

INTISARI

Pemanfaatan teknologi digital tiga dimensi akhir-akhir telah banyak diterapkan untuk membantu pengelolaan sumberdaya budaya di berbagai tempat di dunia. Namun, di Indonesia pemanfaatan seperti itu belum banyak dilakukan. Karena itu, tesis ini membahas peran, manfaat, dan penggunaan teknologi digital *Lidar (Light Ranging and Detecting) TLS (Terrestrial Laser Scanner)* dan *digital photogrammetry* dalam pengelolaan sumberdaya budaya, khususnya warisan budaya dunia (world cultural heritage) Candi Borobudur. Secara khusus, penelitian lebih difokuskan untuk mengetahui manfaat dan produk kedua teknologi tersebut yang dapat digunakan dalam pengelolaan warisan dunia Candi Borobudur.

Penelitian ini mencoba menerapkan konsep “*digital humanities*”, yaitu penggunaan metode komputasional atau perangkat digital untuk menafsirkan dan memahami hal-hal terkait kemanusiaan, termasuk di bidang budaya (a.l. sastra, sejarah, filsafat). Konsep tersebut diterapkan pada pengelolaan warisan budaya dunia Candi Borobudur, yang diamanatkan untuk mengidentifikasi, melindungi, merawat, menyajikan dan meneruskan nilai-nilai warisan budaya itu kepada generasi mendatang. Hasil penelitian ini menunjukkan pemanfaatan Lidar TLS dan fotogrametri di Borobudur telah menghasilkan olahan data, berupa 3D image model, asbuilt 2D, fly through animation dan true view 360°. Untuk tugas konservasi dan pemugaran, data ini dimanfaatkan terutama untuk merekam kondisi warisan budaya, mengenali perubahan secara mikro dan makro, dan merencanakan restorasi secara lebih mudah, akurat, dan hemat waktu.

Dalam melaksanakan program monitoring kelestarian Candi Borobudur, kedua teknologi digital itu sangat bermanfaat untuk mengetahui laju kerusakan dan menyediakan sistem peringatan dini (*early warning system*) karena dapat menyediakan data yang konsisten, lebih terukur, akurat dan mudah dihitung. Produk teknologi Lidar TLS dan fotogrametri ternyata juga sangat membantu dalam program edukasi pelestarian karena lebih mudah diolah menjadi tampilan yang menarik, informatif, mudah dipahami, dan dapat disebarluaskan secara luas yang berdampak pada peningkatan apresiasi, pemahaman, kepedulian, dan partisipasi masyarakat luas untuk memperkuat pengelolaan Candi Borobudur. Selain itu, hasil teknologi digital ini juga bermanfaat dalam presentasi informasi warisan budaya, khususnya untuk membuat miniatur monumen dan replika artefak. Cara ini tidak beresiko merusak benda aslinya, lebih akurat, dan presisi. Pemanfaatan teknologi digital tersebut akan menjadi semakin maksimal apabila dapat dibangun sistem pemodelan informasi warisan atau *Heritage Information Modelling (HIM)*. Apalagi, sejumlah data dan perangkat sudah dimiliki oleh Balai Konservasi Borobudur dan tinggal mengintegrasikan. Dengan adanya HIM, berbagai kegiatan pengelolaan akan dapat dilaksanakan dengan lebih baik.

Kata Kunci : *Lidar Terrestrial Laser Scanner, Digital Photogrammetry, Candi Borobudur, Warisan Dunia*

ABSTRACT

Recently 3D digital technology has been considerably applied to enhance heritage management in many parts of the world. In Indonesia, however, such technology is very limitedly used except in Borobudur World Heritage conservation. This thesis discusses the roles, benefits, and usage of Lidar TLS (Light Ranging and Detecting - Terrestrial Laser Scanner) and digital photogrammetry in the management of Borobudur. It is focused to reveal the products of the digital technology and how these are beneficial to the management of the World Heritage.

This research attempts to employ “digital humanities” concept in which digital instrument and computation are used to interpret and understand humanities, in this case the management of Borobudur World Heritage. In general, the duty of the Borobudur management is to identify, protect, conserve, present, and transmit the heritage values into the future generation. The application of Lidar TLS and 3D photogrammetry in Borobudur has produced 3D image model, as-built 2D, fly through animation and true view 360° which are very useful especially in conservation and restoration. The technology is able to record accurately the condition of heritage and to recognize easily changes in micro-condition of heritage material as well as macro-condition of heritage environment. It is also helpful in restoration planning.

The two digital technologies are also beneficial in monitoring the state of conservation of the World Heritage. The data produced are consistent, measurable, and easily computed, thus providing a reliable rate of material deterioration. In addition, the data can also be set as an early warning system. The products of Lidar TLS dan 3D photogrammetry are also valuable for public education of the World Heritage conservation. It can be manipulated into attractive, informative, easily understood, and widely distribute via internet and social media. Certainly, this will enhance appreciation, understanding, attention, and participation in conservation effort by public. Such technology also offers a more secure ways to make miniature of the monument or replicas of reliefs or artefacts to enhance presentation of information on the heritage, as it is not necessary to have physical direct contact with the heritage. What is more, the result is also more accurate and precise almost exactly the same as the original.

The use of the digital technology in the management of Borobudur World Heritage will be much advantageous if the management can build the so-called Heritage Information Modelling (HIM). In fact, some of the equipment and the data needed for HIM are already available in Borobudur Conservation Office. It is only a matter of integration of the data and equipment into the HIM system is necessary. When HIM is established, many more management activities of the Borobudur World Heritage would be possible to be organised and conducted more easily, efficiently, and integrally.

Keywords: *Lidar Terrestrial Laser Scanner, Digital Photogrammetry, Borobudur Temple, World Heritage*