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Smart Heritage: Defining the Discourse

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Abstract: The academic literature contains an increasing quantity of references to Smart Heritage. These references are at the intersection of the smart city and heritage disciplines and primarily within informative, interpretative, and governance applications. The literature indicates the future expansion of the Smart Heritage discourse into additional applications as researchers apply smart technology to more complex cultural environments. The Smart Heritage discourse signals an advancement in the literature beyond Digital Heritage and Virtual Heritage discourses as Smart Heritage pivots on the active curatorship of heritage experiences by automated and autonomous technologies, rather than technology as a passive digital tool for human-curated experiences. The article comprehensively reviews the emergent Smart Heritage discourse for the first time in the academic literature, and then offers a contemporary definition that considers the literature to date. The review and definition draw on literature across the contributing disciplines to understand the discourse's development and current state. The article finds that Smart Heritage is an independent discourse that intertwines the autonomous and automatic capabilities and innovation of smart technologies with the contextual and subjective interpretation of the past. Smart Heritage is likely the future vanguard for research between the technology and heritage disciplines.

Keywords: smart heritage; heritage; smart city; digital heritage

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1. Introduction

Inspired by Smart Mobility, Smart Infrastructure, and other smart discourses, researchers seek further technology-led innovations by converging the smart city discipline with other disciplines. The next likely prominent convergence is with the heritage discipline, subsequently producing the *Smart Heritage* discourse. The academic literature records an increasing quantity of references to Smart Heritage over the past decade. Such references are currently within informative, interpretative, and governance applications in the literature. They identify Smart Heritage as offering an innovative new frontier in the convergence of smart technology and heritage disciplines; for example, smart devices and systems curating heritage experiences and historical narratives advising technologies' deployment and form within smart cities. Importantly, Smart Heritage delivers a dedicated historical lens into the smart city discussion previously absent and enables the historical contextualization of the smart city and its initiatives. While comparatively nascent in contrast to the now-established Smart Mobility and Smart Infrastructure discourses, Smart Heritage will likely increase its academic and professional presence and expand its applications, such as supporting economic and place-making outcomes.

The article provides the first comprehensive overview of the emergent Smart Heritage discourse and its most up to date definition. The review records the patchwork of contributions across various research fields and discusses how they build to form a novel discourse. First, it records the Smart Heritage in its nascent early years, then as a distinct discourse within select applications, and then its present state as it becomes an established discourse across multiple applications. Lastly, the article presents a contemporary Smart Heritage definition that encapsulates the literature to date. The definition offers a clear foundation

around which researchers can ground their future inquiry into the Smart Heritage discourse and its application.

2. A Contributing Discipline: The Smart City

The rise of the smart city discipline over the past two decades directly contributed to the Smart Heritage discourse's emergence. The discipline grew from researchers at the turn of the millennium who envisioned a city of sensors, wires, and gadgets [1,2]. The 'smart' concept distinguished itself from other future city visions at the time, such as the Sustainable City and the Innovative City, through its automatic and autonomous technological characteristic. In this vision, technology acted independently to human input and held autonomy and agendas. These technologies initially served utility, communication, and civic security functions.

Throughout the following two decades, researchers expanded the discipline to incorporate economic and social considerations. In 2007, Giffinger et al. stated that a smart city included economic, governance, mobility, environment, people, and living elements and is "built on the 'smart' combination of endowments and activities of self-decisive, independent and aware citizens" [3]. Later researchers expanded these social considerations further. The seminal book by Townsend published in 2013 popularised the notion that the smart city included social and humanistic elements [4]. Townsend stated smart cities were "places where information technology is combined with infrastructure, architecture, everyday objects, and even our bodies to address social, economic, and environmental problems". More recently, in 2018, Yigitcanlar et al. identified three main drivers of smart cities; community, policy, and technology [5]. These drivers interlink to produce productivity, sustainability, accessibility, well-being, liveability, and governance outcomes. Importantly to Yigitcanlar et al.'s definition, these outcomes collectively exist within a singular smart city system that is nested within the natural environment and its social and political context. Recent publications refer to Yigitcanlar et al.'s definition as the current smart city understanding in 2021 [6,7].

The smart city is now an established discipline in academia and the professions. It enjoys dedicated research centres in universities, professional conferences globally, and expert 'smart advisors' in businesses and local governments. From a survey of the discipline between 1990 and 2016, Ingwersen and Serrano-Lopez described the discipline as a "dominating concept" that colonialises on other disciplines and institutions [8]. They found that distinct smart discourses, such as Smart Mobility and Smart Infrastructure, result from the smart city discipline drawing on novel datasets in adjacent fields and becoming a popular theme for researchers. Through these convergences, a smart discourse grows to form self-sufficient academic and professional ecosystems.

3. A Contributing Discipline: Heritage

The heritage discipline also contributes to Smart Heritage's development. The discipline is well-established with a matured state of academic and professional thought. Academic researchers emphasise its abstractness, malleability, and its subjective valuing process. For example, Winter stated that "heritage is both enmeshed in, and constituted by, complex, entangled and contradictory processes" [9]. Lowenthal proclaimed it is "as old as humanity" and holds the ability to define perspectives through its subjective interpretation of value [10]. Smith and Waterton identified that heritage is "the performance and negotiation of identity, values and sense of place" [11]. Academic researchers in the discipline mostly share these understandings.

Practitioners of the heritage discipline, including experts and organisations, adopt more precise definitions for use in specific applications. Such as, the United Nations Educational, Scientific and Cultural Organisation (UNESCO) defined heritage as holding "cultural and/or natural significance which is so exceptional as to transcend national boundaries and to be of common importance for present and future generations of all humanity" [12]. This definition is specific to UNESCO's assessment of heritage sites

for inclusion on their World Heritage List; the UNESCO noted that it is not a universal definition. Comparatively, Historic England described heritage as "all inherited resources which people value for reasons beyond mere utility" for their assessment purposes [13].

Amongst these definitions, the UNESCO defined Digital Heritage as "consisting of unique resources of human knowledge and expression . . . created digitally, or converted into digital form from existing analogue resources. Where resources are 'born digital', there is no other format but the digital object" [14]. Researchers over the past decades often viewed Digital Heritage as the vanguard discourse at the intersection of technology and heritage. However, the passivity and archival function of technology in its definition is arguably becoming less relevant with the advancement of active and city-wide smart technologies. As the following sections of this article chronicle, researchers are exploring a new discourse that centres on active technologies so heritage can engage cities' functions and narratives automatically and autonomously. This emergent discourse is Smart Heritage and is a contender for this vanguard position.

4. Method

The researchers reviewed literature from the smart city and heritage disciplines and associated fields such as Digital Heritage, museum management, and cultural technology to understand Smart Heritage's development. The review employed keyword searches in academic literature databases on 'Smart Heritage', 'Smart Cultural Heritage', and 'smart technology'. The researchers identified Smart Heritage through explicit mention of the term or similar terms or descriptions of smart technology curating heritage experiences. Specific attention was given to innovative technologies in Digital Heritage literature to ensure that advancements that also featured technological autonomies were captured. The review was limited to the information presented in English and the researchers' ability to interpret a distinct convergence of the smart city and the heritage disciplines. The researchers draw on smart city literature to define 'smart' as automated and autonomous technology that operates and delivers without direct or constant human oversight. However, the ambiguity of the term 'smart' in the broader disciplines occasionally led to passive technologies in Digital Heritage literature labelled as Smart Heritage or similar; these were excluded from the review findings.

The researchers formulated the comprehensive Smart Heritage definition through deductive reasoning to characterise the essence of the Smart Heritage literature to date. They drew on direct quotations from the literature review and incorporated the smart city and heritage definitions from the underlying disciplines to clarify its interdisciplinary position. The definition anticipates the ongoing development of the discourse. The purpose of the definition is to benchmark Smart Heritage in the literature by understanding its development to date.

5. Smart Heritage in the Early Years

Smart Heritage emerged in the literature in the second decade of the 21st Century. It grew piecemeal in the smart city and heritage disciplines. During this period, smart city researchers sought to resolve social and cultural issues by applying smart automatic and autonomous technologies [5,15]. Alongside livability, community, and economic focuses, the researchers sought additional complex social and cultural issues and eventually found heritage matters. Concurrently, heritage researchers were exploring augmented and virtual technologies and sought new curatorial abilities for technologies. Because of these overlapping innovative inquiries, smart city and heritage researchers converged on investigating how smart technologies and heritage can intertwine to deliver automated and autonomous heritage experiences in cities, culminating in the first Smart Heritage references.

The first explicit reference to Smart Heritage was made by Thwaites in 2013, who described "smart heritage and cultural futures" as "hybrid virtual-real worlds rich in detail, interpretation, and aesthetic impact" and aided by animation, narratives, and immersive

sound and vision technologies [16]. Thwaites proposed that smart technologies created new immersive experiences that interact with digitalised historical sites, artworks, and objects in museums, galleries, and controlled public spaces. Thwaites does not examine the theoretical implications of this novel convergence between smart city and heritage. However, the direct reference to Smart Heritage signalled the awareness of a new paradigm where technology activity curates the heritage experience.

In 2014, Chianese and Piccialli provided the second notable Smart Heritage reference in the literature [17]. While they did not directly state 'Smart Heritage', they discussed a smart "Cultural Heritage Environment" in their application of the Internet of Things within museums and static heritage spaces. The Internet of Things is a decentralised network of devices that communicate with each other and is deployed often in smart cities. Chianese and Piccialli used the Internet of Things to monitor cultural objects' health within an exhibition space, such as measuring moisture and structural strength via online sensors. While initially focusing on authorised museums and controlled cultural spaces, Chianese and Piccialli identified that smart technology has potential applications for enhancing the valorisation, knowledge diffusion, fruition, and growth of a positive and engaging heritage experience through active interaction with museum visitors. They stated, "imagine a situation in which a user is walking within a museum among a number of art objects, and when he is particularly close to one of them, its mobile device (e.g., a smartphone or a tablet) is detected by the object . . . the object begins to talk about itself, its story and its status by means of multimedia content and facilities". Their reference illuminated Smart Heritage as an immersive and smart paradigm, a unique characteristic of the discourse.

Other researchers developed conceptual and practical ties between innovative technologies and heritage but did not explicitly identify the distinct Smart Heritage discourse. Garau explored how augmented reality on mobile devices can create "smart and participative solutions for a dynamic fruition of cultural heritage" [18]. Employing a simulated case study on a historical neighbourhood, Garau presented how smart technology independently creates novel heritage experiences and how heritage informs technologies' application through association with the heritage tourism sector. Aydin and Schnabel investigated mixed realities and immersive gaming experiences in the galleries, libraries, archives, and museums [19]. They found that technology and cultural disciplines have bi-directional relationships regarding experience and value creation.

Many researchers also explored adjacent areas between innovative technology and heritage while referring to Digital Heritage, Augmented Heritage, and Virtual Heritage. For example, Chung et al. [20] explored how augmented reality influences visitors' intention to visit heritage sites. Cayla [21] examined new technologies' intersection with geological histories, specifically digital mapping and data recording processes. However, as the following section describes, the application of smart technology differentiated Smart Heritage as a distinct discourse from these other technological heritage discussions.

6. Smart Heritage as a Distinct Discourse

In the years following, Smart Heritage materialised as a distinct discourse through its application in informative and interpretative contexts that applied the earlier research's concepts. Through these applications, innovative benefits of smart technology were discovered that demarcated the discourse from other technological heritage discussions. It is during this period that references to Smart Heritage noticeably increased in the literature.

In 2015, Qiu et al. referred to a Smart Heritage decentralised "public service platform" where users access "culture, legends, and history of a scenic spot, through a strong physically linked network" [22]. On the platform, smart technology creates a digitally enhanced environment that automatically shares historical site's data with site managers and visitors in real-time. This system also collects user data by monitoring online, onsite, and offline activities through in-situ and mobile device sensors. Qiu et al. envisioned smart technology that "expands the limitations of traditional and single-site area [heritage] consumption" as it transforms formerly and physically independent cultural sites into a broader cultural

landscape. It was their view that Smart Heritage would unlock new cultural landscapes and new economic and social opportunities through the novel convergence of heritage and visitors' data. For example, allowing the analysis of tourist behaviour and cultural and economic patterns to assist in designing, promoting, and managing heritage places at scale across landscapes. Qiu et al.'s offering expanded the Smart Heritage discourse beyond museums and added an economic and touristic lens to the literature.

Borda and Bowen reported novel technological applications within the heritage discipline from Australia, the United States of America, the United Kingdom, South Africa, Spain, and China [23]. The researchers referred to these applications as Smart Heritage, but they mainly employ augmented and virtual reality technologies and closed-intranet connected devices. Only a few applications used smart technologies. For example, *The Collection Wall* in the Cleveland Museum of Art, Ohio, automatically updated and sorted an image exhibition based on users' 'favourited' artworks. Users would 'favourite' artworks on an exhibition interface or a mobile device application. While the automatic updates were an auxiliary function of the exhibition, its presence realised Smart Heritage. They concluded that "smart heritage focuses on adopting more participatory and collaborative approaches, making cultural data freely available, and consequently increasing the opportunities for interpretation, digital curation, and innovation". They foresaw Smart Heritage enhancing community engagement to reach new geographically and demographically diverse audiences through personalised and niche online social networks. However, the researchers recognised that heritage researchers and organisations typically lack the technical knowledge and funding resources to engage the smart technology sector. They indicated the need to resolve this difficulty before Smart Heritage could meaningfully be delivered at scale. The research by Borda and Bowen provided the first glimpse of Smart Heritage in an applied and formal exhibition context.

Wang et al. referred to "smart cultural heritage" in their article that detailed a wireless high-speed video and communication device-to-device network in museums to assist in protecting artefacts [24]. It is similar to the museum management application described by Qiu et al., but introduced new communicative abilities within the network, such as monitoring visitor' movement in the museum [22]. Wang et al.'s article highlighted how the smart city and heritage disciplines improved their practical convergence, likely supported by technological advancements since the previous research, and materialised the Smart Heritage's discourse as a result.

Reflecting on these technological advancements, Khoshelham referred to Smart Heritage in the application of spatial data to support decision-making for managing heritage value in Building Information Management systems [25]. Khoshelham defined Smart Heritage as "the use of technology to optimise decision making on the use and management of heritage buildings". This research produced the first explicit attempt to apply Smart Heritage in engineering contexts, expanding the discourse beyond the established museum discussions.

Piccialli and Chianese edited a special section on "The Internet of Cultural Things: Towards a Smart Cultural Heritage" in the *Future Generation Computer Systems* journal [26]. They defined Smart Cultural Environments as "a novel concept integrating intelligent objects, sensors, services and applications within static cultural places such as museums, monuments, exhibitions and so on". Piccialli and Chianese were evidentially aware of its innovation and distinction, and their contribution is an early attempt to recognise the discourse in the academic literature. Their special section in the journal described case studies where smart technology converges with heritage narratives. Of particular note in the journal is an article by Vassilakis et al., who reported a system where smart technology automatically curates novel heritage exhibitions from an expansive cultural collection database guided by users' personal data [27]. This article highlighted smart technology as the lead curator for heritage experiences in Smart Heritage. It is a stark achievement for Smart Heritage's distinction in comparison to its nascent and conceptual state in Thwaites [16], only five years earlier, and as an assistant to curation in Chianese

and Piccialli [17] through to Wang et al. [24]. However, the special section focused on museum and artefact management specifically, and did not frame the discourse within an overarching discourse emerging from smart city and heritage disciplines. Therefore, it limited its contribution to Smart Heritage's theoretical development and expansion into new applications.

Mar et al. reported the pilot "Smart Heritage City project", which utilised a network of sensors and an algorithmic computer system to aid the maintenance, conservation, energy savings, and tourist management in the historical city of Avila, Spain [28]. The pilot featured a centralised smart system for heritage site managers called "SHCity-Manager", which diagnoses issues with heritage assets and heritage attractions, such as overcrowding and failures of protective measures for objects. The pilot also featured a mobile device system called "SHCity-Tourist", which curates an "optimised visit sequence" tour of the city for visitors based on a short questionnaire of personal preferences, such as accessibility restraints and interests. It compares each user's responses against the real-time wait times at attractions, the user's location, and the distance to the attraction to maximise the time spent at desirable sites. The "SHCity-Tourist" highlighted the individualistic curatorial capabilities of Smart Heritage in a novel tourist user experience, while the "SHCity-Manager" showed the discourse's operational and governance application. Mar et al.'s contributions offered the first Smart Heritage 'product' in the literature, which considered usability and a scalable format, and offered the most developed understanding of Smart Heritage as a tourist experience.

7. Smart Heritage as an Expanding Discourse

In more recent years, Smart Heritage expanded into additional applications that signal its trajectory to become established alongside Smart Mobility and other smart discourses. Researchers are noticeably applying Smart Heritage in governance contexts that enable it to permeate through multi-disciplinary public organisations. The recent breakout into governance contexts mirrors the rapid expansion that the smart city discipline underwent years earlier that established the Smart Mobility and Smart Infrastructure discourses. These smart discourses now support specialised professional sectors, dedicated dissemination journals and conferences, and academic research areas.

Regarding its governance applications, Angelidou et al. referred to "cultural heritage in smart city environments" in their investigation of how smart city tools, solutions, and applications can support the historical and cultural heritage of Barcelona, Amsterdam, and London [29]. In the paper, Angelidou et al. compared smart city and cultural heritage documentation from their local governments and found mutual interests between the disciplines regarding cultural heritage preservation and promotion outcomes. However, they also found that the city documentation did not recognise these opportunities. The paper contributed to the understanding of how Smart Heritage operates within local governments. To resolve the lack of recognition, the researchers advocated for local governments to formally recognise a unified interdisciplinary Smart Heritage discourse in their strategies. However, Angelidou et al. do not offer guidance on how this might materialise.

Angelidou and Stylianidis updated Angelidou et al. with a closer analysis of the shared objectives between smart city and heritage documentation in three other cities, Tarragona in Spain, Budapest in Hungry, and Karlsruhe in Germany [29,30]. Angelidou and Stylianidis found that the smart city and heritage disciplines were discernibly closer than they were in 2017, and there were distinct connections within strategic documentation, mainly serving tourism outcomes. They stated that "it could be argued that we are in front of a new generation of smart city initiatives in which cultural heritage is of increasing importance". However, they still found that further work is required to confirm Smart Heritage's existence in these case studies, such as formally recognising the discourse in the strategic documents and understanding the practical steps for how cities could deliver Smart Heritage. The updated article positioned Smart Heritage as on the verge of

materialising within the local government sector. It indicated that the next step of advancing the Smart Heritage discourse is to formalise this expansion into local government and build its supporting ecosystem of experts and research.

Brusaporci referred to Smart Heritage as a new conceptual and operative relationship between the technology and heritage disciplines [31]. As a point of difference in the literature, Brusaporci directly discussed how Smart Heritage adopts the smart city's holistic approach to the city and its multiplicity of inputs, stakeholders, and outputs. Smart Heritage is described through this holistic approach to include seamless interactions in a personal, continuous, and multidirectional manner between smart technology and heritage. This novel framing is a conceptual leap from the single case examinations by previous researchers. It importantly disestablishes traditional boundaries between the technological and heritage disciplines and defines Smart Heritage as a holistic ecosystem rather than an output of two distinct disciplines. Brusaporci anticipated that Smart Heritage could increase cities' "cultural DNA" by unleashing culturally-rich heritage content by means of smart technology's innovative abilities. Through their convergence, historical narratives would be amplified and explored, while technology would gain new cultural status and relevancy. Brusaporci stated that Smart Heritage is a "cultural turn, in relation to which a Smart City becomes able to innovate its development dynamics in a cultural sense and in a sustainability perspective". Brusaporci does not elaborate on which sustainable perspective Smart Heritage supports.

Recently, Adrian and Kurniawan examined how Smart Heritage may evolve into new conservation applications. They reviewed how Smart Heritage's practical applications support cultural heritage conservation [32]. They proposed that Smart Heritage supports cultural heritage in the pre-conservation phase through immersive educational experiences. These experiences enhance users' appreciation of cultural heritage, which aids the available financial and political support for its ongoing conservation. Smart Heritage also supports cultural heritage in the conservation phase where technology optimises conservation techniques, following similar methods that Khoshelham referred to regarding the automatic capture and management of spatial data [25]. They found that Smart Heritage also supports the post-conservation phase as interactive media raises new economic opportunities that fund further conservation efforts. The application of Smart Heritage to conservation outcomes signals the discourse's further expansion.

8. Defining Smart Heritage

The article finds that Smart Heritage is consolidating as a discourse in the academic literature. It records a reduction in the conceptual distance between the contributing smart city and heritage disciplines over the past decade, and the production of one interdisciplinary Smart Heritage discourse. It is consolidating through its application within informative, interpretative, and governance contexts and holds a trajectory to expand into conservation and other outcomes. The researchers find that the literature still lacks a comprehensive definition that summarises the latest advances in the definition. Therefore, the researchers propose the following comprehensive definition for the emergent Smart Heritage discourse:

Smart Heritage is the convergence between the smart city and heritage disciplines that entwines the autonomous and automatic capabilities and innovation of smart technologies with the contextual and subjective interpretation of the past.

The proposed definition considers the development and present state of the discourse in the literature and, therefore, establishes the discourse's most contemporary understanding. It includes the distinction between the two contributing disciplines that typify the research throughout, for example, in the comparison of smart city and cultural heritage documentation by Angelidou et al. [29]. While distinct, it frames them uniformly within the singular discourse where they reflect on one another, reflecting the recent advancement by Brusaporci [22]. Through the singular discourse framework, the smart city discipline gains historical context and subjective value as it draws on humans' connection to the

past as novel data resources. The data is unique from previous smart city datasets, which previously focused on mobility, telecommunications, and economic metrics, through this dedicated historical perspective. This perspective enables smart technologies to deliver services within a city's historical narrative that may enhance its reception by and meaning for users. In practice, smart technology could curate histories that align with infrastructure maintenance or upgrades, which provide citizens with a greater appreciation of the works and the city's built past. The heritage discipline's adoption of autonomous and automatic capabilities and technological innovation advances it from previous technology and heritage confluences, such as Digital Heritage and Virtual Heritage, as technology is the lead curator in Smart Heritage. The innovation stems from the smart city's continuous expansion into new disciplines and leads heritage to seek new applications. Practically, this challenges heritage to explore narratives that are beyond authorized discourses, which could discover new or fictional historical narratives through technologies' creative curation abilities and lack of direct human oversight. Therefore, the definition draws directly on the contributing disciplines of the smart city and heritage, but collectively advances a new discourse that introduces new perspectives to each discipline. Table 1 presents the contributions in the literature towards the Smart Heritage discourse's development.

Table 1. An overview of the contributions from the academic literature to the proposed Smart Heritage definition.

Researcher	Contribution
Thwaites [16]	"smart heritage and cultural futures are comprised of applications that combine imagery and sound captured at locations of high cultural significance with animation, narratives and immersive sound and vision technologies to create hybrid virtual-real worlds rich in detail, interpretation, and aesthetic impact."
Chianese and Piccialli [17]	" . . . the design and the application of location-based services and technological tools applied to Cultural Heritage environments. These presented prototypes aimed to transfer a smartness to cultural sities, applying different communication technologies and sensors."
Qiu et al. [22]	"The application of smart heritage public service platforms on big data mixes the digital display system, the 3-O service system and the smart management system together, forming a scientific service system, by which tourists can understand the culture, legends, and history of a scenic spot, through a strong physically linked network . . . They can also participate in a variety of cultural experiences, which increase online the consumption, transportation booking and other functions."
Borda and Bowen [23]	"Smart heritage focuses on adopting more participatory and collaborative approaches, making cultural data freely available (open), and consequently increasing the opportunities for interpretation, digital curation, and innovation."
Wang et al. [24]	"Internet of Things (IoT) and wireless sensor network (WSN) techniques are widely used in the cultural heritage protection oriented networks for the environment monitoring, security enhancement issues, and etc."
Khoshelham [25]	"smart heritage refers to the use of technology to optimise decision making on the use and management of heritage buildings."
Piccialli and Chianese [26]	"The Internet of Things (IoT) framework applied to the Cultural Heritage domain is a novel concept integrating intelligent objects, sensors, services and applications within static cultural places such as museums, monuments, exhibitions and so on. The main goal is represented by the transformation of such spaces into Smart Cultural Heritage Environments. The Internet of Cultural Things is an emerging discipline aims to design a novel fruition, tutelage and promotion models of the Cultural Heritage in the worldwide."

Table 1. *Cont.*

Researcher	Contribution
Vassilakis et al. [27]	"We examine how opportunities arising from technological advances in the fields of IoT and semantics can be used to develop smart, self-organizing exhibits that cooperate with each other and provide visitors with comprehensible, rich, diverse, personalized and highly stimulating experiences."
Mar et al. [28]	"With the ambition of integrating urban heritage centres with the smart city concept, an innovative challenge to create an open source tool was embraced within the Smart Heritage City project (SHCity), managing historical centres and helping responsible entities to take accurate decisions about their monuments management. The proposed solution aims to use data collected from a sensor network, which is inserted in urban areas, to control and have access to data related to buildings, its surrounding areas, which allows to prevent against existing risk factors."
Angelidou et al. [29]	"the historical and cultural heritage of cities is and can be underpinned by means of smart city tools, solutions and applications."
Angelidou and Stylianidis [30]	[in the context of discussing a strategic document from Tarragona, Spain] "Heritage and cultural tourism, more particularly, dubbed as 'Smart Heritage', aim to bring out the 2,500-year history and heritage of the city (also acknowledged by UNESCO) to the forefront and promote it as a touristic attraction of the city."
Brusaporci [31]	"the meeting between ICT and Cultural Heritage facilitates a cultural turn, in relation to which a Smart City becomes able to innovate its development dynamics in a cultural sense and in a sustainability perspective."
Adrian and Kurniawan [32]	"With the high level of intensity of the use of ICT in the Smart City era, Smart Heritage must disseminate information about the values of Cultural Heritage to spread quickly so that they can help those who play a role in instilling awareness of the importance of conservation. Smart Heritage by utilizing ICT in the form of audio visual enables the catalyzing of interactive information dissemination through various available social media facilities."

9. Conclusions

The article contributes the first comprehensive review of Smart Heritage in the academic literature. It finds that Smart Heritage emerged in the second decade of the 21st Century and became distinct through informative and interpretive applications in museums and tourism contexts. It then expanded into governance contexts through application to local government strategic documents. Smart Heritage appears to follow the trajectory of earlier smart discourses, like Smart Mobility and Smart Infrastructure, which now have established experts, professional forums, and sub-research areas. The review of Smart Heritage's development is significant for the literature as it reveals the breadth of the discourse, its various applications and contexts, and its development over time. Through this process, it legitimises Smart Heritage as a recognised and tactile research area. The article also contributes a contemporary Smart Heritage definition that considers the development and present state of the discourse. It proposes that Smart Heritage intertwines the autonomous and automatic capabilities and innovation of smart technologies with the contextual and subjective interpretation of the past. The definition is significant as it is the first definition to consider the discourse holistically. Therefore, it benchmarks the Smart Heritage discourse for researchers to further engage with the concept, a novelty that earlier literature did not offer researchers, and sets the course for further research into Smart Heritage.

The authors consider Smart Heritage as the future vanguard for research between the smart city and heritage disciplines. It captures the distinct and trending theoretical advancement from Digital Heritage in the literature and aligns with the now established smart discourses. As the Smart Heritage literature continues to grow and further applications are developed, it seems likely that it will dominate the innovative discussions of the heritage discipline and formalise alongside Smart Mobility and Smart Infrastructure.

However, the researchers note that the discourse still has further consolidation to undergo. A notable future infliction point will be how Smart Heritage balances the philosophical differences between the smart city's user experience focus and the heritage discipline's historical emphasis. The proposed definition is limited by the research to date, and later comprehensive definitions should consider Smart Heritage's development since the review. Further applications of Smart Heritage will test and advance the discourse and its definition by making more explicit its limitations and practical outcomes. Therefore, the researchers of this article anticipate further expansion of the Smart Heritage discourse and ongoing evolutions of the proposed definition, specifically regarding the deepening of the convergence between its contributing disciplines, the refinement of its outcomes, and its practical applications.

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