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# Heritage Loss and Cultural Memory: Applying Traditional Temple Architecture Principles in Modern Restoration Practices in Kashmir

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*"The attack on building was a rehearsal for an assault on people who had been progressively dehumanized and humiliated, a softening-up process for the killing to come. It was also an act of cultural genocide in its own right…. It created a people without a built cultural record. What remained were fragments of this record but, ultimately, not the people who created and cared for it – and to whom their representative buildings acted as evidence of their history, continuing identity and as a containers of memory."* (Bevan, 2007)

**Abstract:** The Kashmir Valley, called the "Paradise on Earth," has been a melting pot of diverse cultures and religious traditions, but is still deeply embedded within the broader Indian spiritual and architectural tradition that draws from ancient Vedic knowledge systems while still maintaining a contextual identity of its own. The temple architecture of the region, characterised by elements such as trefoil arches, peristyle courtyards, and precise geometry, represents the design principles, proportion, and symbolism present in Hindu temples. (Kak, 1933; Cunningham, 1848; Fergusson, 1876). However, prolonged socio-political disturbances, including iconoclasm and neglect, have posed significant challenges to preserving this architectural heritage, which is an expression of intangible collective identity and cultural memory of the people of Kashmir grounded in Vedic cosmology and ritual practices.

This study frames the discussion within the theoretical constructs of cultural violence (Bevan, 2007) and dissonant heritage (Tunbridge & Ashworth, 1996), emphasising the need to protect architecture, the bearer of the collective memory. This study will delve into the deterioration of temple architecture in Kashmir, which is deeply tied to the collective memory of the Kashmiri Hindus, focusing on Martand Sun Temple, a heritage monument built in the 8$^{th}$ century AD, as a representative case study. The study draws on archival sources, architectural historiography, and secondary literature to trace the evolution and subsequent degradation of Kashmiri temple architecture.

The paper further explores how Kashmiri temple architecture can be revived by utilising modern technologies, like 3D scanning, Virtual Reality (VR), and Augmented Reality (AR), for documentation as well as restoration. Through comparative international case studies, the paper assesses the relevance and applicability of these modern technological advancements within the Indian context. This study aims to guide policymakers, conservationists, and local stakeholders in preserving the architectural heritage and cultural and spiritual identity of Kashmir, leveraging technological advancements. This research aims to preserve the cultural identity and ensure the continuity and transmission of Kashmir's rich architectural legacy to future generations.

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**Keywords:** Kashmiri Hindu Temples, Destruction of Memory, Temple destruction, Architectural Restoration, Edutainment, Heritage Conservation, 3D Scanning, Virtual Reality, Augmented Reality, Cultural Heritage Tourism

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## 1 Introduction:

Kashmir, also known as *"Sharda-peeth"* (seat of learning), has always been a region of historical, spiritual and cultural significance. The Rigveda, in its hymn 10.75.6, acknowledges the rivers Vitasta (Jhelum) and Sindhu (Indus) as part of the regional terrain, indicating their cultural and geographical significance in early Vedic Literature (Jamison & Brereton, 2014, p.1505). Due to Kashmir's strategic location at the crossroads of several civilisations and kingdoms, the valley has seen a unique blend of cultural, religious, and architectural traditions. The temples of Kashmir are central to this heritage and follow a distinct "Kashmirian" architecture, a term coined by Cunningham (1848), characterised by lofty pyramidal roofs, trefoiled doorways covered with pyramidal pediments, and the great width of their intercolumniations. According to Cunningham (1848), the temples of Kashmir also draw inspiration from "Grecian art," which gives these temples a highly distinctive style of temple architecture in India. However, the temples of Kashmir, which were once vibrant centres of communal life, have faced destruction, desecration and neglect over the centuries. For example, *Kalhana's Rajatarangini*, an ancient historical chronicle of Kashmir, documents that during the 11$^{th}$ century, the Kashmiri king Harsha plundered temples and extracted temple wealth, which earned him condemnation in the text. It is understood that his campaigns were not intended to erase Kashmir's cultural heritage. During the 14$^{th}$ century, Sultan Sikandar "Butshikan", the iconoclast, planned and led the destruction and demolition of numerous temples like *Paraspur*, *Bijbehara*, *Tripureswara*, *and Martand*. (Eaton, 2000). The collective identities of the Kashmiri people were tied to these temples, and an indigenous and independent type of culture developed in these sacred spaces (Brown, 1959). *Nilamata Purana*, the Kashmiri text dated between the 6$^{th}$ and 8$^{th}$ centuries CE, also provides extensive details on the socio-religious fabric of Kashmir, describing its temples, festivals, and customs rooted in Vedic traditions. Brown (1959) also emphasises how the people of Kashmir differed in their customs and ceremonies from those in most parts of India, as well as the Kashmiri temple architecture,

which is a manifestation of an independent thought and derived little from the development of temple building taking place in the rest of Bharat at the same time (p.299).

As theoretical frameworks by Bevan (2007) and Tunbridge and Ashworth (1996) argue, the destruction of the cultural and architectural heritage is often a targeted act of systematic cultural cleansing aimed at reconfiguring historical narratives. The loss of these temples signifies more than just the physical disappearance of the temples; it represents the destruction of the collective memory of the people of Kashmir. Given the challenges in traditional historic preservation due to the environmental and political accessibility of Kashmir, the study explores how modern technologies such as 3D scanning and modelling, Virtual Reality (VR), and Augmented Reality (AR) can offer new ways for digital documentation, preservation, and public engagement by encouraging "edutainment".

## 2 Methodology:

This study employs a qualitative and historical-analytical methodology, supplemented by a comparative analysis of international case studies in digital heritage conservation, to investigate the preservation potential of Kashmiri Temple architecture, with a particular focus on the Martand Sun Temple. It integrates archival investigation, architectural typological analysis and understanding, comparative case study review, and theoretical interpretation. The analysis is based in two key theoretical frameworks from Bevan (2007), who framed the destruction of architecture as an act of cultural violence aimed at eradicating the collective identity, and the theory of dissonant heritage by Tunbridge and Ashworth (1996), explains how heritage is selectively recognised, suppressed, or politicised depending on the dominant power structures. Both these theoretical constructs help in the critical examination of Kashmiri temple architecture as a site that carries memory, conflict and architectural significance.

Data were collected from multiple sources, including colonial-era archaeological documents (e.g., Cunningham's study on the temple architecture of Kashmir) and secondary historical and architectural literature (e.g., works by R.C. Kak, T.K. Tikoo, James Fergusson, Percy Brown, and Adam Hardy), which offer comprehensive accounts of the peculiar architectural features, spatial organisation and historical context, and visual archives such as historical plans and early photographs. The investigation utilised content analysis and typological mapping to elucidate the historical development and distinctive architectural characteristics of Kashmiri temples with attention given to the architectural features, proportions, material usage to differentiate "*Kashmirian"* temple architecture from the rest of Indian temple typologies.

The Martand Sun Temple was chosen as a focal case study due to its historical and architectural importance, as documented in existing literature, the degree of destruction it has suffered, and its potential for restoration through the

application of modern technological interventions. The paper also provides technological references on how to utilise 3D scanning, Virtual Reality (VR) and Augmented Reality (AR) for heritage conservation. Additionally, global examples of digital heritage preservation were analysed comparatively to determine their relevance and applicability to the context of Kashmiri temple architecture.

The validity and reliability of the findings were ensured through cross-referencing of peer-reviewed academic papers, technical reports, and historical and archival data. The scope of this study is deliberately limited to a single case study of the Martand Sun Temple, representing the Kashmiri temple architecture, and three internationally recognised case studies in the field of heritage preservation that utilise technological advancements. This focus allows for an in-depth understanding of the subject matter while acknowledging the limitations of this study, including its reliance on secondary data for architectural analysis and the absence of field-based surveys and primary ethnographic interviews, which are recommended as avenues for further research. Future research should incorporate fieldwork, contextual stakeholder engagement, and expanded architectural and geographic sampling across the Kashmir Valley.

## 3 Historical Context and the Systematic Destruction of Kashmiri Temples:

To understand why it is important to safeguard Kashmiri Hindu Temples, we must first understand the historical context – the origins and evolution of Kashmiri Hindu Architecture and the philosophical school of thought behind it. Kashmir was one of the primary centres of Buddhism and produced scholars and monks who then spread it throughout Asia (Fisher, 1982; Tikoo, 2013; Fergusson, 1876). Emperor Ashoka is credited with founding the capital town of Srinagar around 250 BCE at Pandrethan and spreading the teachings of Buddhism in the region. Srinagar became the twin city of Taxila, a centre of Buddhist learning in Gandhara. (Beg, 2020). Following in Ashoka's footsteps, King Kanishka of the Kushan Dynasty held a Buddhist Conference at Kanishkapur (present-day Harwan) in Kashmir. (Tikoo, 2013). Both Buddhism and Hinduism flourished side by side in Kashmir, and Kashmir became an epicentre of philosophical and architectural innovation. (Fisher, 1982).

Hindu rulers such as King Lalitaditya Muktapida (8th century CE) constructed grand temples like the *"cyclops of the east"* – the Martand Sun Temple. Several dynasties – including the Karkotas, Utpalas and the Loharas – continued to patronise temple construction, restoration and the development of a unique "Kashmirian" architectural language that blended Vedic sacred geometry with Greco-Roman, Gandharan, and Central Asian stylistic elements. (Cunningham, 1848; Fergusson, 1876; Kak, 1933) According to Brown (1959), the 8$^{th}$ century CE onwards marked the beginning of a grand classical development in architecture, which was stylistically vastly superior to the earlier architectural language prevalent in Kashmir.

King Avantivarman – the first Vaishnavite ruler of Kashmir, built the significantly important Avantivarman & Avantiswami temples (Tikoo, 2013). These temples, although significant, have been excluded from the study to limit the scope. However, many of the temples in the valley were dedicated primarily to Bhagwan Shiva, who was the most followed and favoured in Kashmir. This later developed into *"Kashmir Shaivism[1]"* - native to Kashmiri Hindu religious and philosophical school of thought (Fisher, 1982). Kashmir also became a centre for "*Shakti Upasana"* – an entirely different school of thought in Hinduism – and many shrines were constructed in the Divine Mother's name during the reign of Jaisimha from the Lohara Dynasty (Tikoo, 2013). Kashmir became home to scholars from diverse faiths, and it became the centre of education and co-existence in the form of philosophical exchange amongst different schools of thought. Kashmiri sacred architecture is a blend of diverse architectural and religious influences. Even though Kashmir was on the major artery of the Silk Route and was open to many cultures, traditions and dynasties, a very distinct Hindu Temple architecture evolved, unique to Kashmir, this style of Hindu Temple Architecture was distinct from North Indian Hindu Temples and even adopted many Western architectural features (Percy, 1959; Beg, 2020).

Kashmir saw the advent of Islam around the 14th century, which introduced another layer to Kashmir's already multicultural architecture and societal structure. (Beg, 2020). However, Mongol and Turkish invasions at the beginning of the 14th century started an era of cultural, religious and architectural destruction, which was carried on by many subsequent Islamic rulers of Kashmir, except for Zain-ul-Abdin who was considered relatively a *"tolerant sultan"* and is remembered by the Kashmir people as "*Budshah.*"[2] (Figure 1) (Tikoo, 2103; Sopory, 2022). One of the most brutal Sultans – Sikandar, also known as "Butshikan – the iconoclast" is credited with the destruction of many Hindu temples, including but not limited to *Martand, Chakradhara, Vijayesa Tripureshwara, Sureshwara, Avantipur, Bijbehara, and Paraspur* (Kak, 1933; Eaton, 2000; Tikoo, 2013) (Figure 1). The materials of these destroyed temples were then used to construct mosques and Khanqahs either entirely or partially in Kashmir, still adhering to the architectural language of their predecessors, the Temple architecture of Kashmir (Cunningham, 1848). Sikandar's successor, Ali Shah, continued with the destruction of Kashmiri temples, ancient literature, and culture in Kashmir (Tikoo, 2013). According to Cunningham (1848), the compound wall of Zain-ul-Abdin's tomb was once the enclosure of a Hindu temple. The entrance of a mosque in Nowshera, Srinagar, was constructed during his reign using two fluted pillars from a Hindu temple peristyle. However, this theory has been rejected by Ferguson (1876, p. 281), who highlights how Islamic architectural elements (pointed arches) were

[1] Kashmir Shaivism – *As per the Lakshmanjoo Academy, it is believed that the teachings of Kashmir Shaivism are derived from the ninety-two Tantras, also known as Agamas, revealed by Bhagwan Shiva in the form of a dialog between himself and the Divine Mother. Out of the ninety-two tantras, Kashmir Shaivism derives its teachings specifically from the sixty-four monistic Tantras, known as the Bhairava Tantras, the essence of which is called 'Trika Shaivism'. Kashmir Shaivism used to be an oral tradition and was passed down from teacher to their disciples. Many of the earlier manuscripts are now extinct. However, "Swami Lakshman Joo", the last great master of Kashmir Shaivism, translated many foundational texts and manuscripts like "Abhinavgupta's Tantraloka" and clarified extremely complex concepts for the modern scholars and students of Kashmir Shaivism.*

[2] The term "Budshah" is a Kashmiri nickname for Sultan Zain-ul-Abdin, and the term means the "Great King."

misinterpreted as ancient Kashmir Hindu architectural features. Under the Mughal rule, although many gardens and buildings were constructed, most rulers treated Hindus, their culture, and architecture with contempt. The demolition and destruction of Hindu temples continued under the Mughals (Tikoo, 2013).

The destruction of the collective memory of the Kashmiri Hindu community due to the desecration of their temples continued under Afghan rule. (Tikoo, 2013; Kaur, 2024). However, after the advent of Sikh rule and the subsequent Dogra rule in the Kashmir valley specifically, the rulers undertook efforts to restore some of the temples destroyed over the centuries (Figure 1). However, the partition of India in 1947 and the subsequent accession of Jammu & Kashmir to India added a new dimension to the already deteriorating temples of Kashmir. Amid the rise of political unrest in Kashmir, many temples have been abandoned over the years and have been subject to neglect, encroachment and further deterioration. (Tikoo, 2013). Over the decades, the government has taken steps to restore the Martand temple. However, the restoration efforts have been hampered by a lack of skilled artisans in the field of historic preservation available in Kashmir, limited recent documentation. In the case of Martand, the recent studies indicate that the restoration materials and techniques have not adhered to the temple's original architectural specifications. (Riyaz, 2020). This is where technology can be utilised to virtually recreate this magnificent historical temple and keep the memory associated with it alive, as evidenced by the international case studies discussed later in the paper.


***Fig. 1*** *The figure illustrates the historical timeline of Kashmiri Hindu temple construction, the destruction of Kashmiri Hindu temples, covering the period before the accession of Jammu & Kashmir to independent India. The periods highlighted in "Salmon red" mark the "rule of prosperity and construction of temples in Kashmir"; those in "grey" mark the "decline of Hindu kings and the rise of Islam in Kashmir"; and those in "Black" mark the time periods of destruction of Hindu temples in Kashmir. The figure is the author's visualisation of a historical timeline, based on data and interpretations from historical archives as referenced in the paper.*

## 4 Architectural Significance of Kashmiri Hindu Temples:

Kashmiri Hindu temples are renowned for their distinctive architectural styles, and their uniqueness is rooted in the integration of Grecian and Gandharan art and architecture, as evidenced by features such as triangular pediments, fluted columns, pyramidal roofs, and trefoiled archways (Figure 2). Kashmiri temples come in three distinct shapes: oblong, square, and octagonal. These shapes are then subdivided into closed type- *Vimana* (with a single entrance) or open type - *Mandapa* (with entrances on all four sides) plan. Martand temple is an example of an oblong vimana temple, and Jyeshteshwara or Shankaracharya temple is an example of an octagonal vimana temple. Meanwhile, the temple at Pandrethan is an example of the Square Mandapa style of temple plan. Even though the architectural features of the Kashmiri temples had strong Grecian and Gandharan influence, the arrangement, the sacred geometry, and the dimensions of the temple structures followed the original strict rules of temple design, which Hindus of other Indian regions had forgotten. The height of the Kashmiri Hindu temples always used to be twice their breadth, and all the existing roofs of the temples are pyramidical. In some temples, the roofs were divided into stories, and this style of roof construction was very similar to that of Chinese buildings. This division of pyramidical roofs into stories was also replicated in the wooden roof

structures of Kashmiri buildings. Towards the end of the corner beams of these wooden roofs, the edges used to be adorned with alligator heads resembling the turned-up corners of roofs of the Chinese buildings. This evidence supports the theory that Kashmiri scholars introduced Buddhism to China (Cunningham, 1848). This connection with different cultures and nations thus led to the distinct architectural style of Kashmiri sacred buildings, including but not limited to temples.


***Fig. 2*** *Martand Temple, Kashmir, circa 1870. Original photograph by unknown photographer, sourced from the KITLV collection via Wikimedia Commons (public domain). The author has modified the image to include a contextual sketch illustrating key architectural features like the trefoil arches (highlighted in 'red'), a portion of the massive pyramidal roof (highlighted in 'pink'), and 'Aedicules' (highlighted in 'green') on the main temple shrine doorway.*

According to Kak (1933), the most beautiful feature of the Kashmiri temples is the majestic and imposing colonnade surrounding the temple. The columns consist of three separate parts: the base, the shaft, and the capital, and thus are distinct from the varieties of Hindu temple pillars. The echinus, which is a part of the Kashmirian column capital, is also a feature of Doric columns. Even the diameter of the peristyle columns of the Martand temple was the same proportions as that of the Doric columns. Each of these parts of columns evolved as temple architecture evolved in Kashmir over the years; for example, the base of the Avantipora temple is a plain square block with the upper edge rounded off or elaborately moulded, as seen at the Martand Temple. The height of the capitals of the pillars is equal to the upper diameter of the pillars, which is also similar in proportions to the Greek counterparts. In addition, the intercolumniation of the colonnade at the Kashmiri temples was about two-thirds of the height of the column itself ( Kak, 1933; Cunningham, 1848). However, Brown (1959) disagrees with the notion that the columns bear any strong resemblance to the Doric columns of the Romans. Instead, he calls the columns *Quasi-Doric*, with a certain similarity in the overall form of the capital and the abacus, which bears a somewhat similar appearance to that of its Roman counterpart. The Greco-Roman influence on Kashmiri temple

architecture is evident in the pillared porticos and peristyle arcades. The development of a grand classical style in temple architecture from the 8th century CE onwards coincides with Lalitaditya's successful conquests over an extensive region in high Asia. Brown (1959) deduces that some of the stylistic inspirations would have thus travelled to Kashmir from this larger geographical area (p.294). The famous Kashmiri temples like Shankaracharya Temple, Martand Temple, and Avantipora Temple were constructed with locally sourced limestone, and one wonders how such giant blocks of limestone were lifted to construct the lofty roofs and archways, which means that Kashmiri Hindus and other artisans were skilled "architects and engineers." Iron clamps or metal dowels (some as large as 18 inches long) held together these large blocks of limestone (Cunningham, 1848; Brown, 1959). Brown (1959) notes that the use of lime mortar in buildings was not introduced until the 13$^{th}$ century CE; however, it has been skilfully applied in the buildings in Kashmir as early as the 8th century CE, which is of notable significance.

Furthermore, Hardy (2019) has also highlighted in his extensive research the uniqueness of the Kashmiri Temples. He states that the medieval temples of Kashmir are unique due to their distinctive forms and have developed their own architectural 'language' by fusing indigenous architectural features with Western influences. The unique architectural language of Kashmiri temples differs from that of the Nagara and Dravida Hindu temple typologies. He further emphasised the amalgamation of various features of Kashmiri temples in his work, including the tiered roofs associated with the regional vernacular architectural style, Western classicism evident in the Doric-like or Corinthian pillars, and the coffered vault at Martand Sun Temple, which exhibits Roman influences. Despite this, their foundational principles and typological variations show deep-rooted connections with the classical traditions of Hindu temple architecture throughout India. (Hardy, 2019). The integration and borrowing of different architectural styles from various cultures and geographies have led to Kashmir's present unique temple architecture. The loss of these temples has resulted in the pointed erasure of collective memory and history, accompanied by degradation, forced displacement and erasure of the Hindus of Kashmir.

## 5 Impact of Temple Destruction on Cultural Memory and Identity:

The destruction of Architecture is not merely a physical loss, but it also points towards the erasure and fragmentation of the collective cultural memory. As Bevan (2007) argues, the deliberate destruction of a place's cultural identity markers aims to erase evidence of its identity and history. This phenomenon has occurred in Kashmir throughout history, where the systematic degradation of Hindu temples has historically coincided with broader patterns of sociopolitical changes in the valley. The iconoclastic campaigns led to the systematic destruction of temples and knowledge banks, and the cultural displacement of the Hindu aboriginals of Kashmir (Tikoo, 2013). The destruction of Hindu Temple architecture culminated in the cultural and ethnic cleansing of Kashmiri Hindus.

While the international community has strongly condemned acts of cultural destruction in various parts of the world – such as the deliberate destruction of the two standing Buddha statues in the Bamiyan Valley in March 2001, a tragedy which UNESCO and other world heritage authorities denounced as an assault on global heritage – there has been little to no vocal opposition regarding the ongoing deterioration of Kashmiri temples. Despite their deep historical, spiritual, and cultural significance, the continued deterioration, neglect, and loss of these rare and sacred temples contribute to a form of "forced amnesia" as Bevan (2007) describes, where the absence of physical markers of heritage and culture, a community's past becomes invisible within the broader historical narrative. Tunbridge and Ashworth (1996) also suggest that heritage associated with politically inconvenient groups is often suppressed or allowed to decay. Without a tangible heritage to anchor their history, the displaced communities can face challenges in transmitting their traditions intergenerationally, especially in the case of Kashmir, where the rituals are tied to the land. Thus, heritage preservation becomes important not just for architectural restoration but for safeguarding the memory of the people and their distinct cultural identity.

## 6 The Martand Sun Temple:

Martand Temple is one of the most impressive and significant examples of distinct *Kashmirian* temple architecture located in Mattan, a short distance from Anantnag, which is erroneously referred to as Islamabad[3]. Martand commands and overlooks one of the most magnificent views in Kashmir. Cunningham (1848) notes that Martand's total height is precisely twice its width and is designed according to strict guidelines of Hindu temple architecture. The pinnacle of the temple's pyramidal roof reaches about 75 feet, and the length of the temple is 63 feet, making it a grand building dedicated to the Sun god (Surya Deva). The temple is standing in a quadrangle surrounded by a peristyle colonnade comprising fluted columns with trefoil-headed recesses. The temple building features a tri-patha plan, meaning it is placed on a heightened plinth and approached by a flight of steps (Brown, 1959; Raina and Mallick, 2023). The central temple consists of three distinct chambers – *the Ardha-mandapa, or the half temple (an outermost portion of the temple), the Antrala (middle portion), and the Garba-griha (innermost sanctum), all of which share similarities with* their Greek or Roman counterparts. The "garba-griha" of the temple was quite plain, but it was designed so that the image of the Sun was illuminated by its beams. (Cunningham, 1848). Brown (1959) states that the central building has outstanding features, including trefoil arched recesses under angular pediments, on all four faces of the building, separated by massive pilasters at each angle. The temple also had a considerable number of carvings in high relief, especially of figures in smaller niches or *aedicules.* In addition, the interior of the quadrangle was once believed to be filled with water (Brown,1959). Similar examples can still be seen

[3] Anantnag (Kashmir, India) is called Islamabad (unofficially) and should not be confused with Islamabad, the capital of Pakistan.

today in Kashmir, such as the Kheer Bhawani temple, although not on the same massive scale as the Martand temple. However, despite its historical and architectural significance and uniqueness, the temple now stands in ruins. This grand temple is an ideal candidate for restoration via modern technological interventions. Digitally preserving and virtually reconstructing the temple will not only aid in physical restoration but can also help in increasing "digital tourism" to the temple complex.

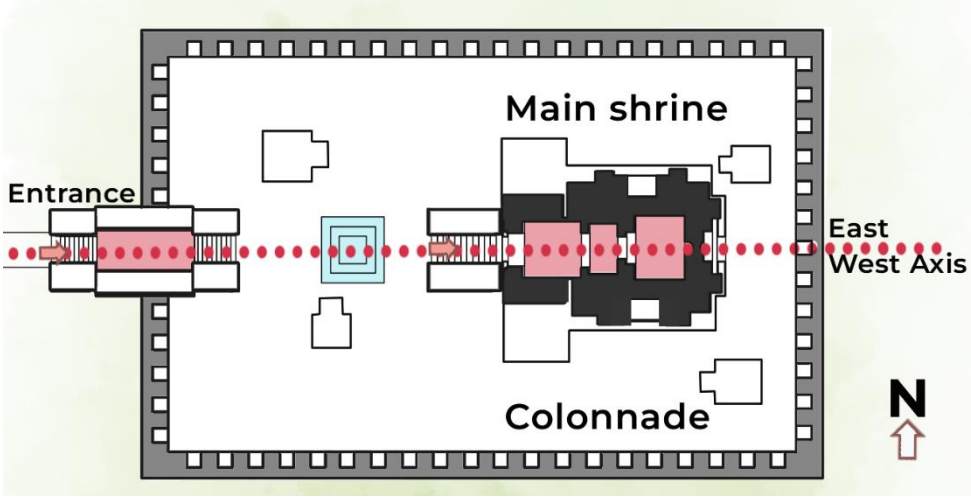


***Fig. 3*** *Martand Surya Temple: This drawing is an interpretative reconstruction based on site photography, archaeological records, and historical plans available in the public domain. Not to scale*

## 7 Modern Technological Interventions in Heritage Preservation and Restoration:

We are witnessing the ongoing threats to cultural and religious sites and their destruction worldwide due to several reasons, and in such instances, architecture becomes one of the silent casualties of war (Bevan, 2007). Modern technological advancements have become helpful in the preservation and restoration of architectural and cultural heritage sites. This section examines how technologies such as 3D scanning, Virtual Reality (VR), and Augmented Reality (AR) can offer promising solutions to conserve and revive endangered heritage. Martand Sun Temple can be used as a focal case study for potential application.

It is essential to measure, model, and restore historical buildings with accuracy, both physically and digitally, to preserve their cultural heritage. Technologies such as 3D scanning enable the precise and accurate digital preservation of heritage buildings by creating digital replicas of them. Digital photogrammetry techniques have been used to acquire data from heritage buildings and convert them into 3D point clouds, resulting in 3D models; however, they often fail to capture complex surfaces with absolute accuracy. However, 3D terrestrial laser scanning (TLS) provides better spatial information about a heritage building by constructing complex 3D visualisations created using the high density of data (denser 3D point clouds), and these precise 3D models are accomplished in a short period. Unfortunately, the lasers cannot identify the colours and texture of the scanned surfaces of the buildings. A combination of digital photogrammetry and terrestrial laser

scanning techniques can produce complex and visually rich 3D textured models of historic buildings with high geometric accuracy (Wei et al., 2010).

Using various 3D scanning technologies, the researchers can digitally document and archive the architecture of Kashmiri temples, preserving their dimensions, peculiar design elements, and current condition. These digital archives can then be used in both physical restoration and virtual reconstruction of the temples, ensuring accuracy and authenticity in replicating the unique architectural features of the Kashmiri temples. These "digital archives" will become a valuable resource for future generations of the displaced Kashmiri Hindu community and can also become a means of "*edutainment"* not just for the rest of India but for global audiences as well. Edutainment can be achieved by developing interactive, user-friendly digital platforms and mobile applications that allow for the remote exploration of these architectural marvels, thereby minimising their physical damage.

After the digital archives have been created, Virtual reality (VR) would enable immersive reconstructions of these Kashmiri Hindu temples by adding a layer of extra information to the 3D models. By combining architectural data with historical, religious and cultural research, VR can recreate the sites as they existed in their prime. This will allow people to experience the original form, the features, the unique details, and the magnificence of *Kashmirian* temple architecture through different time periods from anywhere in the world, offering both educational and emotional engagement. The three-dimensional virtual reality technology is a realistic computer-generated virtual environment where any human can immerse themselves in the realistic settings of that building, with the possibility of interacting with the available contextual heritage data (Fassi et al., 2016) (Zhong et al., 2021).

VR allows the users to be active participants in the simulated three-dimensional experience from anywhere in the world. Kashmir Hindu temples, many of which are inaccessible due to political or environmental constraints, could greatly benefit from being available virtually to anyone through a "Virtual Museum" application or platform. These virtual museums could also offer virtual exhibitions and tours with the use of gamification, interactions and other immersive styles. These virtual worlds can include simulations that closely resemble authentic and detailed versions of heritage buildings, as well as the environment and weather conditions available at different points in time, through 3D renderings of nature and even virtual humans. VR headsets, VR controllers, 360° photography and 360° videos have made VR-based experiences accessible to a larger population. By utilising the power of smartphones in conjunction with advanced interaction technology, user experience can be further improved by including information and interaction points (Pervolarakis et al., 2023). VR reconstructions of these buildings can then be used for educational purposes and Cultural Heritage tourism.

Augmented Reality (AR) technologies provide an immersive audio—visual experience by superimposing computer-generated information, graphics and imagery, sounds and sometimes tactile experience opportunities onto the real-world environment. AR creates an interactive virtual layer between the user and the physical environment and allows them to perceive the environment in an enhanced way. AR provides the users with a multi-sensorial experience by encouraging them to interact with the heritage building and enables them to be able to touch its virtual artefacts, all the while listening to supplementary historical and cultural information about the heritage building and its artefacts (Boboc et al., 2022). AR has excellent application possibilities in the field of digital cultural heritage tourism. For example, Kyoto National Museum uses AR devices to let users view the virtual artefacts and holograms of monks moving in the virtual space. Similarly, the Palazzo Museum in Rome uses AR technology to guide the users through the museum and enhance the user experience with video explanations and holographic images (Chen et al., 2024).

The restoration teams, which include conservationists, architects, and other stakeholders, can utilise Augmented Reality (AR) to provide real-time visual guidance for historic restoration purposes by following digital blueprints and superimposing these blueprints on the actual historic locations. As a result, the fundamental features of the temples can be accurately preserved and restored to their original architectural language. Not only can AR be used for on-site restoration but also for enriching the user experience – digital and physical. This will then lead to the rehabilitation of the cultural, religious and historical memory of the Hindu community in Kashmir. This process has been explained further in Figure 4. These processes and technologies have been combined and successfully utilised worldwide. For example, International precedents, such as the restoration of Notre Dame after the 2019 fires, were accomplished using these technologies together, and many other heritage buildings around the world have been successfully restored similarly. In the case of Kashmiri temples, where physical restoration can be complex, digital restoration offers an alternative means of preserving not only the architecture but also the cultural narratives tied to it.

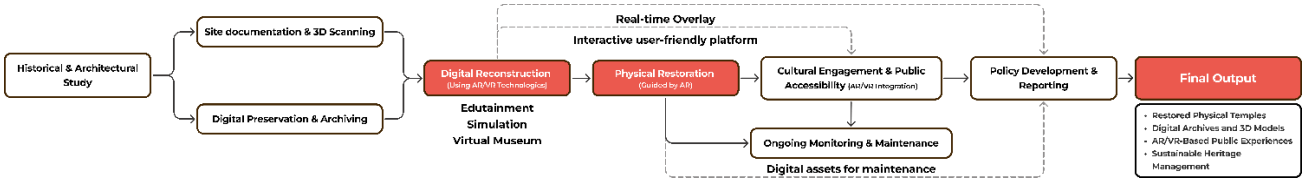


***Fig. 4*** *Flowchart of how technology can be utilised for the restoration of temples – Physically & Virtually: The flowchart shows how 3D scanning, and digital preservation can help in the creation of simulations and virtual museums using AR/VR technologies. These simulations can also aid in the physical restoration of historic buildings and enhance public and cultural engagement* ***(Source: Author)***

## 8 Case Studies: The Restoration of Notre Dame Cathedral, Milan Cathedral, and Palermo Cathedral:

### a. Notre Dame Cathedral:

After the devastating fire in 2019 at the Notre Dame Cathedral in Paris, digital restoration technologies like AR and VR became indispensable. The fire had destroyed the roof, timber frameworks supporting the spires, the nave and the vaults (Gros et al., 2023). Andrew Tallon – a historian – had conducted an in-depth laser scanning project of the cathedral prior to the fire. He had documented the heritage building and created a detailed 3D digital archive which provided precise measurements of the cathedral's structure and how the structural changes happened over the centuries. The 3D scans captured the architectural details, including the intricate ribbed vaults, spires, and detailed stained-glass windows. These scans were then used as a blueprint, ensuring the accurate reconstruction of the cathedral. The various stakeholders were able to explore Notre Dame in an immersive environment, plan the restoration of the elements that were destroyed in the fire, and test the restoration methods virtually beforehand by using the elaborate VR models that were constructed. The AR overlays were used during the on-site restoration to guide the conservationists in recreating the original details with absolute precision. The interactive AR experiences were then used to engage the users, and they took this opportunity to showcase the digital cultural heritage artefacts and details of the cathedral (Cook'10, 2023).

### b. Milan Cathedral (Duomo di Milano):

The Milan Cathedral, located in Italy, is one of the prime examples of Gothic architecture. It was extensively surveyed using a combination of laser scanning and photogrammetry. This helped create an extensive database of images that were then used to accurately represent and digitally reconstruct the intricate details of the cathedral. The three-dimensional modelling was done using Rhinoceros and Grasshopper. The digital archival project utilised advanced AR and VR technologies integrated with Building Information Modelling (BIM) systems, and a dedicated "*WebBIMDuomo"* system was created to manage the digital restoration activities. This interactive 3D virtual model allows the stakeholders using a standard web browser to access, explore and manage restoration data in real time (Fassi et al., 2016). VR immersive techniques were used to simulate the structural conditions and details of the cathedral for application in conservation and facility management fields. This resulted in the creation of a high-resolution 3D reconstruction of the main spire of the cathedral that was closed to visitors and, thanks to technology, can now be visited virtually by the public.

### c. Palermo Cathedral:

The Palermo Cathedral is in Italy and was significantly changed during the "Riforma". A research project was conducted to develop an immersive virtual tour of the cathedral, aiming to preserve digital cultural heritage and focus on

the field of *edutainment.* The researchers recreated many cathedral features using laser scanning, archival data, and available architectural drawings, including the *"Tribuna of Gagini"*. Interactive elements, including annotated virtual walkthroughs, a browsable book and gamified information nodes, were designed to enhance user engagement and historical interpretation. (Agnello et al., 2019).

The global case studies in virtual cultural heritage preservation demonstrate how immersive digital technologies can aid not only in structural restoration but also in preserving cultural memory. These case studies collectively illustrate the importance of utilising technologies like AR, VR, 3D scanning, and gamification. Not only can people visit these historical buildings, but these immersive technologies can also enhance the user experience, boost user engagement and expand virtual tourism worldwide. Kashmiri Hindu temples can be restored similarly by utilising AR and VR technology to create interactive and immersive 3D visualisations. For example, in the case of the Martand Sun Temple, the 3D model could include a complete and accurate representation of the temple. This model could also be dotted with "nodes" carrying historical and religious information about the architectural features, making it engaging for the visitors. The 3D model reconstruction of the grand temple could be made available to anyone from around the world, like in the case of Notre Dame, and other cathedrals explained earlier in the paper, increasing virtual tourism and possibly generating revenue.

## 9 Conclusion:

In addition to being a symbol of Kashmir's distinctive architectural heritage, the Kashmiri Hindu Temples, particularly exemplified by the Martand Sun Temple, are also important reminders of the cultural identity and historical continuity. Their gradual deterioration – whether through destruction, neglect, or insufficient restoration initiatives – constitutes a profound loss not only to regional heritage but to global architectural history. This paper has attempted to trace the architectural significance of Kashmiri temples and the impact of their loss on cultural memory. It has also illustrated how immersive digital technologies can help not only in physical restoration but also in virtual reclamation of heritage buildings. Through notable international case studies, the research has showcased how these modern tools can be used to document, reconstruct, and create immersive digital environments.

Moving forward, the research calls for a multidisciplinary, policy-integrated approach to heritage conservation in Kashmir. Field-based surveys, digital archives, and stakeholder engagement must complement each other in future research initiatives. Government agencies, heritage conservation professionals, and local stakeholders must collaborate to document, preserve, and restore architectural heritage, utilising both traditional methods and modern technologies.

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