evaluation of energy consumption optimization interventions in historic buildings while safeguarding heritage significance. The research adopts a qualitative methodology based on comprehensive literature review, content analysis, and logical–analytical reasoning. Drawing upon Environmental Impact Assessment principles and Heritage Impact Assessment frameworks, a three-stage process is proposed, including baseline condition assessment, identification of intervention strategies, and impact evaluation relative to baseline conditions. The framework integrates five assessment criteria: heritage value conservation, energy performance, $CO_2$ emission reduction, indoor thermal comfort, and economic efficiency. Findings indicate that applying a structured scoring system and a multi-criteria evaluation approach improves transparency in decision-making and allows systematic comparison of alternative interventions. Furthermore, prioritizing heritage impact assessment at early stages helps eliminate incompatible measures before detailed energy analysis, reducing potential risks to historic fabric. The study concludes that the proposed framework provides a comprehensive and adaptable methodological structure for researchers and practitioners, facilitating more balanced, evidence-based, and sustainable energy retrofit decisions in historic buildings, particularly in contexts where standardized assessment protocols are limited.

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** This article is taken from Mozhdeh Soroush's doctoral dissertation entitled "Developing a Method for Assessing the Impact of Energy Consumption Optimization Interventions on Historic Buildings (Case Study: Qajar-era Houses in Sanandaj City)," which was conducted under the supervision of Dr. Vahid Ghobadian and the consultation of Dr. Shervin Mirshahzadeh at the Islamic Azad University, Central Tehran Branch.

## INTRODUCTION

In recent years, the perspective of policymakers and conservation specialists regarding Energy Performance Enhancement in Historic Buildings has undergone fundamental transformation. In the past, such Interventions were considered a threat to Heritage Values, and regulatory exemptions were employed as conservation tools; however, today these exemptions are recognized as restrictive factors and as contributors to an energy burden imposed on the built heritage. In this context, emerging approaches are based on the assumption that Energy Performance Enhancement Interventions can support continued utilization, adaptation to contemporary requirements, and prevention of abandonment and progressive deterioration of Historic Buildings (Webb, 2017). Nevertheless, energy oriented rehabilitation in Historic Buildings has consistently been associated with significant challenges due to the unique and heterogeneous physical characteristics of these buildings, as well as the necessity of preserving Heritage Values (Nair et al., 2022). These challenges have led to increased attention in recent years toward improving Energy Efficiency in Historic Buildings, resulting in the development of numerous methods, projects, and standards by researchers and related organizations (Felius et al., 2023). In recent studies related to the enhancement of Energy Efficiency in Historic Buildings, Interventions are selected based on a Process-Oriented Approach, with the objective of establishing a balance between the improvement of Energy Efficiency and the conservation of Heritage Values (Buda et al., 2022). However, due to the provision of general guidelines and strategic recommendations across different stages of the decision making Process, users often lack a precise understanding of how to implement each stage. Moreover, the selection criteria for measures are inherently subjective and non-quantitative, and decision-making is performed by a multidisciplinary expert team based on qualitative Assessment Tools. Consequently, achieving consensus and equilibrium becomes challenging, and determining the actual effectiveness of each Intervention, as well as their accurate prioritization, remains limited. To address these gaps, the present study, through the review and analysis of existing knowledge in three domains: (1) conservation of Heritage Values, (2) Energy Consumption Optimization, and (3) approaches to improving Energy Efficiency in Historic Buildings, aims to achieve the primary research objective, namely the development of an Impact Assessment Process for Energy Consumption Optimization Interventions in Historic Buildings.

## MATERIALS AND METHODS

In general, the evolution of methodologies related to the improvement of Energy Efficiency in Historic Buildings can be categorized into four temporal phases, as illustrated in the timeline presented in (Fig. 1)


Figure 1: The evolution of methodologies related to improving energy efficiency in historical buildings

The formulation of energy conservation regulations for Existing Buildings in Europe began with Article 6 of Directive (EC/2002/91). This directive introduced the requirement to comply with specified Energy Performance parameters in major renovation projects, provided that such compliance was technically, functionally, and economically feasible. However, buildings with significant heritage significance were exempted if compliance would result in unacceptable alterations to their physical characteristics or appearance, as defined by the European Parliament and Council (2002). Following this exemption, individual countries were granted the authority to establish their own energy performance requirements for Heritage Buildings. This policy framework stimulated the development of numerous guidelines, research studies, and projects. During this period, the majority of research efforts focused primarily on evaluating the Energy Performance of Interventions, with only indirect consideration of heritage conservation aspects, as observed in the study conducted by Gagliano et al. (2014). In parallel with these studies, several technical guidelines and manuals were published, mainly serving to provide general recommendations without defining step-by-step procedures for Impact Assessment and implementation. The primary objective of these documents was to supply evaluation tools and criteria to heritage protection authorities, enabling critical assessment of Energy Consumption Optimization projects and supporting professional judgment within conservation teams to ensure simultaneous protection of cultural heritage and improvement of Energy Efficiency (Garzulino, 2020). For example, the guideline titled "Energy Efficiency and Historic Buildings", published by English Heritage (2010), represented the first systematic attempt to introduce a comprehensive set of practical guidelines, principles, methods, and risk considerations for stakeholders involved in Energy Performance Enhancement. Although this document does not establish a Process-Oriented Framework for selecting appropriate Interventions, its publication marked an important milestone toward the methodological systematization of energy-related actions in Historic Buildings (Gholami et al., 2021). In this context, several research projects primarily supported by the European Union, including 3Encult, RESTART, New4Old, BRITA in Pubs, EFFESUS, and RIBuild, have contributed to the development of Process-Oriented Guidelines that must be adapted to the specific characteristics and conditions of each Historic Building (Piderit et al., 2019). Nevertheless, differences can be observed in the objectives and evaluation procedures of these projects. For instance, the EFFESUS Methodology, recognized as one of the most comprehensive initiatives funded by the European Union in this field, employs a six-stage cycle combined with a Decision Support System (DSS) to simultaneously evaluate proposed Interventions based on heritage conservation, energy performance, cost efficiency, and indoor comfort criteria. A distinctive feature of this methodology is the quantitative assessment of the heritage value of building components and the effects of Interventions on Heritage Values. However, the evaluation procedures for other criteria such as energy performance, cost, and indoor environmental comfort are not transparently defined, and assessments remain largely confined to the DSS environment. The advancement of methodologies in academic research and technical projects ultimately led to the development of the European standard EN 16883:2017, entitled Conservation of Cultural Heritage – Guidelines for Improving the Energy Performance of Historic Buildings.

This standard introduced a six stage Decision-Making Process for selecting energy related Interventions, aiming to reduce energy demand and greenhouse gas emissions. The methodology is based on Risk–Benefit Analysis for evaluating Interventions (Buda et al., 2022). The development of the EN 16883:2017 standard, defined by EN 16883:2017, became a key driver for subsequent research and guideline development. As a result, a significant number of researchers have proposed the use of Multi-Criteria Assessment (MCA) methods to achieve an integrated evaluation of Energy Consumption Optimization Interventions. For example, Garzulino (2020) applied a Multi-Criteria Assessment Framework to simultaneously analyze Heritage Values, Energy Efficiency, durability, and cost parameters. Through descriptive analytical models, this approach enabled systematic comparison and optimal selection of Energy Performance Enhancement Interventions in Historic Buildings. However, only a limited number of methodologies developed in recent years have incorporated fully quantitative evaluation procedures across all stages of assessment. For instance, in the study conducted by Fiore et al. (2020), the Analytic Hierarchy Process (AHP) was employed to prioritize improvement measures based on criteria including conservation performance, structural safety, Energy Efficiency, $CO_2$ emissions, functional disturbance, implementation time, and economic considerations. In Iran, the absence of standardized protocols or formal guidelines for expert decision making regarding Energy Consumption Optimization Interventions in Historic Buildings is clearly evident. The existing research literature in this field remains limited and is still in its early developmental stages. For example, studies conducted by Alikaram (2021) in the historical Kazakhkhaneh Mansion and Shoja (2022) in Dolab Historical Village mainly focused on evaluating the energy performance of Interventions with only indirect reference to heritage conservation considerations. Nevertheless, Gholami et al. (2021) attempted to develop a systematic Process-Oriented Framework for intervention in Historic Buildings by qualitatively analyzing previous decision making processes. However, this study was also affected by the persistent limitation observed in earlier research, namely the reliance on qualitative assessment tools and the lack of clear evaluation mechanisms across different stages of the Impact Assessment Process. Despite the considerable expansion of research over the past decade and the development of diverse methodologies for evaluating energy-related Interventions in Historic Buildings, there remains a significant lack of a unified, transparent, and standardized Assessment Framework to guide the evaluation process and clarify the measurement of criteria at each stage. Consequently, a substantial portion of assessments, particularly those related to Heritage Value Evaluation, continues to rely on qualitative tools lacking objective and well defined measurement mechanisms. This research gap indicates that the development of a comprehensive methodology capable of balancing factors influencing intervention selection, while utilizing transparent criteria and quantitative evaluation instruments for identification and prioritization, is essential.

*Methodology*

The present study is developed with the aim of proposing a structured and transparent impact assessment framework for energy consumption optimization interventions in historic buildings; therefore, in terms of research objective, it is categorized as an applied–developmental study that seeks to bridge theoretical knowledge and practical decision-making needs in the field of architectural heritage conservation and energy efficiency. From a methodological perspective, the research follows a qualitative paradigm grounded in interpretivist and constructivist approaches, emphasizing the interpretation and synthesis of existing theoretical frameworks rather than experimental testing. The nature of the research is descriptive–analytical, as it systematically reviews and analyzes prior studies, international standards, and professional guidelines to extract key concepts, criteria, and evaluation mechanisms relevant to the research problem. Data collection is conducted through library-based and documentary methods, including the review of peer-reviewed journal articles, international charters, technical standards, books, and official reports related to Environmental Impact Assessment (EIA), Heritage Impact Assessment (HIA), and energy retrofit strategies for historic buildings. The analytical process is based on qualitative content analysis combined with logical reasoning, through which recurring variables, conceptual relationships, and methodological gaps in the literature are identified and synthesized. The research procedure follows several sequential stages: first, a comprehensive review of theoretical foundations related to heritage value conservation and energy efficiency improvement is performed; second, existing assessment models and decision-making frameworks are comparatively analyzed to identify their strengths and limitations; third, key evaluation criteria and variables influencing intervention selection are extracted and classified; and finally, by integrating these components within an EIA-inspired structure, a three-stage impact assessment process is formulated, including baseline condition assessment, identification of intervention strategies, and multi-criteria impact evaluation. This methodological approach allows the development of a coherent conceptual framework that reflects the interdisciplinary nature of historic building interventions while enhancing transparency and consistency in evaluation procedures.

## FINDINGS AND DISCUSSION

Considering the necessity of establishing a balance between the conservation of Heritage Values and the improvement of Energy Efficiency in Historic Buildings, the theoretical literature of this study is organized into two main domains. The first domain addresses the theoretical foundations related to the identification and explication of Heritage Values and value-based intervention principles. The second domain focuses on actions associated with Energy Consumption Optimization in Historic Buildings.

*Value-Based Heritage Conservation*

Throughout history, the conservation of architectural heritage has been fundamentally based on the values attributed to heritage assets. These values have manifested with varying intensity and emphasis across different historical periods (Pahlevanzadeh, 1397). Since recent decades, value-oriented approaches have emerged as one of the fundamental axes in heritage conservation theory and practice. These approaches emphasize the identification and protection of Heritage Values, thereby shaping the direction of conservation Interventions. In the research literature, this approach is reflected under various titles such as Value-Based Conservation, Value Management, significance-based approach, and cultural heritage value assessment (Olukoya, 2021). Over the years, various efforts have been made to develop comprehensive value typologies. For example, in the study conducted by Qalehnoui et al. (1397), which focused on identifying and prioritizing architectural and urban heritage values in Naghsh-e Jahan Square, four value categories including historical, emotional, socio-cultural, and scientific functional values were selected for evaluation following a review of theoretical literature. Similarly, Vargas and Mora (2022) noted that although multiple heritage value classification systems have been proposed over time, none have fully replaced Riegl's classification model. By updating and adapting Riegl's value framework to contemporary contexts, they proposed a revised heritage value classification including antiquity value, historical value, memorial value, functional value, novelty value, artistic value, social value, and economic value (Vargas & Mora, 2022).

*Assessment of Architectural Heritage Values*

From a methodological perspective, two general approaches exist for the Assessment of Heritage Values: a structured or formalized approach (scoring system) and an approach based on linking values to physical building elements (Goranskaja & Nichiporovich, 2023). The first approach is mainly applied in Adaptive Reuse and in prioritization processes for Renovation, Restoration, and Rehabilitation decisions. Approximately 50% of studies in this domain employ Multi-Criteria Decision Analysis (MCDA) methods to construct scoring systems (Nadkarni & Puthuvayi, 2020). This approach generally consists of three sequential stages: (1) identification of relevant values, (2) extraction and explication of values (detailed interpretation and conceptual expansion of value dimensions), and (3) ranking and prioritization, which involves integrating and ordering values even when conflicts exist, enabling their application in resolving stakeholder interest contradictions

(De la Torre, 2002). These systems typically use ordinal scales such as 1–4, aiming to achieve quantitative and precise evaluation of architectural heritage assets (Mehta, 2014). In the second approach, which is based on linking values to physical components, the heritage value of each architectural asset is derived from its physical characteristics. In other words, physical and structural attributes of the building such as materials, design configuration, and current conservation condition are considered the primary carriers of heritage values (Goranskaja & Nichiporovich, 2023).

*Impact Assessment of Interventions on Heritage Values*

EIA is recognized as a comprehensive evaluation tool and serves as the foundation for other Impact Assessment instruments (Morgan, 2012). It is considered an effective mechanism for providing a transparent process (Morrison-Saunders & Bailey, 2000,261) and a systematic and integrated evaluation method (Seyedashrafi et al., 2017) that promotes environmental awareness and conservation (Weston, 2010). Among impact receptors, cultural heritage is identified as a sensitive component in EIA guidelines, and its evaluation within the EIA framework has consistently been considered a challenging issue (ICOMOS, 2011). Therefore, heritage resources, particularly World Heritage (WH) sites, require specialized Impact Assessment methodologies to ensure that the unique characteristics of cultural heritage and its associated values are appropriately considered. In 2011, the International Council on Monuments and Sites (ICOMOS) developed the Heritage Impact Assessment (HIA) guideline within the framework of Environmental Impact Assessment (EIA) (ICOMOS, 2011). This guideline considers cultural heritage as an independent and distinct entity and separates it from environmental assessment processes. It also addresses specific aspects of World Heritage properties, including Outstanding Universal Value (OUV), authenticity, and integrity, which require special consideration in HIA procedures (ICOMOS, 2011). The Impact Assessment Process of heritage related Interventions, based on this guideline, is illustrated in (Fig. 2)

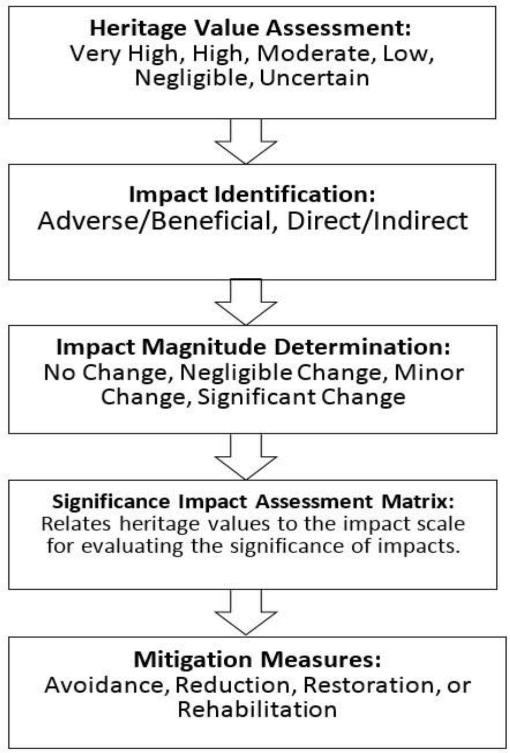


Figure 2: Heritage Impact Assessment Process. Source: (ICOMOS, 2011, p. 19)

Over the past five decades, with theoretical and practical advancements, numerous methodologies have been developed in the field of Environmental Impact Assessment (EIA). Among these, methods suitable for assessing impacts on Cultural World Heritage Properties include checklists, matrices, flowcharts and networks, mapping techniques, Geographic Information Systems (GIS), quantitative and statistical methods, and professional judgment (Ashrafi et al., 2021).

*Energy Efficiency Improvement Interventions in Historic Buildings*

A building is considered energy efficient when it provides greater services for the same energy input or delivers the same level of services with lower energy consumption (IEA, 2015). Strategies for improving Energy Efficiency in existing buildings are generally classified into four main categories: Passive Measures, Active Measures, Renewable Energy Utilization, and User Behaviour Management (Gadonneix et al., 2010 Huang et al., 2022. 13184; Taherian & Peters, 2023, Vasseur & Marique, 2019). Building envelope rehabilitation, including roofs, external walls, and windows, is considered part of Passive Measures. Active Measures mainly involve the replacement or modification of heating, ventilation, and air conditioning (HVAC) systems as well as lighting systems. Measures related to Renewable Energy primarily include solar photovoltaic systems and ground-source heat pump technologies (Huang et al., 2022). Passive Measures aim to minimize energy demand but cannot eliminate energy requirements throughout all seasons. Therefore, Active Measures are applied to generate and distribute the required energy to ensure occupant comfort (Konstantinou & Hoces, 2018). Since each of these strategies has specific advantages and limitations, none can completely replace the others. Consequently, an integrated approach combining multiple intervention types is necessary to maximize Energy Efficiency in buildings (Li et al., 2017,Luo, 2023 Taherian & Peters, 2023). In this context, Standard 34 of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), entitled "Energy Guideline for Historic Buildings," is recognized as one of the most important references in the field of Energy Efficiency in Historic Buildings (Gholami et al., 1400). This standard categorizes energy rehabilitation Interventions into four main groups: building envelope, energy and environmental control systems, heating cooling ventilation systems (HVAC), and lighting systems. Building envelope interventions include internal and external wall insulation, roof and floor insulation, cavity insulation, sealing of envelope joints and thermal bridges, moisture and water protection in foundations, roofs, and walls, improvement and sealing of doors and windows and their surrounding areas, and the application of shutters or adhesive films on glazing surfaces. Recommendations for Energy and Environmental Control Systems include the installation or upgrading of energy management and control systems and the selection of efficient energy sources capable of integration with Renewable Energy systems. In the category of heating, ventilation, and air conditioning (HVAC) systems, the use of Variable Refrigerant Flow (VRF) systems, optimization of existing systems, and seasonal adjustment of cooling and heating setpoints are proposed. Finally, in the lighting sector, the use of energy saving lamps, adjustable lighting intensity systems, occupancy sensors, and timer switches is recommended (ASHRAE Guideline 34, 2019).

*Structure Definition of the Assessment Process*

Analysis of the research background in the field of Energy Efficiency improvement in Historic Buildings indicates that frameworks based on the Environmental Impact Assessment (EIA) model are among the most appropriate tools for evaluating energy-related Interventions in such structures. The common structure of assessment methodologies based on this model consists of a three stage sequential process, including (1) baseline condition evaluation, (2) identification of changes, and (3) impact evaluation of changes relative to the baseline condition, as proposed by International Association for Impact Assessment (1999, p. 4). This approach provides a methodological foundation for developing the proposed Impact Assessment Process, enabling integrated and systematic analysis of Energy Consumption Optimization Interventions in interaction with Heritage Values. The development of the assessment framework is based on the principle that Historic Buildings represent integrated and dynamic systems that respond interactively to any modification of their components. Accordingly, implementation of energy-related Interventions without a system oriented perspective may lead to unintended consequences that can damage both the physical fabric and materials of the building, as well as negatively affect occupant health and comfort (Franco & Mauri, 2024). This interdisciplinary nature of interventions in Historic Buildings requires that such actions be implemented within a framework that simultaneously considers environmental, economic, social, and cultural dimensions (Webb, 2017). Therefore, in the present study, in addition to evaluating Energy Performance and Heritage Value Conservation, Thermal Comfort is analyzed as an indicator of indoor environmental quality, and $CO_2$ Emission Reduction is considered as a measure of environmental sustainability. Furthermore, assessment of intervention effectiveness requires the use of complementary economic criteria to evaluate cost benefit performance. This issue is particularly significant given the economic conditions influenced by high inflation rates in the country and the limited financial resources of responsible institutions such as the cultural heritage authority.

*Baseline Condition Assessment*

Considering the integrated evaluation of Interventions based on five criteria and in alignment with the primary structure of the proposed Impact Assessment Process, the first stage focuses on assessing the baseline condition of the building. In this stage, in addition to Energy Performance, the Heritage Values of the building, carbon emission level, energy consumption cost, and indoor thermal comfort are evaluated. The necessity of applying quantitative approaches in analyzing Heritage Values, to enable the integration of assessment results across multiple evaluation criteria in the final intervention decision-making process, led to the adoption of a structured assessment approach in this stage. This approach consists of three sequential steps: (1) criteria identification, (2) criteria explication, and (3) scoring (De la Torre, 2002). To identify the required evaluation criteria, the heritage value typology proposed by Zammit and Bianco (2022) was adopted. In this framework, Heritage Values are classified into four main categories, including physical formative values, socio cultural values, informational values, and economic functional values, along with their associated sub-values. This typology was selected because it comprehensively covers various dimensions of building heritage significance, including design and form, materiality (substance), use and function, traditions and techniques, site and context, spirit and feeling, and other internal and external factors related to heritage assets. Furthermore, this typology is consistent with the framework proposed by Lipe (1984,), which is considered one of the most comprehensive classifications in heritage studies. In that framework, heritage values are organized into four groups: aesthetic, associative/symbolic, economic, and informational values.

*Change Identification*

Within the framework of the present study, necessary changes namely Energy Efficiency Improvement Measures were classified into three levels: Main Strategies, Systems, and Actions, to enable staged analysis and implementation (Flores, 2013). This structure provides users with a comprehensive list of Energy Consumption Optimization Interventions, allowing the selection of appropriate measures based on the specific characteristics of each Historic Building. Based on systematic analysis of previous studies and with the aim of covering the full spectrum of Interventions, five strategy groups were initially considered at the strategic level, including Passive Measures, Active Measures, Renewable Energy Generation, Energy Management and Control Systems, and User Behaviour Management. Considering technical, economic, and implementation limitations associated with the deployment of energy management and control systems in Iran (Khosravani, 2024), this category of interventions was excluded from the grouping to focus on feasible and practical solutions applicable to Historic Buildings. Finally, by aligning the defined grouping with system components and intervention measures extracted from the research literature, and considering the necessity of utilizing executable and accessible measures under existing national conditions, a structured framework for Energy Efficiency Improvement Interventions was developed within the proposed Impact Assessment Process.

*Impact Evaluation of Changes Compared to Baseline Condition*

In this stage, the impacts of identified Interventions on Historic Buildings are evaluated based on five assessment criteria. Considering the priority of Heritage Conservation over other criteria in the field of Energy Efficiency improvement in Historic Buildings (Historic England, 2024), the impact of each intervention on Heritage Values is first assessed. At this stage, the methodology of the EFFESUS research project was adopted, which is considered one of the most comprehensive approaches for Heritage Impact Assessment of interventions. This methodology employs a scoring system to determine the impact of measures on Heritage Values based on three dimensions: physical, visual, and spatial characteristics. In the next step, the results of heritage significance evaluation are combined with the results of Heritage Impact Assessment of Interventions, and measures that are in serious conflict with conservation principles are eliminated. The necessity of defining this stage arises from the principle that if an intervention is clearly unacceptable from a heritage conservation perspective, further complex Energy Consumption Optimization analyses are unnecessary, since such an intervention should not be implemented even if it offers high energy efficiency performance (International Energy Agency Energy in Buildings and Communities Program, 2021). Subsequently, the remaining interventions are evaluated based on four criteria: Energy Performance, Thermal Comfort, $CO_2$ Emission Reduction, and economic efficiency. Finally, the assessment results obtained at each stage are integrated to enable prioritization of Interventions. The proposed Impact Assessment Process is illustrated in (Fig. 3)(Fig. 4)(Fig. 5) Therefore, the final structural model consists of the implementation of the following steps

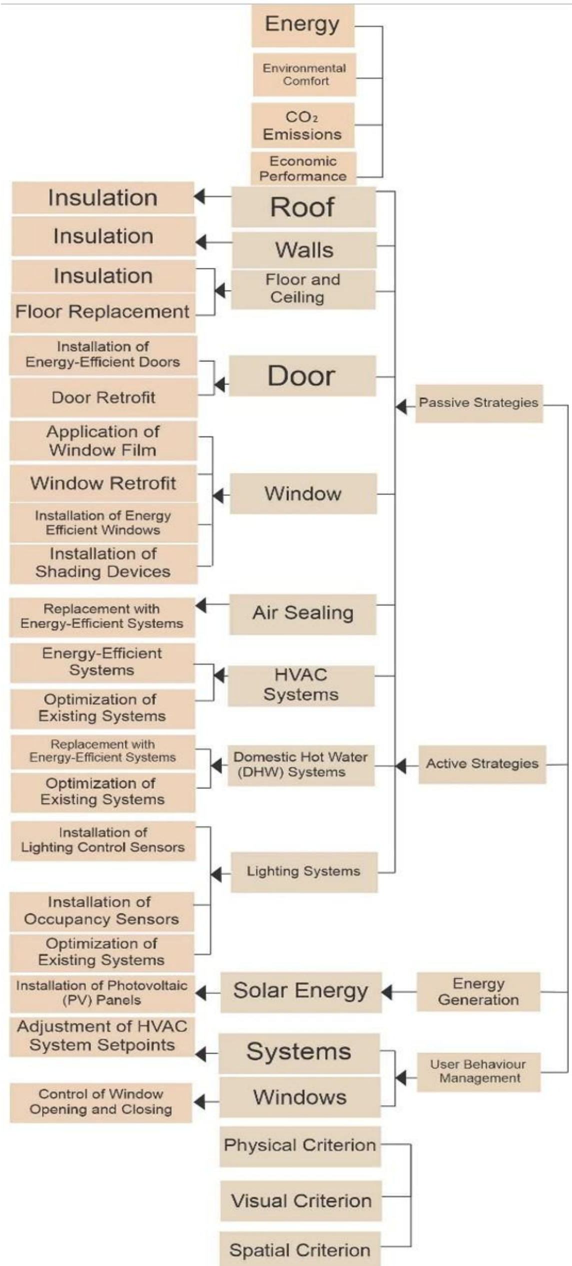


Figure 3: Part c: Structural Model

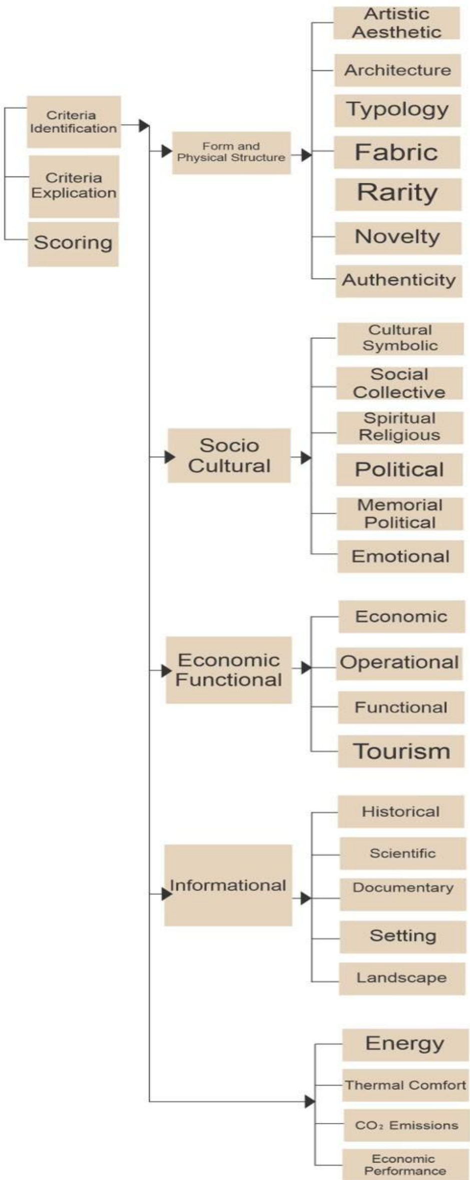


Figure 4: Part B: Structural Model

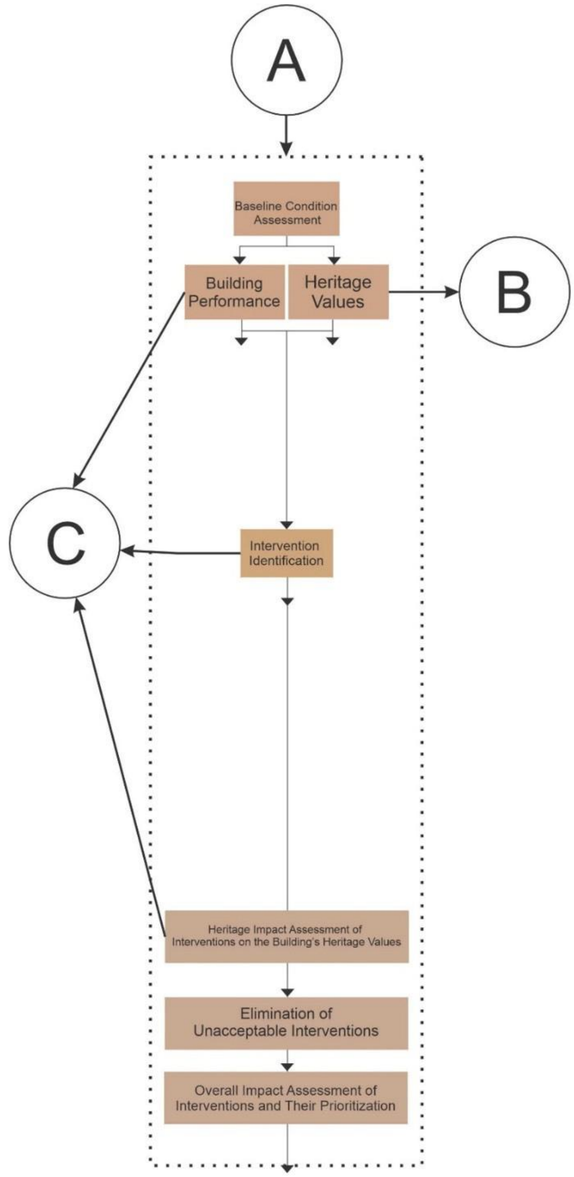


Figure 5: Final Research Model

## INTRODUCTION

The interdisciplinary nature of restoration interventions in Historic Buildings requires that conservation measures be developed based on the simultaneous consideration of environmental, economic, social, and cultural dimensions. Therefore, in the case of Energy Consumption Optimization Interventions in Historic Buildings, achieving an optimal balance among factors influencing strategy selection is critically important through the establishment of a transparent, systematic, and integrated Assessment Framework. This necessity is particularly prominent in Iran, where many restoration and conservation activities are implemented without standardized methodological frameworks and are often influenced by individual professional judgment. Under such conditions, the development of a comprehensive Impact Assessment Process can serve as a roadmap for researchers and policymakers while helping prevent potential damage to Heritage Values. In explicating the proposed process of this study, the primary structure is based on the Environmental Impact Assessment (EIA) model and consists of three stages: Baseline Condition Assessment, Identification of Energy Efficiency Interventions, and Impact Evaluation of Interventions Relative to Baseline Conditions. Considering the importance of simultaneous analysis of factors influencing intervention selection, five criteria including Energy Performance, Heritage Conservation, $CO_2$ Emission Reduction, Thermal Comfort, and economic performance were evaluated during the baseline assessment of the historic building. In the assessment of Heritage Values, a structured scoring system was employed, in which the heritage significance of the building was determined based on predefined evaluation criteria. In the assessment of Heritage Values, a structured scoring system was employed, in which the heritage significance of the building was determined based on predefined evaluation criteria. The identification of Energy Efficiency Improvement Interventions in the proposed framework was conducted using a three-level hierarchical structure consisting of Strategies, Systems, and Actions. In the final stage, namely Impact Evaluation, and considering the priority of Heritage Value Conservation over other criteria, the heritage impact of interventions was assessed using a scoring system based on physical, visual, and spatial characteristics. Interventions that caused unacceptable adverse effects on Heritage Values were eliminated from further consideration. Subsequently, by evaluating the remaining components and integrating multi-criteria results, intervention prioritization was performed. The proposed Assessment Framework provides an integrated and systematic structure that enables simultaneous evaluation of energy performance, heritage conservation, and other sustainable development indicators. The proposed Assessment Framework provides an integrated and systematic structure that enables simultaneous evaluation of energy performance, heritage conservation, and other sustainable development indicators. This approach enhances transparency in the evaluation procedure at each stage and facilitates quantitative assessment, allowing comparison of alternative interventions based on multiple criteria. Such a framework reduces limitations associated with complex and time-consuming expert assessments and mitigates challenges arising from interdisciplinary coordination, thereby supporting more efficient decision-making in the selection of Energy Consumption Optimization Interventions.

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