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Digitizing Cultural Heritage of Nepal: Tools for Conservation and Restoration

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Abstract

Our identity as a human being is a result of generations of handed-down culture and traditions. The definition with which we identify today as a society, as a community, as a nation and as a world all dates back to time immemorial. Be it the 2015 Earthquake that hit Nepal and shattered most of our preserved monuments or the stolen artifacts which are sold for millions to foreign countries illegally, every passing day, our identity as Nepalese is threatened. With little importance paid to the 'actual conservation' of our temples, monuments, arts and crafts, this paper calls for sensitivity towards a cultural emergency. While problems exist, solutions have been adopted in the past, like the 3-D Laser Scanning of Pancha Deval Temple or the efforts made by National Heritage Documentation Project for constructing a wide-ranging digital records of historical artistic monuments in the danger of extinction. To preserve the roots of our forefathers, we should ramp up the process of utilizing available technology. With the evolution of technology, we have many resources to take inspiration from. Digitization of Cultural and National Heritage will help secure our original heritage in the finest of the finest circumstances. With the aid of technologies like Machine Algorithms, Laser scanning and many more not only the physical structure of the heritage can be preserved but also the age long history behind the heritage will be intact. The following paper outlines some possibilities of using new technologies in the heritage of Nepal and possibilities to explore further.

Keywords*:* 3-D laser scanning, digitization, cultural and national heritage, algorithms, robotics

Introduction

The United Nations Educational, Scientific and Cultural Organization (UNESCO) Framework for Cultural Statistics defines cultural heritage as that which includes artefacts, museums, monuments, sites and buildings which have diverse values like symbolic, ethnological, historic, aesthetic, artistic or anthropological, social and scientific importance. Basically, cultural heritage incorporates tangible heritage : movable or immovable or underwater; cultural heritage also incorporates intangible heritage which have been embedded into the artefacts, monuments

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and sites. Cultural heritage also covers any cave paintings or industrial heritage (UNESCO, 2009). The 1972 Convention Concerning the Protection of the World Cultural and Natural Heritage defines Natural Heritage as the natural features, formations which are physiographical and geological and also those delineated areas which constitute the environment and habitat of endangered species of plants, animals and natural locates of value from the viewpoint of natural beauty, science and conservation (Heritage, 1972). Natural Heritage also includes publically as well as privately protected natural habitat, reservoirs, marine ecosystems, botanical gardens, zoos, sanctuaries, aquaria and other natural areas (UNESCO, 2009).

Nepal is a country which is rich in natural and cultural heritage. Altogether there are ten World Heritage Sites in Nepal as enlisted by UNESCO. Besides, there are numerous cultural heritage sites in Nepal like the Durbar Squares, Stupas, Temples and many more. The Natural Heritage of Nepal have been preserved in various National Parks like Sagarmatha National Park, Chitwan National Park and many others (Proudhindu, 2014). Additionally there are many medieval architectural complexes as such of the Panauti as well as the ancient Shakya Kingdom's archaeological remains in Tilaurakot. Other important heritage of Nepal include the Muktinath Valley's cave architecture in Mustang and the Mustard oil seed heritage of Khokana. The list goes on (Board, n.d.). Estimably, 2900 heritage structures in Nepal, especially in Kathmandu Valley and other northwestern regions were severely affected during the 2015 Earthquake in Nepal. Around 700 heritage were damaged among which 131 were totally destroyed by the earthquake (Dhonju, 2018). This is only one instance where cultural heritage of Nepal were threatened due to a natural calamity, there are still many such anthropogenic and natural threats which directly affect the Natural and Cultural Heritage in Nepal. Hence, preservation of such heritage remain a big challenge for a developing country like Nepal. Preservation and Restoration are both important facets of developing a nation holistically for which technological advancements are a vital factor. Heritage objects have certain values of sentiments, history and antiquity attached to it, restoration requires precision and accuracy with regards to the object being preserved. It is here where new technologies come into play. Digitization remains one of the many imperative technological processes which aids in heritage conservation (both cultural and natural heritage). Be it the physical structure of the object or the skill of art which has been handed down through generations, everything has a mathematical calculation and geometrical figure with can be reduced to algorithms and numerical value which are understood by electronic machines like the computer (Pavlidis, 2006). Preservation of heritage through electronic means makes it durable and reliable at the same time. In this modern era of technological development, there are various tools and techniques for heritage conservation and restoration through electronic means, the same has been detailed and discussed as the paper follows. Such technologies need to be sustained in Nepal since our country has an abundance of heritage which need to be preserved today and for posterity.

The main question then is what are the efforts made by Nepal to utilize emerging technologies and trends to preserve the heritage in the country? Have there been instances in the past when institutions in Nepal undertook initiative towards introducing such platforms of digitization in Nepal? Finally, how can Nepal, looking at the economic and technological constraints present in the country, introduce such new technologies in conservation of Cultural and National Heritage? Such questions have been addressed in the paper. The major objective

of this paper is to make the readers familiar with the available technologies in the field of heritage preservation and restoration, especially post-earthquake era where many heritage sites of Nepal were affected. The paper also outlines efforts made by Nepal in introducing technologies in Nepal vital for protection of our cultural and national heritage.

UNESCO defines digital heritage as that which is made of computer generated materials that which has an enduring value and can be kept for the generations to come (UNESCO, 2022). Digital Heritage comprises all heritage which have been handed down to communities through generation and has various forms, preservation of such heritage is a vital area to work upon.

Methodology

The article elaborates and provides a description of various emerging developments in technology in preserving heritage. The paper has been prepared by evaluating, analyzing and critically assessing the efforts put forward by Nepal in the process of digitization in addition to highlighting some best practices. Simultaneously, a comparative study has been carried out with regards to the Tools of Digitization and instances of usage of such tools in the context of Nepal.

Literature Review

In their paper titled 'Methods for 3D Digitization of Cultural heritage', Pavlidis (2007) has set out that digitization of cultural heritage is a multidimensional process which has a plethora of methods, technologies, and approaches. The very target of every single one of such techniques is to appropriately address a particular type of object or class of objects or different forms of such monuments, or to achieve particular set of demands and needs of a specific digital recording project through precision which includes and is not limited to a comprehensive recording for the purpose of archiving heritage, digitization for presentation of natural and cultural heritage as well as digitization for commercial exploitation. Similarly, Gomes (2014) has emphasized that Cultural Heritage objects and sites greatly differ from each other and a maximized conformity of the 3D reconstruction is a core and fundamental requirement. The scholars have further emphasized that digitization of heritage ensures that objects to retain their shape and appearance and do not lose their authenticity while ensuring accessibility for the general public through virtual museums, which ensures long term protection. In their paper, Pandey & Kumar (2020) discovered that many of the digitization projects had been challenged by inadequate funding, lack of national-level digital preservation policy and the absence of technical infrastructure in the process of digitizing and preserving the cultural and heritage resources. The same kind of analysis can also be found in the context of Nepal. The paper has further identified that in order to provide long term access to analog and digital information for future generations, the preservation of cultural material is a crucial aspect.

Concept of Digitization

Digital Technologies have a great potential in safeguarding and conserving some of the most valuable assets that have been in existence over time, more so in preserving some of our increasingly endangered natural and cultural heritage. The process of Digitization, in the

simplest understandable form, includes converting any physical pictures, arts, texts, sounds and many others into digital form which can be administered and processed by a processor in a computer. Digitization results in the representation of a document, sound, object, image or signals in a computer readable form, also called a digital form or digital representation, which can be obtained by generating a series of numbers which describe a distinct set of points or samples. In the practice of modern times, any digitized data is in the arrangement of binary numbers which enable processing by digital computers and various other operations. Simply, digitizing means the transfiguration of analog correspondent source materials into arithmetical-numerical format, decimal, binary or any other number system that which can be used instead of the source material itself (Bloomberg, 2018). Digitization of any archaeological sites or monuments includes the exact documenting and recording of the site object's geometrical features in such a way that it reliably depicts its geometric structure, form and location in space or area with the use of diagrams be it 2-D (two dimensional) or 3-D (three-dimensional) models with the help and use of personal computers (Dahal, 2008). There are various techniques used in Digitization. Some of them include Photogrammetry which uses photographic images to extract reliable metric information of objects and environment, another is Scanning which uses laser-triangulation using laser-based instruments commonly known by the name: terrestrial 3D Laser Scanner. Along with Laser Scanners, Laser Detectors and Laser Profiles are used to scan a monument and record the geometric characteristics of the cultural heritage. Such information is used to create contour patterns and preserve them for the future generations permanently. These instruments have high level of accuracy even over larger space areas. The multi-dimensional process of Digitization covers various thematic areas like Information Management, Documentation and Recording of Information Systems of the Cultural Heritage. In addition, other matters like digital image processing, archaeological surveying, 3-D representation of structures as well as management and photography of various cultural landscapes is covered by Laser Scanning and other techniques of Digitization (European Union, 2018).

Tools of Digitization for Restoring and Conserving National and Cultural Heritage

Any form of Digital Recording of Cultural and National Heritage is a vital step in conserving, restoring and understanding the values of memories of the past. Creating a precise digital record for the future generation also provides a means to educate and communicate any knowledge to the society regarding any skills and value of tangible objects and remains of the past (ICOMOS, 2022). Some of the major tools of preservation through Digitization have been discussed below:

3D Tools

Some major 3D Tools within the ambit of 3D Digitization include 3D Laser Scanning, 3D Line Drawing, Geometric Modeling, Texture Mapping and many more. Large numbers of heritage get destroyed and damaged because of disaster (both man-made and natural), natural eroding and weathering away. In these kinds of unforeseeable situations, capturing the digital form of various forms of natural and cultural heritage and objects can be very useful for conservation, restoration, access and scholarly study of the particular kind of natural and cultural heritage. In the modern era, great strides have been made in 3D Digital Technology which have proven helpful for the archaeological and digital preservation of the heritage. Using 3D Technology, geometry and texture of the object can be recovered, both with high-level

precision and accuracy. The modern three-dimensional technology can be helpful; in virtual restoration, digital archiving, virtual display and 3D Line Drawing. Within the massive pipeline of 3D Digitization, many techniques are incorporated among which are 3D Data Capturing, Geometric Modeling, 3D Registration and Texture Mapping (Renju Li, n.d.). Texture mapping includes a graphic designing process where by a 2D (two-dimensional) surface called texture map is wrapped around a 3D (three dimensional) object. It is a method in computer graphics of applying imageries to plain surfaces (Malešević, 2013). 3D Data Capturing includes using different methods in obtaining a range data from various views, the data need to be merged and registered which is then termed 3D Registration. The process of Geometric Modeling includes a process of polygonising (to sub-divide a plane into polygons which are 2D- two dimensional shapes made of straight lines and the shape is closed meaning all the lines connect), filling in the polygons and some other post-processing technique. The final output of the process of geometric modelling is a mesh that represents a geometric property of an object. Therefore, for a more realistic rendering, the process of Texture Mapping is required to map high resolution photos on geometric models (Ltd.)

The 3D Tools are a form of Digital Preservation which combines various strategies, policies and actions in order to ensure proper access to digital content regardless of the different forms of challenges like technological change, media failure or others. The data once recorded remains there for generations to come with no damage. The main goal of such digital preservation is to render accurate and authenticate content even if it covers the period of long years (Khan, 2018). Therefore, even if there are certain forms of natural or manual intervention, the preserved heritage is not affected and the future generation will have access to the information of the heritage. The 3D Scans blueprints and other mathematical data remain in the software forever. Hence, 3-D tools are the best option for a country like Nepal whose heritage are prone to damage through various calamities and disasters.

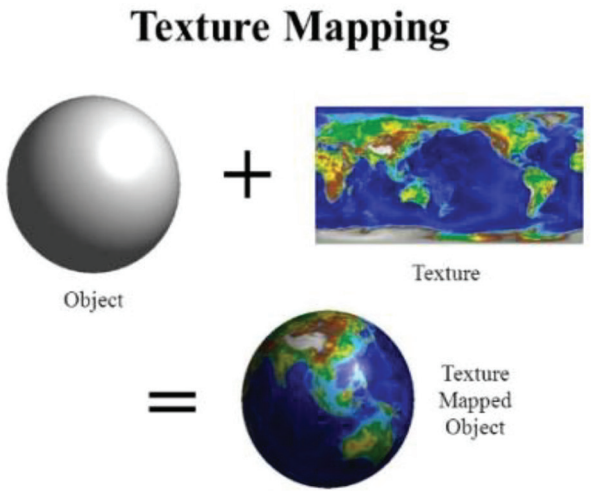


Figure - Texture Mapping (Creative Commons, 2019)

Instance of 3D Laser Scanning in Nepal (Pancha Deval Temple)

After the 2015-Nepal Earthquake, in 2018, with the collaboration of and in association with UNESCO-Nepal, Prairie View A&M University, School of Architecture (PVAMU-SoA), had extensively led a comprehensive 3D laser scanning of Pancha Deval Temple in Kathmandu. The principal aim of this scan was to create an analog and digital record of the temple as it was a historic site which had been affected by the earthquake. After the 3D laser scanning, it was found that 3D Laser scanning has an exceptional capability, as well as long term potential for a standard use in any preservation, restoration and conservation projects related to natural and cultural heritage. The method could generate accurate and precise data with no-contact means to the object (Batson et.al., 2018).

Figure- 3D Model of Pancha Deval Temple (Batson et.al., 2018)

Artificial Intelligence

Artificial Intelligence (AI) and other advanced technologies can help with the digitalization, restoration, conservation, maintenance, management and preservation of many tangible heritage, both cultural and natural . AI works as assistants to historians and archaeologists in conserving work which cannot be done by humans on their own or any time-consuming project. Additionally, AI works as important tools for people to make the best utilization and improve their working processes to a higher and efficient level (Yan, 2022).

Artificial Intelligence is a sub-field of computer science as well as mathematics that is related with the study of human intellect in terms of machine understanding for the performance of a specific task in a distinct and well-defined manner on its own. Artificial Intelligence may also refer to any simulation of human intelligence in machines, which have been programmed and set to think, act and perform like humans. Machine Learning, mathematically comprises of sets of algorithms that automatically acquire from data, a sub-set of Machine Learning is Deep Learning which extracts and takes the features from the database and excels in resolving problems within high dimension (Das, 2022). The major role of Artificial Intelligence and related technologies in natural and cultural heritage is to preserve and restore them. There are specifically two main emphases and foci of AI; first is in the ambit of textual format and second is the preservation and restoration based on a sensor called the Internet of Things (IoT).

To explain it better, for instance, AI can help process millions of historical monuments, landscapes, historical documents, texts, paintings and much more. Language Technology (LT) is also connected with AI, hence many forms of research work can be made possible by using language technology on historical textual data. Various kinds of developments have been made throughout history through language technology, for instance, language understanding and generation of Parts of Speech of any language, other works which have been done include tagging of parts of speech, analysis of morphological data and text (morphology is study of internal structure and arrangement of words), translation by machine, summarization of texts, retrieval of information, answering of questions, analysis of sentiments and much more.

We can for instance take an example of digitization of any novel, textual data, literature or historical manuscripts such as, holy texts like Bhagwad Geeta, Ramayan, Mahabharat using AI and Language Technology. Digitization work involves proper tagging, cataloging and labelling process. To understand it simply, once the entire textual data has been fully and properly labelled, catalogued and tagged with accurate annotations, it then turns into being a good corpus (*corpus* is a body of text).

To help ease this lengthy and hectic process, sometimes machines can also help in doing laborious work for a large amount of raw corpus with the help using Language Technology as well as machine receptive algorithm for faster processing which is not time-consuming and tedious. Such machines are incorporated with AI Technologies. The primary advantage of digitization using the tool of Artificial Intelligence is that the object can live for lengthy period of time through long years. Another major advantage is that the object becomes an extremely useful resource for scholars, researchers, academicians as well as industry individuals. These kinds of findings are widely used in research works like retrieval of information, automated translation and many more. Many historical monuments of Nepal, for instance, the centuries-old temples have been worn and torn over a long period of years, sometimes certain pieces of the architecture, like stones keep falling from the structure. In such situations, when there is no human resource to assess the situation, AIs can prove to be extremely helpful. AIs can restore those destroyed structures in terms of sensor; the sensors of AI will aid in capturing frequent images of the structure and frequently analyze the data from the image to extract information as to the structure's situation assessing the weak and strong portions of the structure. Such data from the captured image can also be stored in the form of numeric values represented in the forms of vectors or array (*vectors* are mathematical or geometrical representation of a quantity having both magnitude and direction. Related learning algorithms then may be applied to such numeric values to analyze the data. Therefore, damage can be assessed and repairing can be done soon with the help of such analyzed data.

Robotics and Algorithms

Robotics falls under the branch of engineering; more specifically under the branch of computer science (Bibliothek, 2020). Robotics mainly includes everything about robots from construction to design, use and overall operation of robots. Robots are machines which have been programmed by a computer and are capable of performing complex actions, sometimes even beyond human aptitudes. A robot basically has three major structures; a mechanical construction; electrical component to supply power to the machine and; a computer programming to provide instructions

to the machine to perform specific tasks (Revision, 2022). The chief aim of the field of Robotics is to come up with machines which are capable of helping and assisting human beings in various activities. Robotics is an inter-disciplinary field, therefore requiring the integration and aid of various other independent fields. In a way, Robotics brings together many other areas of engineering like mechanical, electrical, information, mechatronics, bio-engineering, computer, control, software, mathematics and many more. Robotics basically develop electronic machines that are capable of substituting for any form of human actions as they replicate those actions and perform as per the instructions provided in numerical form understood by machines, like binary numbers in the form of 0s and 1s. An important building block of robotics are algorithms. Simply put, *algorithms* are a finite sequence of instructions which are used for solving specific kind of problem in mathematics, data processing and computer science. Thus, algorithms set out instructions for the robot to perform instructed tasks. Robot algorithms are important tools as they apply to physical objects in the real world which go one step further than just computer algorithms as they connect to robots in the corporeal domain with regards to heritage conservation (Tsianos, 2010).

With regards to heritage preservation, mobile robots have been used frequently in the past. Mobile Robots are automatic machines which are controlled by software using sensors and various other technologies to locate, identify and assess its surrounding as well as having capabilities of locomotion. Such mobile robots have been used in museums in many countries, for instance, in Italy where mobile robots have been put in place to source isolated contact to users at a distance, also accommodate and guide people while in the museum and at the same time survey areas where entry is not permitted and record the data. The robots are equipped with sensors, cameras and other tools like laser range-finders (Milella, 2008). Surveying of the Archaeological Objects and Architectural Structures is considered a complex field in itself, therefore, by using Algorithms and Robotics, it is possible to penetrate into the deepest and concealed nature of architectural monuments, as well as bring to light the stories and other historical events which had occurred: the stories in which the monuments and objects were the central character in the time that has long passed by. Robotics also help bring out the original form of the structures with accuracy and precision, at the same time subsequent transformation of the monuments over various eras are also noted by such technologies which provide us with a full image of the ancient structures and archaeological monuments graphically. Another useful facet of the tool of Robotics is in monitoring. The kind of monitoring done by Robots is put in a 3D created virtual form through a computer which has proven to be very helpful as it allows a more time-efficient and cost-effective planning. It is useful in testing a model from its initial phases itself—from design to operation within the environment which is an accurate and precise simulation of the area which is being conserved, restored or preserved. Also certain forms of modifications can be carried out in cases where mistakes have occurred in the process of re-construction of the ancient objects which otherwise would be risky to carry out on an original piece of monument or structure (Ceccarelli, 2008).

Examples of Robots used for heritage preservation

Unmanned Aerial Vehicles (UAV)

A great example of Robots which have been used for heritage conservation is the Unmanned

Aerial Vehicles (UAVs also referred to as Drones). UAVs are autonomous aerial robots which are efficient in technological assistance. UAVs are capable of monitoring, documenting and observing areas which are not easily accessible within the ambit of human abilities. If not for the drones accessing the difficult to reach areas, humans would need to build scaffolding or platforms which are high lift, but with new technologies human efforts are minimized. Specifically in the field of documentation of interior structure of structures with historical value and other difficult to reach areas are monitored by the UAVs. If we are to compare taking photographs all the way from ground to using UAVs, there is a comparatively better performance by UAVs as they offer time-efficient and fast documentation of the structure's interiors, surfaces and other areas from appropriate angles. UAVs also provide a seamless, continuous chain of assessment of structural/mechanical integrity of the buildings and other constructions, they also allows sporadic assessment and examination of the structures as well as provide precise data as UAVs are mounted with sensory equipment (Vít Krátký, 2021)

Figure- UAV also called Drones (Getty Images)

Autonomous Underwater Vehicle (AUV)

Another example is the Autonomous Underwater Vehicles (AUV) which is used specifically for conservation of underwater heritage like various marine species, plants and animals. AUVs are also used for discovery as well as the surveillance of various underwater archaeological sites. AUVs are cost-effective in comparison to other technologies which are used in the current times like submersibles which are manned or ROVs (Remotely Operated Vehicles) (Ramiro Dell'Erba, 2019). AUVs are un-crewed and are used specially for survey missions like mapping, surveying and detecting submerged wrecks, remains, rocks and various such obstructions underwater, during such survey mission heritage are also recorded and the data is analyzed to preserve the heritage present underwater (Service, 2022).

Figure- Bluefin SandShark Unmanned Underwater Vehicle UUV (General Dynamics)

Attempts Made By Nepal: The 2019 Digital Nepal Framework for National and Cultural Heritage Preservation

Nepal has set a goal of achieving the developing nation status by 2022 and by 2030, Nepal aims to achieve middle-income country status. While Nepal's digital journey is progressing relatively slower than its neighboring countries, the growth is steady. Our digital journey is still stuck to internet penetration and mobile penetration as there are many places where even light has not reached. Therefore, to address this problem and with an aim to digitize Nepal, in 2019, the then Government of Nepal, Ministry of Communication and Information Technology, in collaboration with Frost & Sullivan came up with the 2019 Digital Nepal Framework (Government of Nepal, 2019). The Framework is a blueprint and a plan which offers a roadmap on achieving certain positive aspects through digital initiatives such as how digital initiatives could contribute to the economic growth of Nepal, also to find innovative and creative ways to solve some major specific challenges in a time-efficient way, in light of the paucity of resources. Not only this, the Digital Framework also aims to achieve opportunities for Nepal which would enable it to participate in the global economy and be a vital part of it. The Digital Nepal Framework has six major steps of strategic methodology for the implementation of the vision of integrating Information Communication Technology for development of Nepal. The steps include:-

i. Draft Framework

ii. Integration

iii. Roadmap with Recommendations

iv. Framework Delivery Methodology

v. Implementation

vi. Monitoring and Evaluation

Additionally, the Framework has eight sectors and eighty digital initiatives it aims to work on. The 8 sectors include; Education; Agriculture; Tourism; Energy; Urban Structure; Health; Digital Foundation and Finance. Simultaneously, 80 digital initiatives have been identified under those 8 sectors (Government of Nepal, 2019).

However, special focus has not been given to digitizing Cultural and Natural Heritage of Nepal. Digitization should cover each and every aspect of a country's original and primary heritage in order to achieve a holistic development—be it social or economic growth. Cultural and Natural Heritage is the identity of a country, hence preservation and restoration of heritage is the preservation of the identity of a nation. Despite this crucial knowledge, the Digital Nepal Framework could not address digitization of heritage conservation in Nepal. Nevertheless, the efforts cannot be negated. The Government, in order to revitalize the tourism sector, had come up with a 100-day action plan to achieve the target in key areas like Technology, Innovation, Infrastructure and Administrative Sector. One of the key points under administrative sector was to settle the debate over usage of modernized raw materials to construct ancient archaeological monuments and heritage. This goes to show how important digitization is; because, in order to rebuild ancient monuments, the choice of raw materials, history of monuments and other

important details need to be identified and recorded for future when the heritage monument may need reconstruction. This is possible only through digitization as the original structure can be preserved through various tools of digitization like Artificial Intelligence, 3D Technology and many others.

Under the Tourism Sector of the 2019 Digital Nepal Framework, the cultural and natural heritage sites were one of the priorities of Government of Nepal. One key priority was to introduce solar energy in vehicles to reduce pollution in Lumbini World Heritage Site. In fact in 2017, a grant of 1.35 million US dollars had also been allotted to procure a 150 KW (kilo watt) solar power plant. Also, the Framework has mentioned how Digitization can act as an enabler in the preservation of cultural and natural heritage like heritage and monumental sites could be connected to Internet of Things (IOT) and sensor technologies as well as QR Codes (QR = Quick Response) and RFID tags (RFID = Radio Frequency Identification) in order to provide necessary information with regards to the particular sites. Another initiative by the Government of Nepal includes the ongoing programs by Nepal Tourism Board like 'Safa Nepal' which fosters hygiene and cleanliness around heritage and monument sites. Another great initiative to fill the void in tourism infrastructure of Nepal, an app called 'Welcome Nepal App' was set to provide information on heritage sites of Nepal for tourists among various other functions of the app. To some degree, the important data of heritage of Nepal has been digitized, even though much remains to be done.

Thus, the Framework, overall, has somehow touched the aspect of introducing Information and Communication Technologies to the Cultural and Natural Heritage of Nepal. However, the core areas of Digitization specifically in the sector of Natural and Cultural Heritage preservation has not yet been addressed. Hopefully, the 2019 Digital Nepal framework is the starting step for Nepal and there are more areas of heritage conservation for Nepal to work on in the future.

Best Practices of Digitization of Heritage around the World

Each and every cultural heritage around the world tells a story—story of a past which is the foundation of generations that have gone by and for those that are yet to come. For a better understanding of how the concept of Digitization of Cultural and Natural Heritage work, it is crucial look at the some of the best practices and most influential works around the world. They have been roughly outlined below-

The Digital Michelangelo Project

In the year 1998 A.D., a professor of Computer Science at Stanford University, Prof. Marc Levoy alongside his team began the Digital Michelangelo project_at Stanford University (Norman, 1998) with an objective of creating a 3D computer archive of the principal statutes and architecture of Michelangelo. Popularly known as the masterpieces of Renaissance sculpture that have been created in marble between 1501 and 1504 by the Italian artist Michelangelo, the project was aimed at digitizing this very heritage in Italy. Laser Scanners had been used as a newest form of technology for the project which was a very innovative concept at that time. The data obtained in 1998 through laser scanners had been extremely useful during 2002 where restoration of the sculptures had begun. Additionally in 2009, a 3-D model of the sculpture was also ready (Levoy, 1998). This is a renowned example of digitization which shows how new technologies can help preserve such ancient monuments for so many years to come.

Figure- A 3D printed replica of Michelangelo's Statue of David (3Dnatives)

Conclusion and Recommendation

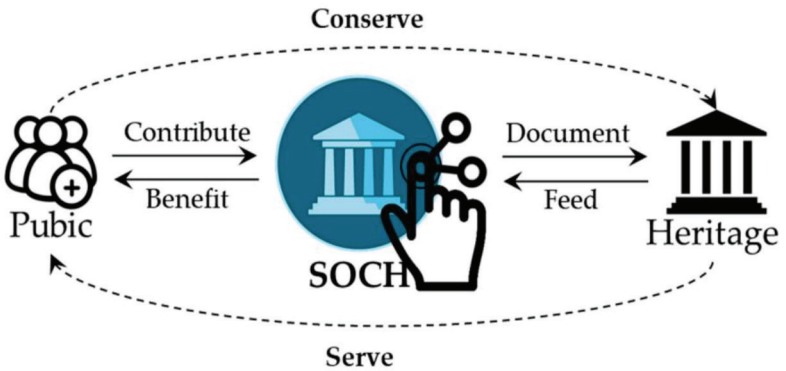
In Nepal, the awareness regarding value and importance of our cultural and national heritage among public is very little. Such non-recognition by the local inhabitants and the authorities involved is the main reason why there is a heritage emergency in Nepal. The heritage which is present in various parts of the country has not been cared for adequately, also discovery of new heritage and conservation of the ones present remains a big challenge for Nepal due to lack of proper resources, natural calamities or other reasons. It is thus important to address the situation in the most pragmatic way. Even today technologically advanced machines which are crucial for heritage conservation remains a far off idea for Nepal. In this situation, it is necessary that the government prioritizes the agendas related to our heritage. Cultural and Natural Heritage also is a major part of travel and tourism and carries a great economic value for a country. In addition to the economic value, heritage have great economical and spiritual importance as well. For this conservation, restoration and preservation of heritage is important.

First, Nepal is far behind in drafting proper laws and frameworks that are relevant in modern times. The *Ancient Monuments Preservation Act*, 2013 (1956) needs to be amended and new perspectives need to be added to the existing laws to accommodate the changing dynamics of the society. Frameworks like the 2019 Digital Nepal Framework need to incorporate aspects of digitization of Cultural and National Heritage of Nepal and be updated with the advanced technologies which are useful for heritage preservation.

Second, the principal governmental institution which has been established by the Ancient Monuments Preservation Act, called Department of Archaeology, lacks necessary resources and other mechanisms which are required to oversee and monitor the heritage spread throughout Nepal. Besides the Department of Archaeology other such government funded or private institutions need to be brought to light, research wings need to be established within the departments for effective monitoring, researching and preservation of heritage as well as to search the possibility of techniques for digitization within the cultural context of Nepal. Government needs to invest more in this department and sufficiently provide them with resources. The departments also need to analyze the local cultural contexts and move forward with the action plan of conservation of heritage rather than rely on international standard frameworks.

Third, the documentation of cultural and national heritage of Nepal need to be reality-based where in real objects are measured, mapped and recorded in the data using various tools and techniques. An instance of this is the Share Our Cultural Heritage (SOCH) initiative, which is an initiative for large scale documentation of cultural heritage worldwide using various technologies like geo-crowdsourcing system (Dhonju, 2018). Crowdsourcing along with citizen science are systems which have been used recently to voluntarily collect geographic information which is usually supported by web and mobile geographic information system (GIS). In Nepal, such systems can be launched where common public can give out information regarding certain Cultural and National heritage sites and such data can be proof-checked and researched to make them more efficient.

Figure- A demonstration of SOCH initiative



Crowdsourcing is only one such technique, other tools like mobile apps, photogrammetric modelling 3D reconstruction, web-mapping, online visualization techniques and many others can be put to place to record important information about the heritage sites. Apps engaging the public are also necessary.

Finally, the pre-existing projects like Annapurna Conservation Area Project (ACAP) and many others need to be well-equipped with latest technologies which can aid in their quest for discovery and conservation of heritage sites. Other initiatives like the ACAP and the initiative taken by Former King Mahendra called the KMTNC (King Mahendra Trust for Nature Conservation) for management of Upper Mustang Lomanthang region need to be established and equipped with technological machines for better monitoring (Chapagain, 2008).

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