Digital Preservation: A New Approach to Protecting Historical and Cultural Towns and Villages

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Abstract: Digital technology has penetrated all aspects of modern life and is pushing society forward by profoundly changing the way people live and think. It can not only eternalize cultural heritage, but also allow relevant knowledge to be spread more quickly and effectively. China is home to a diverse array of historical and cultural towns and villages, which are an important cultural heritage. Digital preservation means leveraging technologies such as mapping, remote sensing, computers, 3D imaging, virtual reality, plus physical and chemical techniques to collect data to monitor, record, restore, and rebuild with the goal of preserving both their physical shapes and cultural legacies.

Keywords: digitization; historical and cultural towns and villages; 3D technology; virtual reality; digital legacy

Thanks to the rapid development of computer and information technologies, digital applications have grown both in terms of width and depth and have penetrated all aspects of our lives, driving the growth of every sector of production. Digital preservation has been advocated for years as an approach to protecting cultural heritage by UNESCO, and how well a country does this has become an indicator of its technology and facility readiness for cultural heritage protection. This paper examines the ongoing efforts to protect towns and villages of historical and cultural importance with digital technology and discusses the trends and methods for the digital preservation of China's cultural heritage.

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1. The ubiquity of digitization

Digital technology is a product of the perfect combination between mathematical logic and electronics and computer technologies. Digitization is the representation of information with the symbols 0 and 1 in the system of formal logic, while digitization methods are a direct application of formal logic and its approaches. Digital technology is the cause and driving force behind today's information revolution because the development of information technology is built on computers and the Internet, whose invention was in turn built upon digitization (Cai, 2001). Digitization has reached into all aspects of our daily lives and production activities, including education, healthcare, business, urban construction, archeology, public administration and environmental management.

From the perspective of the evolution of human society and civilization, digitization is more than just a paradigm shift. It is impacting the way people live and think and inducing far-reaching social changes (Chen & Gao, 2004). Examples include the digital management of resources and the environment as well as public and government affairs and the building of digital museums for the permanent preservation of cultural resources. In the meantime, there has been discussion over the cultural significance and philosophical limitations of digital technology (Ouyang, 2005). The combination of digital technology and communication networks has had a profound influence on the cultural development of society, the forms in which culture is represented, and the ways we engage in production activities. For instance, digital technology has brought major disruptions to the traditional cultural and media industries. It also underlies the notion of intelligent buildings and model-based product design, processing and manufacturing processes. The great convenience brought to our daily lives by the wide adoption of digital technology in different areas and industries is turning digitization into a major trend of our time (Ni, 2003).

Globally, despite the rapid advancement in digital technology, the level of digitization varies sharply from nation to nation. That said, there is no denying that digitization, powered by information and communication technologies, is on a quick and irreversible path to tearing down the walls between different industries, social classes and organizations. The digital divide among different countries is narrowing as well. As a matter of fact, digital technology is increasingly bridging the development gap among different countries and regions of the world. As mankind steps into a new age driven by information technology, we need to embrace digital technology with an open mind so that it can bring new growth to each industry.

2. Digitization: new technology to protect cultural heritage

Mankind today is living in an age of digitization, with digital technology, characterized by the processing, distribution and sharing of information resources, profoundly influencing and transforming people's everyday lives. In the conventional area of cultural studies, the promotion and application of digital technology has become a major international trend. Google, for example, simulated the evolution of human civilization over the past centuries. In a bid to strengthen its soft power and build its cultural confidence, China is also exploring the quintessence of its traditional culture. Promoting cultural diffusion with digital technology and using modern digital technology to protect cultural heritage have become a crucial part of a broader project to promote cultural progress in China. It has become clear that making full use of digital technologies to record and store human cultural data and quantitatively analyzing and uncovering the trajectory of mankind's cultural development fit into the global trend and China's needs

for social and economic development at the current stage.

UNESCO has been promoting the permanent preservation of mankind's common cultural heritage worldwide. Powered by modern information technology, the digitization of cultural heritage is becoming a trend that is sweeping the global digital industry. As an unprecedented extinction crisis haunts cultural heritage around the world, using digital technology to preserve cultural heritage can ensure that cultural resources of historical, artistic and scientific importance are passed on. This has become a common focus of the world's academic and industrial circles and has led to the launch of such projects as the European Commission's cultural heritage digitization project (http://www.climate for culture.eu) and the U.S. Village Ecodynamics Project (http://village.anth.wsu.edu). Today, digital technology is already being used for the preservation, development and exploitation of different types of cultural heritage.

The combination of the information revolution and the globalization and modernization process has posed a serious threat to the original environment that accommodates intangible cultural heritage. This makes the digital storage, development, exploitation and preservation of intangible cultural heritage a priority for different countries of the world. After all, intangible cultural heritage holds the "cultural genes" that are continuously passed on over the course of mankind's existence and development. Efforts should be made to address potential problems in the digital preservation of intangible cultural heritage. These include clarifying the copyright issues on a legal level and exploring the legitimacy and possibility of making digitization part of the existence of intangible cultural heritage (Song & Wang, 2015). This can inject new life into intangible cultural heritage and can help them adapt to modern society as well as fully demonstrate their cultural, economic and social value. Developed countries like France and Italy have gained useful experience in protecting intangible cultural heritage with digital technology, at the core of which is the establishment of mature technology systems for the collection, storage and preservation of data and the building of databases under the guidance of the government and support from professional research institutes and NGOs.

At this stage, studies in China on the digital preservation of historical and cultural towns and villages and their heritage remain rudimentary. A set of core, systematic theories to support such studies are nonexistent, and technical standards and procedures for related applications have yet to be established. The scope of applications is also limited. These problems are a great hindrance to the digitization of historical and cultural towns and villages and the popularization of related applications in China. Addressing them will no doubt have great social significance.

Intangible cultural heritage in China tends to concentrate in certain regions, whose distribution exhibits a zonal pattern. Areas populated by ethnic minorities are often home to large amounts of intangible cultural heritage with unique environmental, cultural and social values (Liang, Zhao & Wang, 2015). However, China has yet to establish the technical standards for data collection and the technology systems needed to protect, preserve and spread the influence of intangible cultural heritage (Huang & Tan, 2012). It's true that Chinese scholars have made notable progress in the theories and technologies related to the digital preservation of intangible cultural heritage, but in the context of big data, more in-depth research must be conducted on the nature of intangible cultural heritage, the building of databases that meld data with knowledge and the integration of digital cultural resources across nationalities. As the cultural heritage cause gained momentum, in a bid to better explore, interpret and carry forward the historical significance and cultural value of cultural heritage, the academic circle established a dedicated discipline for

the study of cultural heritage. Meanwhile, UNESCO put forward the concept of digital heritage and, thanks to the development of digital technology, related theories and applications soon flourished. As digital technology evolves, big data analytics (Bao & Liu, 2015) and cloud computing technologies (Huang & Miao, 2016) are influencing and facilitating the digital preservation of cultural heritage as well. The major task for those dedicated to the digital preservation of cultural heritage at this stage is to establish a systematic theoretical framework to support cultural heritage digitization projects and applications with solid theoretical evidence, methods, data models, software tools, technical operating procedures and management services, etc.

As countries around the world engage in fierce competition to boost their overall strength, the cultural and creative industries have increasingly come to be seen as a mainstay of a nation's economic growth. But cultural and creative industries are different from other industries in that they are emerging fields that depend heavily on intellectual resources. To wit, practitioners' artistic creativity, imagination, ability to design and develop products and digitally present them are crucial to the growth of the industries. For example, with respect to the design and development of creative travel souvenirs, the use of ethnic minorities' traditional cultural resources in product design and the integration of traditional cultural elements into advertising to boost product sales. At present, the Chinese cultural and creative industries are rife with homogeneous products. To address this problem, practitioners and relevant government bodies need to blend traditional cultural elements into the development of digital products, draw artistic inspiration from cultural heritage in the innovation and design of the forms, techniques, functional structures and concepts of products, and let digital technology and approaches inject vitality into the industries. As emerging information technologies like web 2.0 and digital technology supplemented by virtual reality, cloud computing, big data analytics and GIS, advance and gain traction in applications, there has been a gradual shift from technology accumulation towards systematic applications. The digital preservation of cultural heritage is a major application for this transitional stage.

3. Digitization: a new approach for preserving historical and cultural towns and villages

Digitization is a new way of preserving historical and cultural towns and villages, which are richly blessed with tangible and intangible cultural heritage.

3.1 Digital preservation is the best approach for guaranteeing the perpetual availability of historical and cultural towns and villages

Once the homeland of the people in historic periods, historical and cultural towns and villages bear evidence of the unique production modes and lifestyles of the people in the past. It is thus imperative that these towns and villages are preserved as an integral part of Chinese civilization. Digital preservation of historical and cultural towns and villages refers to the practice of capturing the said objects' essential data, including their physical and chemical traits, and reconstructing them in a digital fashion for preservation and exhibition by fully leveraging modern information technology, remote sensing technology and virtualization technology. In an era when information technology powers almost everything and cultural and economic globalization is an irreversible trend, how to preserve historical and cultural towns and villages and guarantee their perpetual availability by employing modern technologies has thus become both a significant social issue and an urgent scientific issue. A digital archive enables the "cultural genes" of historical and cultural towns and villages to be permanently preserved, provides cultural heritage professionals with

a readily available pool of resources to further unlock the cultural, economic and social value of the towns and villages of historical and cultural importance, and, more importantly, ensures the sustainable utilization of historical and cultural towns and villages

The advantages digital preservation has over the traditional means and theories of preservation are substantial. First, digital means makes possible the permanent preservation of the original data of historical and cultural towns and villages passed down from a certain historic period. Second, historical and cultural towns and villages can be preserved in their entirety with a digital archive documenting the details of historical and cultural towns and villages, including geographical information, environment as well as culture and customs. Third, digital preservation renders possible other ends including digital storage, digital diffusion of cultural heritage, online exhibition and virtual tourism. Also, one of the multiple merits of digital preservation is that a digital archive encourages digital management of historical and cultural towns and villages. For instance, a smart management system could be developed for managing towns and villages of historical and cultural importance, thus substantially enhancing management efficiency. As demonstrated above, digital preservation is the one and only approach for guaranteeing the perpetual availability of historical and cultural towns and villages.

In 1992, UNESCO established the "Memory of the World" program, marking the worldwide initiation of digitization of cultural heritage. With the support from this program, digital archives have been successfully established for an extensive range of historic relics, including Angkor Wat in Cambodia, Sukhothai in Thailand, Banff National Park located in the Rocky Mountains of Canada, Huế in Vietnam

Angkor Wat

and Mayan ruins in Mexico (Wang, 2015). Overall, the western countries, particularly the United States, the United Kingdom, Germany and France, have already made substantial headway in digital preservation of historical villages in terms of data collection and modeling, means of digitization, reconstructing, virtual reality, information sharing and drawing services for the public. China embarked on the preservation of historical villages in the 1980s. The 21st century has witnessed the widespread application of digital technologies in a wide range of sectors. Inspired by this trend, many scholars and groups in China have turned to digital technologies for the preservation of cultural heritage. Among these endeavors include the digital preservation of the Old Summer Palace in Beijing and the Mogao Caves in Dunhuang. In these cases, vision technology was adopted to reconstruct the real scene (Tu, Peng & Zhong, 2016). In recent years, scholars in China have increasingly started to reflect on the digital preservation of historical villages, including data collection and the standards as well as practice guidelines, from the perspective of preserving architectural heritage (Wu, Guo & Ai, 2016). Although the technologies, including geographic information technology, satellite positioning and measurement technology and remote sensing technology, have already been widely used in the preservation of historical villages, relevant data standards and practice guidelines for digital preservation still need further deliberation.

3.2 Fully developed digital technologies facilitate the preservation of historical and cultural towns and villages

The digital preservation of historical and cultural towns and villages, in general, involves two processes. One is digital documentation and storage, the other is digital exhibition and diffusion. More specifically, the former, which is basically data input, is the basis of the latter, i.e. the output.

As the digital preservation technologies for international cultural heritage gradually come to the point of maturity, it is entirely possible to better preserve historical and cultural towns and villages for further utilization and future availability by exploiting the modern technologies including digital technology, information technology and network technology. Nevertheless, the digital documentation of towns and villages of historical and cultural importance, in most cases, remains at the superficial level of gathering data on physical structures, while their intrinsic value, i.e. "cultural genes," is largely neglected. The techniques currently used for data collection are mostly traditional techniques including scanning, photographing and video recording. As above, an integrated digital preservation approach has not yet taken shape, much less the fact that there are now no available data standards or practice guidelines, let alone reference data. On another side, the development of information technology in recent years has given birth to a trove of techniques for collecting data of historical and cultural towns and villages. With their measurement accuracy being pegged at millimeter-level, these techniques can thus substantially enhance the accuracy of the digital record of historical and cultural towns and villages. For this reason, study on the application of the digital technologies, including advanced measurement technology, high performance geo-computation technology, technologies enabling smarter planet, big data and cloud computing, in the digitization of cultural heritage, historical and cultural towns and villages in this case, must be carried out earnestly to create an integrated and up-to-date digital preservation approach. In the meantime, data standards and practice guidelines must be formulated to drive the digitization of historical and cultural towns and villages across the country. These efforts mirror a new perspective concerning the sharing of the cultural genes and perpetual preservation of the towns and villages of historical and cultural importance and, at the same time, offer a practical guidance on the digitization of

cultural heritage. The digitization of cultural heritage also produces opportunities for communications between people from different cultural backgrounds.

3.3 Major issues confronting the digital preservation of historical and cultural towns and villages

To facilitate digital preservation of historical and cultural towns and villages, two major issues need to be addressed. First is building a systematic approach for digital documentation and storage and evaluating its applicability. The ultimate goals of digital preservation are to enable the perpetual preservation, convenient search and public accessibility of cultural heritage, in this case towns and villages of historical and cultural importance, by leveraging digital technologies to capture the original data of cultural heritage and thus establish a digital archive. The development of modern digital technologies has brought forth a myriad of new methods for collecting and storing data of historical and cultural towns and villages. The technologies that could be used for data collection include holography, 3D laser scanning, satellite remote sensing, aerial photography with UAV and motion capture. And the data collected are mainly stored with the mediums enabled by optic storage, network storage or cloud storage in the form of database, which have the capability to house all relevant information of historical and cultural towns and villages and enable storage by categories and easy access (Huang, 2015). However, the technologies mentioned above are by no means an exhaustive list of all the technologies for the preservation of the towns and villages of historical and cultural importance and their intangible cultural heritage. This is particularly true for the preservation of intangible cultural heritage, which generally takes many different forms. For this reason, the preservation of intangible cultural heritage usually involves more than one digital technology, as this process often includes such unique elements as digital story arrangement & storytelling, digital choreography and digital voice systems. The same also applies to the preservation of tangible cultural heritage. The digital preservation of large-scale towns and villages of historical and cultural importance also requires the engagement of a multiple number of digital technologies. For example, 3D laser scanning and oblique photography may excel in capturing the real scene and reconstructing a virtual surrogate, but high resolution images are still needed for details like texture. In view of this, further efforts must be made to organize and evaluate the applicability of the trove of digital technologies in a bid to build a systematic digital preservation approach.

The second issue concerns the technical guidelines and the data standards for building databases for historical and cultural towns and villages across the country. Building databases is one of the fundamental tasks for the digital preservation of historical and cultural towns and villages. Currently, a national database for the towns and villages of historical and cultural importance has yet to be established. Whereas, basic databases have already been built for the 528 "well-known historical and cultural towns and villages in China" and the 4,153 "Chinese traditional villages" (figures published respectively by the Planning Department and the Rural Department of the Ministry of Housing and Urban-Rural Development of the People's Republic of China). But these databases are not adequate in that they contain only some basic information like text and are devoid of any multimedia information, including audio, video, layouts, remote sensing images, computer simulated 3D models and the virtual surrogate of certain historical towns and villages. While it is true that the governments across China have made few attempts to digitize and establish databases for towns and villages of historical and cultural importance within their respective jurisdiction, these databases usually lack geographical information of any kind. Furthermore, the absence of standards on database establishment has also

resulted in nonuniformity among existing databases, obstructing the access to the information stored in each independent database. Given this reality, the research group plans to build a geodatabase for historical and cultural towns and villages across the country. The geodatabase, once built, should enable searches of detailed geographical locations (displayed in different forms, like maps) of all historical and cultural towns and villages in China. The "Web Display Platform for Chinese Well-known Historical and Cultural Towns and Villages" the research group is currently working on, for example, is an embryo of that endeavor and a framework for the eventual "Cloud Platform."

3.4 The concepts, study contents and framework for the digital preservation of historical and cultural towns and villages

While reinforcing the preservation of historical and cultural towns and villages with traditional methods, we must also ramp up their digital preservation by employing the rapidly evolving information technologies. The latter obviously represents the general trend. The digital preservation of historical and cultural towns and villages effectuates the following concepts. First, digital preservation. Digital preservation refers to the practice of preserving the endangered architectural cultural heritage in rural areas by adopting digital technologies. Second, digital monitoring. This refers to the real-time monitoring of the key protected historical and cultural towns and villages, and the potential environmental hazards around them with the application of astronomical observation techniques. Third, digital diffusion. This essentially refers to the multi-dimensional exhibition of the digital records of towns and villages of historical and cultural importance. Fourth, digital restoration. This refers to the restoration of damaged (natural wear and tear, human behaviors and natural disasters) towns and villages or buildings of historical and cultural importance based on relevant digital records.

Studies of the digital preservation of historical and cultural towns and villages are generally focused on aspects including theory, method, paradigm and mechanism. Specifically, they include the following: (1) The conceptual framework and general scope of historical and cultural towns and villages and their digital preservation; (2) The systematic approach for digital documentation of towns and villages of historical and cultural importance and its applicability; (3) The systematic approach for digital diffusion of cultural heritage (towns and villages of historical and cultural importance in this case) and its applicability; (4) The elements, mechanisms and approaches concerning the application of the digitized contents of historical and cultural towns and villages in urban-rural planning; (5) The elements, mechanisms and approaches concerning the application of the digitized contents of historical and cultural towns and villages in cultural industry. All in all, the preservation of historical and cultural towns and villages must be conducted in a scientific, information-base, intelligent and systematic manner while delving into the theory, principles, methods and mechanisms of the digital preservation of historical and cultural towns and villages.

The focus of all the studies on the digital preservation of the historical and cultural towns and villages are directed at its theoretical system, methodology and utility value. But for establishing a scientific theoretical system, technical standards and general practical guidelines for the digital preservation of historical and cultural towns and villages, we must make "Three Transitions:" (1) Focus more on the elements of what real digital preservation stands for, including preservation, diffusion, exhibition and comprehensive utilization, instead of simply on data collection and storage; (2) Embrace cross-disciplinary collaboration on data collection and utilization rather than independent approaches; (3) Forsake the old approach towards digital preservation, which generally places more emphasis on techniques and typical

cases, and is guided by no standards, in favor of a new standard that highlights theory, exemplary cases and standards to root out repetitive, decentralized and substandard work.

The framework for the study on the digital preservation of the towns and villages of historical and cultural importance can be summarized as follows: (1) Establish the general guiding frameworks like theoretical systems, methodology and application guidelines; (2) Flesh out the theoretical systems for the digital preservation of the towns and villages of historical and cultural importance, study the methods for digital documentation and storage as well as digital exhibition and diffusion, and explore the application of the fruits of digitization in urban-rural planning and management, and the industrialization of digitized contents.

By following the above framework, we hope to eventually accomplish the following five goals for the digital preservation of historical and cultural towns and villages. (1) Establish a sound theoretical system. This should include establishing the theoretical system for the study of the digital preservation of historical and cultural towns and villages, refining the study of the theory and application of the cultural genes of traditional towns and villages, and establishing the theoretical paradigm for the digital preservation of historical and cultural towns and villages. (2) Determine a systematic approach for digital documentation and storage. This should include picking and organizing the technologies that could be leveraged for the digital preservation of historical and cultural towns and villages and thrashing out technical guidelines and data standards for building geodatabase and "cultural genes" databases for towns and villages of historical and cultural importance. (3) Establish a systematic approach for digital exhibition and diffusion. This should include establishing a new mode for digital diffusion, resolving the universal theoretical issues currently confronting digital diffusion of cultural heritage, establishing assessment criteria for digital diffusion methods and building a cloud platform for sharing and utilizing the digital information of historical and cultural towns and villages, and for exemplary and study purposes as well. (4) Facilitate the application of the digitized contents in urban-rural planning and management. This should include building a query system for urban-rural planning, laying more stress on local characteristic elements while planning for the preservation of traditional villages and the construction of urban villages, establishing a monitoring and warning system for better preservation of traditional towns and villages and building a smart management platform for traditional towns and villages. (5) Facilitate the industrialization of the digitized contents. This should include establishing an operating mechanism, exploring effective approaches and developing a management strategy for the industrialization of the digitized contents of historical and cultural towns and villages (Figure 1).

Advancing the digital preservation of historical and cultural towns and villages, establishing a theoretical system and methodology alone is not enough. Relevant technical guidelines and standards also need to be formulated. Furthermore, digital preservation should not just stop at the simple tasks like data collection, storage, monitoring and restoration. It should also involve the comprehensive utilization of the digitized contents, 3D modeling and digital exhibition. All these combined will serve to guarantee the perpetual availability of historical and cultural towns and villages, and boost virtual cultural tourism.

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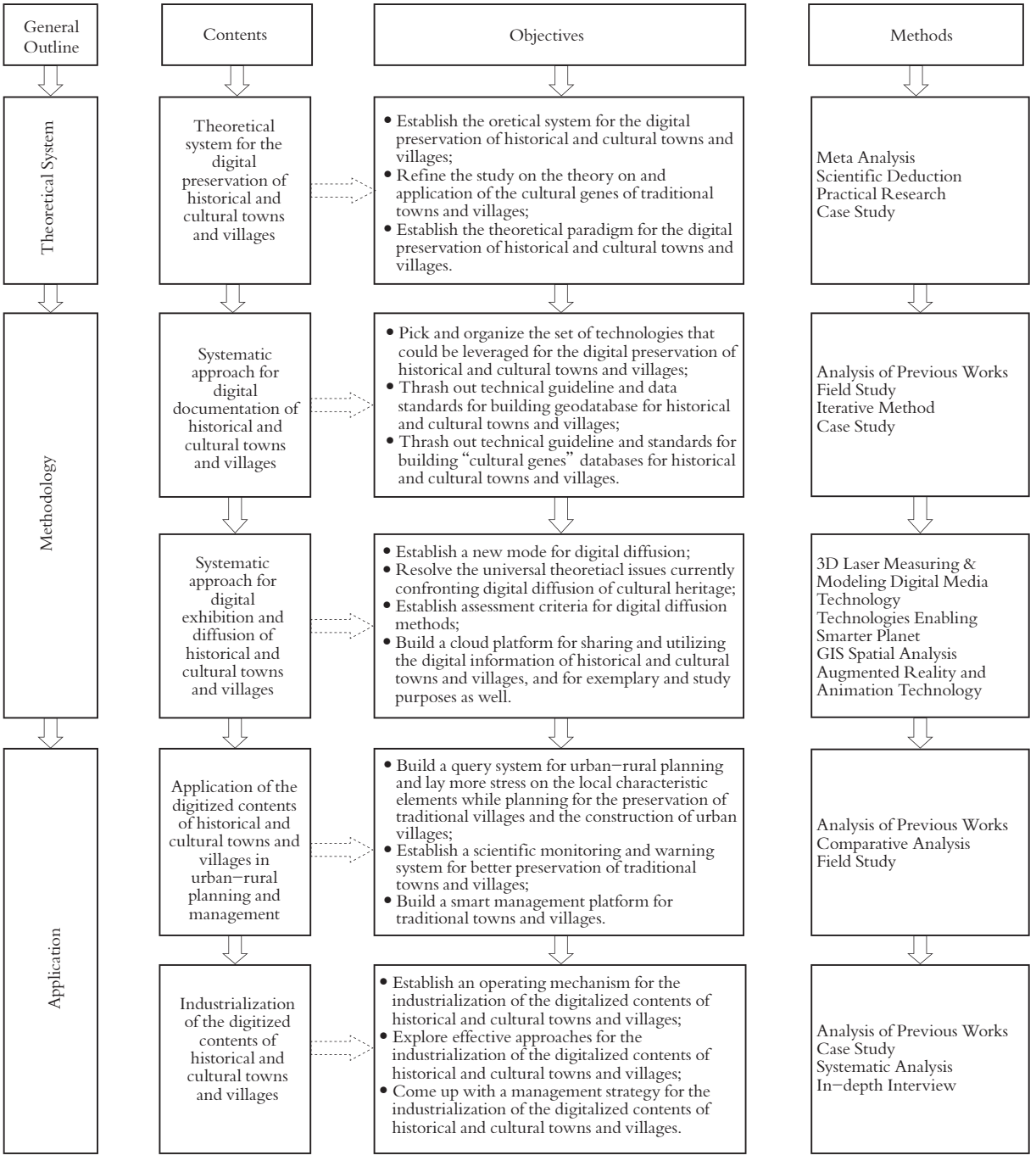

Figure 1 Objectives and Framework for the Study on the Digital Preservation of Historical and Cultural Towns and Villages

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