



# Conservation And Reuse Of Historic Electrical And Plumbing Systems In Kollapur Palace

K V Shanmukhi Ramya Sri<sup>1</sup>, Ar.Narasimman R<sup>2</sup>

<sup>1</sup>Postgraduate Scholar, <sup>2</sup>Assistant Professor

Department of Architecture, School of Planning and Architecture Vijayawada Andhra Pradesh, India,

**Abstract:** Historic buildings often undergo adaptive reuse, requiring the integration of modern building services such as electrical wiring and plumbing networks. However, conservation research has primarily focused on architectural fabric while neglecting the technical infrastructure embedded within heritage structures. This study examines strategies for the conservation and adaptive reuse of historic electrical and plumbing systems in heritage buildings through a systematic literature review using the PRISMA screening method. Twenty research papers were identified, including ten Western and ten Indian studies. After applying inclusion criteria related to heritage conservation, adaptive reuse, and building services integration, the literature was analysed thematically. The review reveals that Western research largely focuses on energy retrofitting and environmental performance, while Indian studies emphasise broader heritage conservation frameworks. Despite these contributions, limited research specifically addresses the conservation of historic electrical and plumbing infrastructure. The study identifies this gap and proposes future research directions focused on documentation, reversible interventions, and conservation-compatible service integration in heritage palace architecture such as Kollapur Palace.

**Index Terms -:** Adaptive reuse; Electrical systems; Historic infrastructure; Plumbing systems; Retrofitting

## 1.INTRODUCTION

Historic buildings represent important cultural, architectural, and technological records of the periods in which they were constructed. Conservation research has traditionally focused on aspects such as structural integrity, architectural design, and the preservation of historic materials and decorative elements. However, functional systems within buildings, particularly electrical wiring networks and plumbing infrastructure, also form an integral part of the historical evolution of these structures. These service systems reflect the technological advancements of their time and demonstrate how historic buildings adapted to changing social needs and modernization processes. In recent decades, adaptive reuse has emerged as an important strategy in heritage conservation, enabling historic buildings to remain functional and relevant in contemporary contexts. As these structures are repurposed for modern use, the need to upgrade electrical and plumbing systems to comply with present-day safety standards, operational requirements, and environmental considerations has become increasingly significant. However, interventions related to building services often require alterations within walls, floors, and ceilings, which may lead to the removal or damage of historic fabric if not carefully designed and executed. This creates a complex challenge for conservation professionals, who must balance the need for safety and functionality with the preservation of authenticity and heritage value. Palace complexes such as Kollapur Palace represent important examples of architectural and technological transition within the former Hyderabad State. Located in the present-day Nagar Kurnool district of Telangana, Kollapur was historically the seat of the Surabhi Dynasty, a princely estate under the Nizams. The palace complex reflects a blend of late nineteenth- and early twentieth-century architectural influences, combining Indo-European stylistic elements with local Deccan construction traditions. The introduction of modern infrastructure in the region coincided with broader modernisation efforts initiated during the reign of Mir Osman Ali Khan, when electricity began to be introduced in parts of the Hyderabad State in the early twentieth century, particularly after the establishment of power

generation facilities in Hyderabad city around the 1910s–1920s. As a progressive princely estate closely associated with the administrative networks of the Nizam's dominion, the Kollapur Samsthanam was among the early regional centres to adopt modern utilities such as electrical lighting and improved plumbing systems within palace architecture. These early service installations represent an important phase of technological adaptation within traditional palace environments. Studying how such historic electrical and plumbing systems were incorporated, and how they can be conserved and reused today without compromising the authenticity of the historic fabric, therefore forms a significant aspect of heritage conservation research



Figure 1 Kollapur Chandra mahal palace



Figure 2 Kollapur Rani mahal palace



Figure 3 Broken Plumbing pipe



Figure 4 Old electrical wooden lines



Figure 5 Old plumbing connection



Figure 6 Old electrical switch board

Table 1: Objectives for this research

Objective	Description
<b>Objective 1</b>	To analyse existing research on building service integration in heritage conservation and adaptive reuse projects both Indian and international
<b>Objective 2</b>	To identify research gaps and strategies for conserving historic electrical and plumbing systems in palace architecture such as Kollapur Palace.

To address this issue, the present study adopts a systematic literature review approach following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework. The PRISMA method provides a structured and transparent approach to identifying, screening, assessing eligibility, and final inclusion, thereby ensuring rigour and reproducibility in the review process. The four-stage PRISMA process applied in this study is described in detail below.

### **Stage 1: Identification**

An extensive literature search was conducted using five major academic databases, namely Google Scholar, ScienceDirect, SpringerLink, Emerald Insight, and SAGE Journals. A total of approximately 2,000 research papers were initially identified using the following keyword combinations: “heritage conservation,” “adaptive reuse of historic buildings,” “energy retrofit historic buildings,” “building services in heritage buildings,” “electrical systems in historic buildings,” and “plumbing systems in heritage architecture.” These searches were conducted across multiple iterations to ensure comprehensive coverage of both Western and Indian scholarship in architectural conservation, building technology, and heritage management. The distribution of records across databases is illustrated in Figure 7.

### **Stage 2: Screening**

After removing duplicate records and irrelevant titles, approximately 300 papers were shortlisted based on title and abstract screening. The following inclusion and exclusion criteria were applied systematically during this stage. Studies were included based on four principal criteria: first, research that focused specifically on heritage or historic buildings; second, studies addressing adaptive reuse or conservation strategies; third, papers discussing building services such as HVAC, electrical systems, plumbing systems, or environmental control; and fourth, peer-reviewed journal articles published between 2010 and 2025 in the English language. Conversely, the following categories of studies were excluded from the review: research focused exclusively on modern or contemporary buildings without conservation relevance; purely structural engineering studies that lacked a conservation context; papers that did not address building services or adaptive reuse; conference abstracts for which full-text versions were unavailable; and duplicate studies identified across multiple databases. The application of these criteria reduced the pool to approximately 100 papers that were retained for further review.

### **Stage 3: Eligibility**

Following detailed full-text review, approximately 50 papers were assessed for their relevance to building service integration, retrofit strategies, and conservation approaches. At this stage, each paper was evaluated not only for topic alignment but also for methodological quality, clarity of findings, and direct relevance to the conservation or adaptive reuse of building services within heritage contexts. This rigorous assessment resulted in approximately 30 papers meeting the eligibility criteria for final consideration.

Table 2: Shows out of 30 papers which are excluded and included.

No	Author / Paper	Decision
1	Tejani (2021)	Included
2	Allaie & Dhiman (2025)	Included
3	Berwal & Yadav (2021)	Included
4	Singh et al. (2025)	Included
5	Vijayalaxmi (2023)	Included
6	Nayak (2025)	Included
7	INTACH Journal (2023)	Included
8	Sriram et al. (2019)	Included
9	Tripathi & Misra (2018)	Included
10	Ravindran (2016)	Included
11	Webb (2017)	Included
12	Mazzarella (2015)	Included
13	Ascione et al. (2015)	Included
14	Bertolin & Loli (2018)	Included
15	Franco & Magrini (2017)	Included
16	Fabbri & Gaspari (2018)	Included
17	Lucchi (2018)	Included
18	Bullen & Love (2011)	Included
19	Ni (2023)	Included
20	Ni et al. (2024)	Included
21	Energy Systems in Smart Buildings – Chen (2019)	Excluded
22	Modern HVAC Efficiency – Brown (2020)	Excluded
23	Urban Energy Infrastructure – Lopez (2018)	Excluded
24	Sustainable Building Technology – Kumar (2021)	Excluded
25	Contemporary Plumbing Design – Smith (2017)	Excluded
26	Smart Building Automation – Garcia (2022)	Excluded
27	Energy Management Systems – Patel (2020)	Excluded
28	High-Rise Building Services – Wang (2019)	Excluded
29	Green Building Mechanical Systems – Taylor (2018)	Excluded
30	Digital Infrastructure in Modern Architecture – Ahmed (2021)	Excluded

#### Stage 4: Final Inclusion

After applying all criteria, 20 research papers were selected for detailed analysis. These comprised 10 Western studies and 10 Indian studies, as illustrated in Figure 8. The selected papers were further analysed using thematic categorisation across five key themes: adaptive reuse and conservation (n=6), energy retrofit and performance (n=5), building services integration (n=4), digital monitoring and documentation (n=3), and heritage policy and management (n=2). These papers were categorized into two regional groups in order to understand differences in research approaches, frameworks, and conservation priorities between international and Indian scholarship. The complete PRISMA flow diagram is presented in Figure 6, and the screening funnel showing papers retained versus excluded at each stage is shown in Figure 9.

Table 3: Papers selected which are from India

S.No	Title of Paper	Discipline of Author	Year	Journal	Abstract (Short Summary)	Keywords	Discussion	Research Gap Identified
11	HVAC Integration in Historic Buildings in India	Mechanical Engineering / Conservation	2021	ScienceDirect (Elsevier)	Investigates methods for integrating HVAC systems into historic buildings while minimizing damage to historic fabric.	HVAC retrofit, heritage conservation	Shows challenges of installing climate control in heritage buildings.	Does not address electrical or plumbing systems.
12	Retrofitting Strategies for Historic Buildings	Civil Engineering	2025	ScienceDirect (Elsevier)	Analyses retrofit methods for improving energy efficiency in heritage structures in developing countries.	Retrofit strategies, sustainability	Demonstrates sustainable upgrades for historic buildings.	Focuses mainly on energy systems rather than services.
13	Energy Conservation Retrofit Strategies	Building Engineering	2021	ScienceDirect (Elsevier)	Discusses energy conservation measures for improving efficiency of historic buildings.	Energy conservation, retrofit	Highlights sustainability potential of heritage buildings.	Lack of focus on electrical infrastructure conservation.
14	Deterioration and Conservation of Heritage Structures	Structural Engineering	2025	ScienceDirect (Elsevier)	Studies structural deterioration and conservation methods in historic buildings.	structural conservation, deterioration	Focuses on structural repair techniques.	Neglects building service systems.
15	Heritage Conservation Frameworks in India	Heritage Studies	2023		Examines conservation policies and planning frameworks for heritage buildings in India.	heritage policy, conservation planning	Highlights institutional approaches to heritage protection.	Does not address technical infrastructure.
16	Technology Upgrades in Heritage Buildings	Architecture / Technology	2025	INTACH Official Publications	Investigates modernization of historic buildings using new technologies.	technology integration, heritage buildings	Discusses modernization challenges in conservation.	Limited discussion of historic service networks.
17	Heritage Conservation Research (INTACH Journal)	Heritage Conservation	2023		Provides research insights into documentation and preservation of heritage structures in India.	heritage documentation	Emphasizes documentation of architecture and materials.	Building services rarely documented.
18	Energy Efficiency in Indian Heritage Buildings	Architecture / Sustainability	2019	SpringerLink	Evaluates energy efficiency improvements in historic buildings through retrofit strategies.	energy efficiency, heritage buildings	Shows sustainable performance improvement approaches.	Does not analyse historic service infrastructure.
19	Adaptive Reuse of Colonial Buildings	Architecture / Urban Studies	2018	Emerald Insight	Discusses reuse of colonial structures in India and associated conservation challenges.	adaptive reuse, colonial architecture	Highlights functional transformation of historic buildings.	Limited research on infrastructure upgrades.
20	Conservation Approaches in Indian Architecture	Architecture / Heritage Studies	2016	Taylor & Francis Online	Reviews conservation philosophies and practices used in Indian historic architecture.	conservation philosophy, heritage architecture	Provides theoretical framework for conservation practice.	Lack of technical analysis of building services.

Table 4: Papers selected which are from Foreign countries

S.No	Title of Paper	Discipline of Author	Year	Journal	Abstract (Short Summary)	Keywords	Discussion	Research Gap Identified
1	Energy Retrofits in Historic and Traditional Buildings: A Review of Problems and Methods	Architectural Engineering	2017	ScienceDirect (Elsevier)	The paper reviews challenges involved in improving energy efficiency in historic buildings while preserving heritage values. It discusses criteria for evaluating retrofit strategies and decision-making methods for balancing conservation with performance improvements.	Energy retrofit, heritage buildings, sustainability	Demonstrates the complexity of upgrading historic buildings due to preservation constraints and performance needs.	Limited focus on technical service systems such as electrical or plumbing infrastructure. (EconPapers)
2	Energy Retrofit of Historic and Existing Buildings	Building Physics	2015	ScienceDirect (Elsevier)	Examines regulatory and technical frameworks guiding energy retrofit interventions in historic structures. The paper highlights legislative constraints and conservation considerations.	Energy retrofit, policy, heritage conservation	Shows importance of policy and regulatory frameworks in retrofit strategies.	Does not examine building service infrastructure in detail. (Taylor & Francis Online)
3	Energy Refurbishment of Historic Buildings	Mechanical Engineering	2015	ScienceDirect (Elsevier)	Evaluates refurbishment methods to improve energy performance of historic buildings using simulation models and case studies.	Energy refurbishment, sustainability	Demonstrates technological solutions for energy improvements.	Focuses mainly on thermal systems rather than electrical networks.
4	Renewable Energy Technologies in Heritage Buildings	Environmental Engineering	2018	MDPI Journals	Examines integration of renewable technologies such as solar systems in heritage buildings while maintaining historical authenticity.	Renewable energy, heritage buildings	Highlights challenges in integrating modern technologies with heritage conservation.	Limited discussion of historic service systems.
5	Historic Buildings and Energy Performance	Architecture and Sustainability	2017	ScienceDirect (Elsevier)	Investigates strategies for improving environmental performance in historic buildings through energy analysis.	Energy performance, heritage buildings	Identifies balance between conservation and sustainability.	Lack of focus on historic electrical and plumbing systems.
6	Energy Efficiency and Thermal Comfort in Historic Buildings	Building Science	2016	ScienceDirect (Elsevier)	Reviews methods used to achieve energy efficiency and thermal comfort in heritage structures across different building types.	Thermal comfort, energy efficiency	Demonstrates retrofit approaches and environmental control techniques.	Does not address service infrastructure conservation. (ScienceDirect)
7	Energy Efficiency in Historic Buildings	Architecture and Sustainability	2018	ScienceDirect (Elsevier)	Discusses sustainable development approaches for maintaining historic buildings while improving performance.	Sustainability, heritage conservation	Highlights importance of conservation-compatible retrofit strategies.	Limited focus on technical systems documentation. (Structureae)
8	Adaptive Reuse of Heritage Buildings	Architecture and Urban Planning	2011	MDPI Journals	Examines adaptive reuse as a strategy for conserving historic buildings and extending their lifecycle.	Adaptive reuse, heritage conservation	Shows reuse as an economically sustainable approach.	Limited analysis of infrastructure systems during reuse.
9	Digital Monitoring Systems for Heritage Buildings	Civil Engineering and Digital Heritage	2023	Emerald Insight	Explores digital monitoring technologies such as sensors for tracking building performance and deterioration.	Monitoring systems, digital heritage	Demonstrates the potential of smart technologies in heritage management.	Does not analyze historic service infrastructure.
10	Digital Twin Technologies for Historic Buildings	Digital Engineering / Heritage Science	2024	ScienceDirect (Elsevier)	Introduces digital twin models for predictive maintenance and performance monitoring of historic structures.	Digital twin, smart monitoring	Provides advanced technological tools for conservation management.	Focuses on monitoring rather than service system conservation.

## PRISMA Flow Diagram - Systematic Literature Review

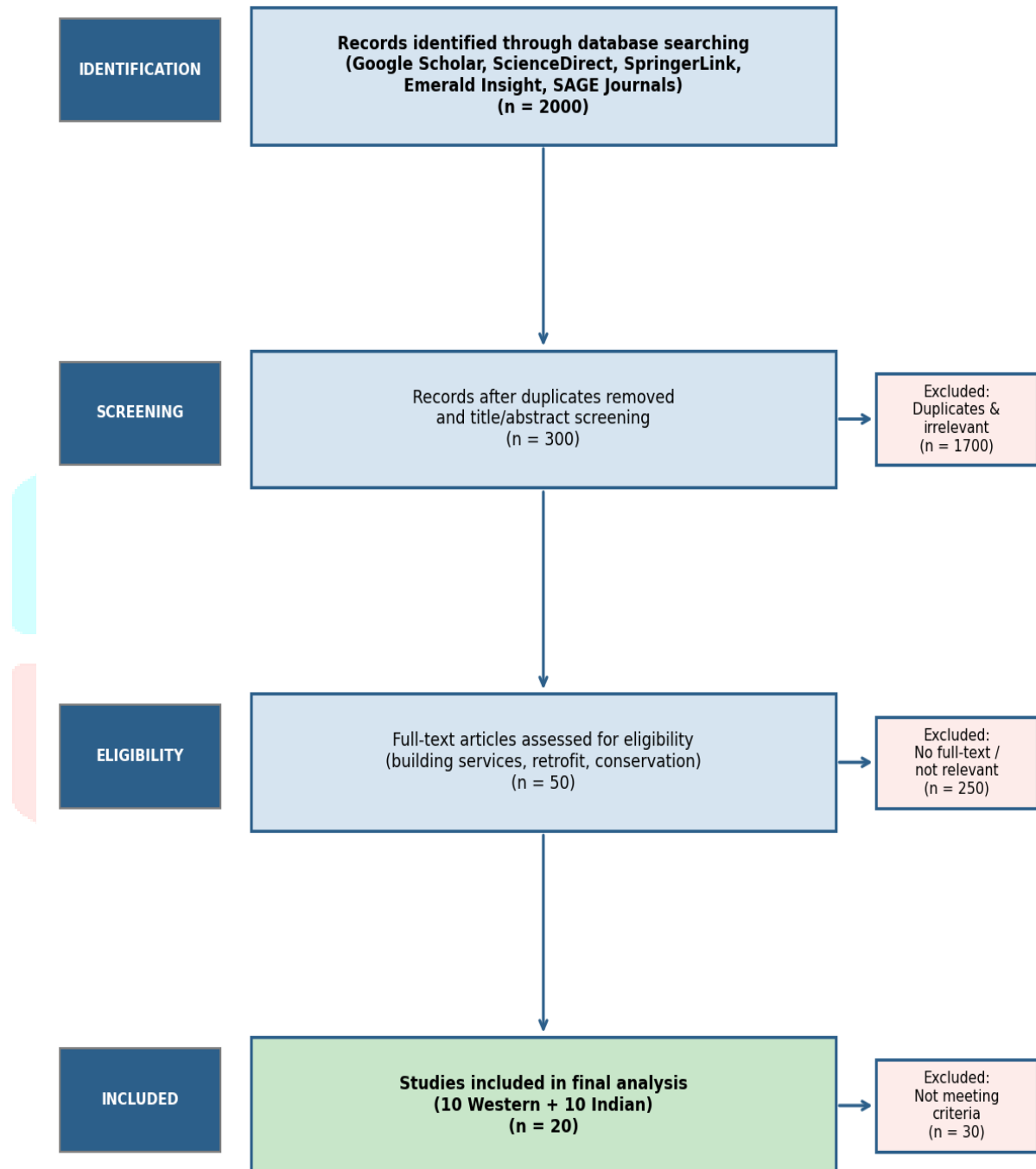


Figure 7. PRISMA Flow Diagram — Systematic Literature Review

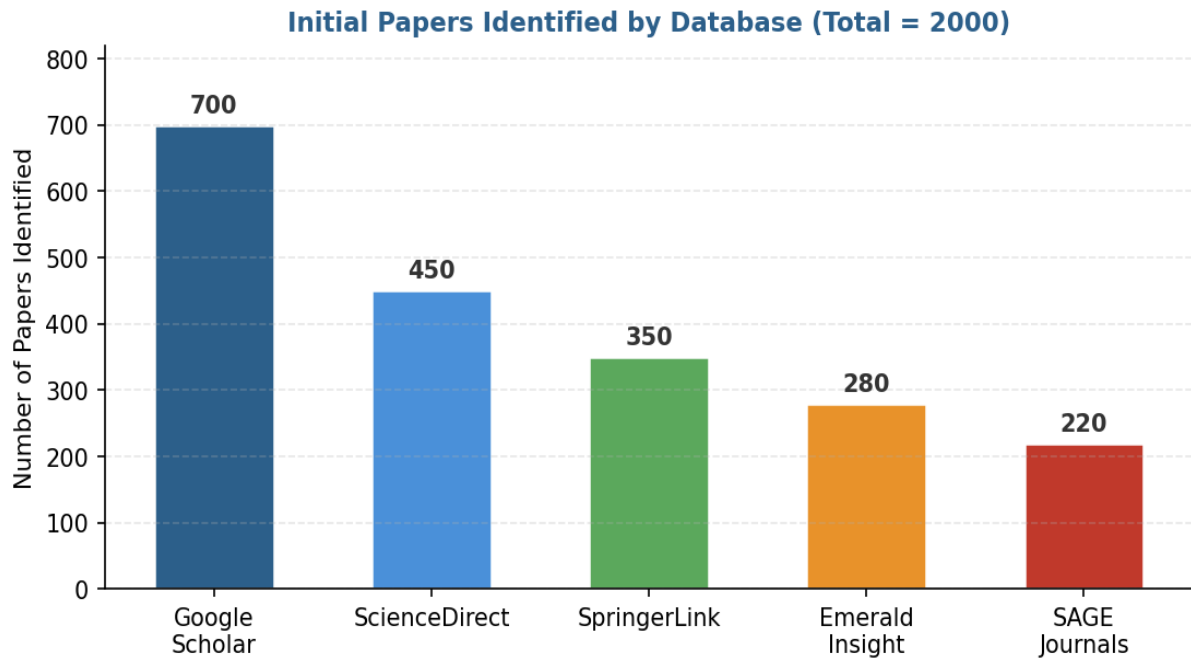


Figure 8. Records Identified per Academic Database (Total n ≈ 2,000)

### Final 20 Included Studies by Region

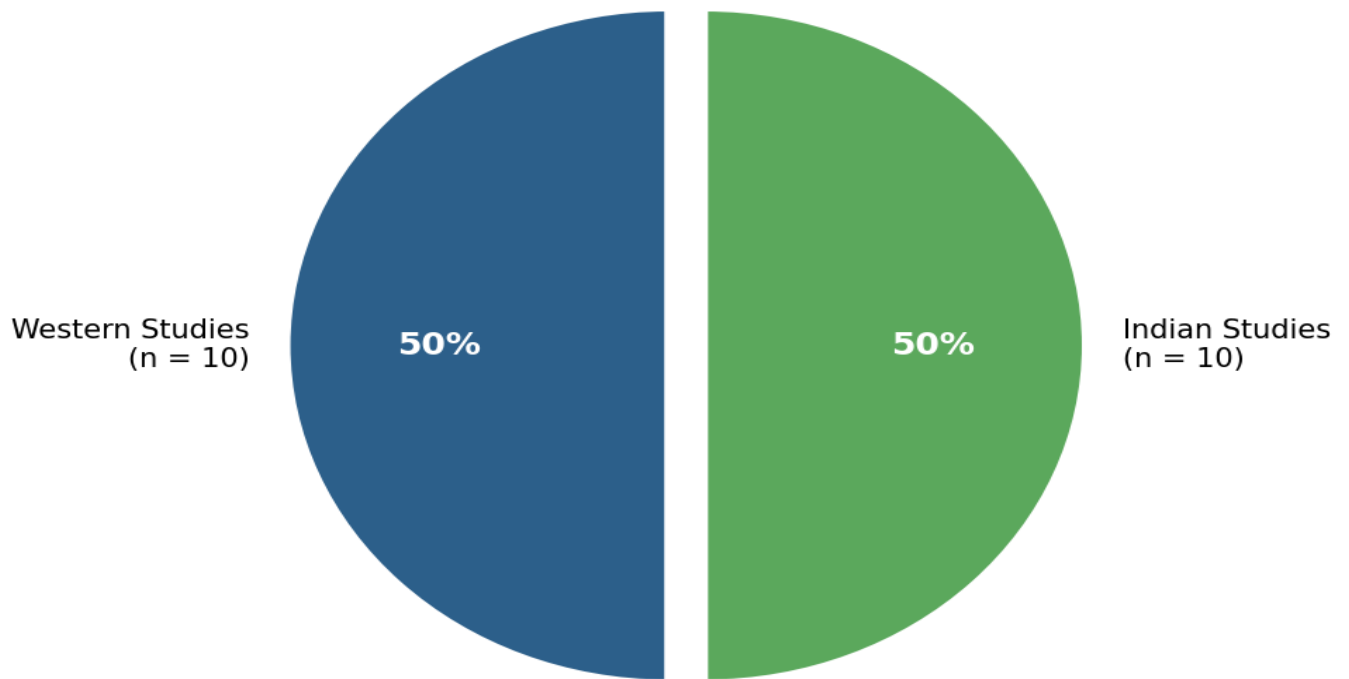


Figure 9. Final 20 Papers: Western vs Indian Studies and Thematic Distribution

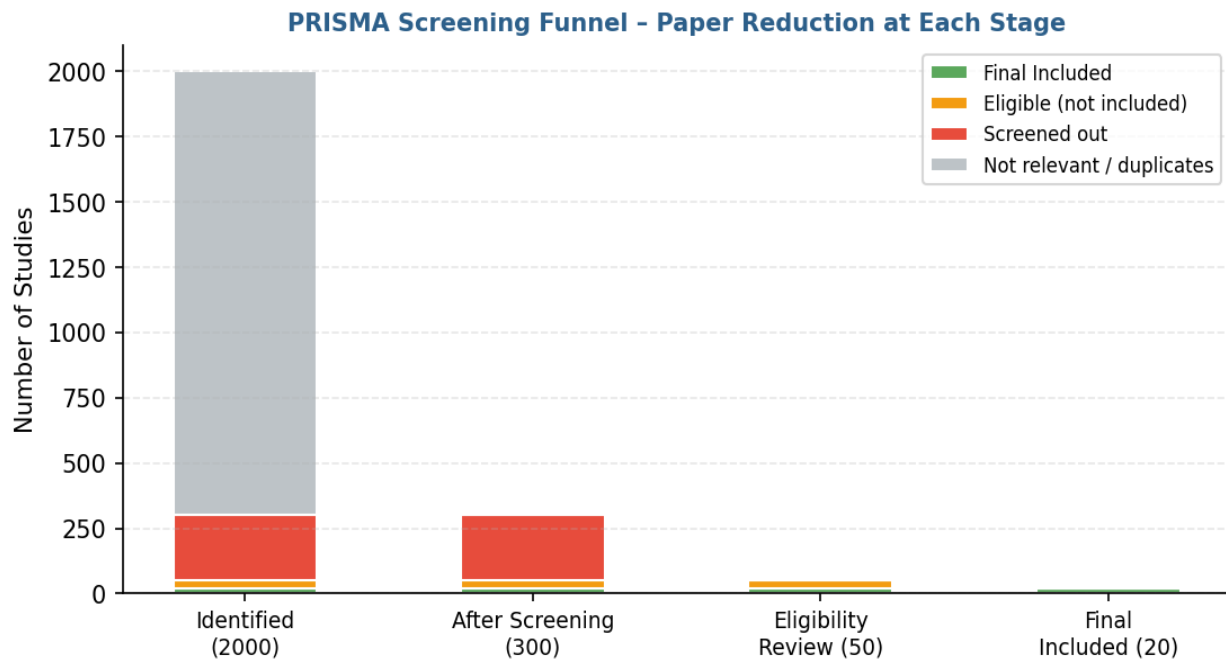


Figure 10. PRISMA Screening Funnel — Papers Retained vs Excluded at Each Stage  
**Venn Diagram — Inclusion Criteria for 20 Final Selected Papers**

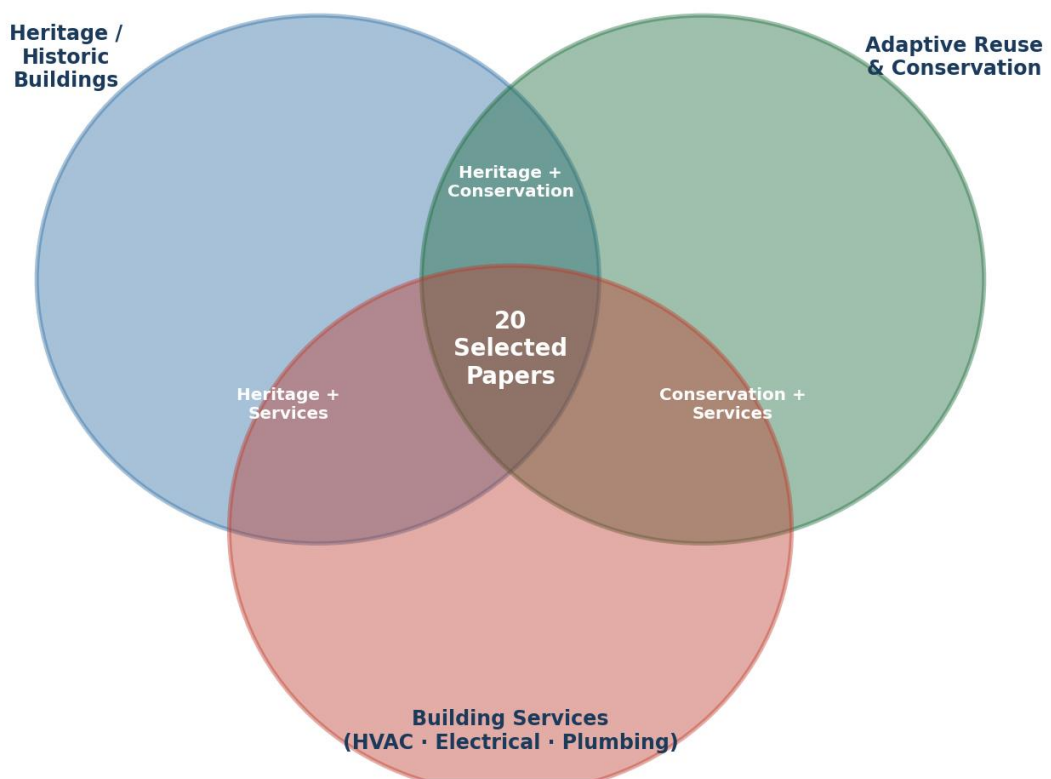


Figure 11. Venn Diagram — Overlap of Inclusion Criteria for Final 20 Selected Papers

## 2.Literature Review and Discussion

Recent scholarship in architectural conservation has increasingly addressed the challenges of integrating modern building services within historic structures, particularly in the context of adaptive reuse and sustainability. Several Western studies focus on the intersection of energy efficiency, technological upgrades, and heritage conservation. For instance, research by Paola Mazzarella (2015) highlights the complexity of improving energy performance in historic buildings while preserving architectural authenticity. Similarly, Renato Ascione et al. (2015) propose integrated retrofit frameworks that attempt to balance conservation values with environmental performance requirements. Studies such as those by Alessandra Bertolin (2018) and Gianfranco Fabbri (2018) further emphasize the role of sustainable technologies and environmental monitoring systems in improving the performance of heritage buildings. These works collectively demonstrate that technological interventions, including electrical and

environmental control systems, can be introduced through reversible and minimally invasive methods when guided by conservation principles.

Another group of Western studies examines adaptive reuse as a key strategy for maintaining the functional relevance of historic buildings. Research by Peter Bullen and Peter Love (2011) discusses how adaptive reuse projects often require extensive upgrades to building services in order to meet contemporary building codes and user requirements. Similarly, Andrea Lucchi (2018) explores the integration of energy efficiency measures within historic buildings while maintaining the integrity of heritage values. More recent technological approaches are highlighted in studies by Zhen Ni (2023; 2024), which discuss the use of digital monitoring systems and smart technologies for assessing building performance and managing conservation interventions. These studies collectively suggest that technological integration in heritage buildings is increasingly supported by digital documentation and monitoring tools that allow conservation professionals to assess the impact of service upgrades with greater precision. In the Indian context, research has largely focused on conservation policies, heritage management practices, and adaptive reuse of historic buildings. Studies by Ravindran K. (2016) and Ritu Tripathi (2018) examine how adaptive reuse has been applied to colonial and historic buildings in India as a strategy for extending their functional life. Research by A. Sriram (2019) and Neha Berwal (2021) explores energy efficiency improvements in buildings while acknowledging the constraints posed by heritage regulations. Other studies, such as those by M. Vijayalaxmi (2023) and Rakesh Nayak (2025), highlight the importance of heritage management frameworks and technological upgrades in historic structures. In addition, conservation guidelines developed by INTACH emphasize the need for minimal intervention and reversibility when integrating modern services within heritage buildings.

Although both Western and Indian studies address the broader themes of adaptive reuse, sustainability, and technological integration, the literature reveals a notable imbalance in the depth of research related specifically to historic electrical and plumbing systems. Western studies tend to focus on environmental performance, digital monitoring, and energy retrofit technologies, often treating building services as components of overall building performance systems. Indian research, on the other hand, places greater emphasis on conservation policies, heritage documentation, and adaptive reuse practices rather than detailed analysis of building service infrastructure. As a result, the conservation of historic electrical wiring networks, plumbing layouts, and early service technologies embedded within heritage buildings remains relatively underexplored in both contexts. This gap becomes particularly significant in palace complexes such as Kollapur Palace, where early twentieth-century modernisation introduced electrical lighting and plumbing infrastructure as part of a broader technological transformation. Understanding these systems as historical artefacts in their own right, rather than merely functional components, is therefore essential for developing more comprehensive conservation strategies for heritage buildings.

### **3. Research Gap**

The review of existing literature indicates that considerable research has been undertaken on adaptive reuse, sustainability, and technological integration in heritage buildings. Western scholarship largely concentrates on improving environmental performance, energy efficiency, and digital monitoring of historic structures, while Indian studies focus more on conservation frameworks, heritage policies, and reuse strategies within historic contexts. Although these studies provide important insights into the broader challenges of upgrading historic buildings, they rarely address the conservation of historic building service systems themselves as components of heritage value. Electrical wiring networks, lighting fixtures, water supply lines, drainage layouts, and other service infrastructures are generally treated as elements that must be replaced or modernised rather than documented and conserved as part of the building's technological history. This limitation reveals a significant research gap in the field of architectural conservation. Historic electrical and plumbing systems represent evidence of technological transition and modernisation within traditional architectural environments. In many heritage buildings, particularly those constructed or modified during the late nineteenth and early twentieth centuries, these systems reflect early experiments in integrating modern utilities within historic fabric. However, the conservation discourse has not sufficiently developed methodologies for identifying, documenting, assessing, and selectively conserving these service infrastructures while ensuring compliance with modern safety standards. As a result, many early service systems are removed during restoration or adaptive reuse projects without being studied or recorded as part of the building's technological heritage.

### **4. Contribution to the field of Architectural Conservation**

The present study addresses this gap by proposing a research perspective that treats historic electrical and plumbing systems not merely as functional utilities but as integral components of the technological and cultural evolution of heritage buildings. Through a systematic literature review using the PRISMA

screening method, the study synthesises international and Indian research to identify existing approaches to service integration, retrofitting, and conservation. The innovation of this research lies in shifting the focus from purely performance-oriented retrofitting toward a conservation-oriented framework that recognises historic service systems as valuable historical evidence. By doing so, the study contributes to expanding the scope of architectural conservation to include the documentation and adaptive reuse of technological infrastructure embedded within heritage architecture.

### **5.Way Forward**

The findings of this literature review indicate the need for a more focused research approach toward documenting and conserving historic building service systems within heritage structures. Future studies should emphasise the systematic documentation of existing electrical and plumbing networks in historic buildings, treating them as part of the technological evolution of architecture rather than merely functional utilities. Developing conservation guidelines that address the retention, repair, and reversible upgrading of these systems can help ensure that modernization does not result in the loss of valuable historical evidence. In addition, interdisciplinary collaboration between conservation architects, engineers, and heritage managers will be essential in creating adaptive reuse strategies that maintain both the operational efficiency and historical authenticity of heritage buildings. Such an approach can contribute to more holistic conservation practices and provide a practical framework for managing historic service infrastructure in sites such as Kollapur Palace and other heritage complexes undergoing functional transformation.

### **6.Conclusion**

This study examined the conservation and adaptive reuse of historic electrical and plumbing systems in heritage buildings. The research highlighted that service systems are an essential part of heritage structures, representing technological history and engineering practices of their time. However, they are often neglected or completely replaced during restoration projects without proper assessment.

Through literature review and case study analysis, the study identified common issues such as deteriorated wiring, corroded plumbing lines, insufficient load capacity, and safety risks. At the same time, it was observed that many historic service elements can be retained or sensitively upgraded if proper documentation, technical evaluation, and planning are carried out. The findings emphasize that conservation decisions should balance safety requirements with heritage value rather than focusing only on performance.

The research also underlined the importance of reversible interventions, material compatibility, and interdisciplinary collaboration between architects and service engineers. By integrating modern systems carefully within existing structures, heritage buildings can continue to function effectively without losing their authenticity.

Overall, the study concludes that conserving historic electrical and plumbing systems contributes not only to sustainable development by reducing material waste but also to preserving technological heritage. A structured conservation framework is necessary to guide future adaptive reuse projects and ensure that building services are treated as an integral part of heritage conservation practice. It will be shown in the case of Kollapur Palace with suggestions.

### **References:**

- I. Ascione, F., De Masi, R. F., de Rossi, F., & Vanoli, G. P. (2015). Energy refurbishment of historic buildings: A multi-criteria approach for energy efficiency improvement. *Energy and Buildings*.
- II. Berwal, N., & Yadav, R. (2021). Energy conservation retrofit strategies for heritage buildings in India. *Journal of Sustainable Architecture and Civil Engineering*.
- III. Bertolin, C., & Loli, A. (2018). Renewable technologies and sustainability in heritage buildings. *Journal of Cultural Heritage*.
- IV. Bullen, P. A., & Love, P. E. D. (2011). Adaptive reuse of heritage buildings. *Structural Survey*.
- V. Fabbri, K., & Gaspari, J. (2018). Thermal comfort evaluation in historic buildings. *Energy and Buildings*.
- VI. Franco, G., & Magrini, A. (2017). Historic buildings and energy performance: A review of retrofit approaches. *Energy Procedia*.
- VII. Lucchi, E. (2018). Energy efficiency and sustainability in heritage buildings. *Sustainable Cities and Society*.
- VIII. Mazzarella, L. (2015). Energy retrofit of historic and existing buildings: The legislative and technical challenges. *Energy and Buildings*.

- IX. Ni, Z. (2023). Digital monitoring systems for heritage buildings: Applications in conservation management. *Journal of Cultural Heritage Management*.
- X. Ni, Z., et al. (2024). Digital twin technologies for historic buildings and heritage conservation. *Automation in Construction*.
- XI. Nayak, R. (2025). Technology upgrades and modernization in heritage buildings in India. *Journal of Heritage Conservation Studies*.
- XII. Ravindran, K. (2016). Conservation approaches in Indian architecture. *Architectural Heritage Review*.
- XIII. Singh, A., Sharma, R., & Gupta, S. (2025). Deterioration and conservation strategies for heritage structures. *International Journal of Heritage Studies*.
- XIV. Sriram, A., Kumar, P., & Rao, S. (2019). Energy efficiency in Indian heritage buildings: Challenges and opportunities. *Journal of Building Engineering*.
- XV. Tejani, S. (2021). Integration of HVAC systems in historic buildings in India. *Journal of Architectural Conservation*.
- XVI. Tripathi, R., & Misra, A. (2018). Adaptive reuse of colonial buildings in India. *Journal of Heritage Management*.
- XVII. Vijayalaxmi, M. (2023). Heritage conservation frameworks and policy approaches in India. *Conservation and Management of Archaeological Sites*.
- XVIII. Webb, A. (2017). Energy retrofits in historic buildings: Balancing conservation and sustainability. *Energy and Buildings*.
- XIX. Allaie, S., & Dhiman, S. (2025). Retrofitting strategies for historic buildings: Challenges and conservation approaches. *Journal of Architectural Conservation*.
- XX. INTACH. (2023). Studies in heritage conservation and management. *INTACH Journal*.

