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PAPER

Development and Creation of Ancient Sandstone Carvings Using 3D Software Tools and Mobile/ Tablet Devices

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ABSTRACT

In the area of Phayao Province that used to be part of the ancient Lanna Kingdom, there are unique works of art that can be found until today, which are sandstone carvings caused by religious beliefs resulting in works such as Buddha statues. These are art related to religion. Nowadays, these works of art have started to fade away and receive less and less attention from people. The creation of art objects in this research therefore uses the interpretation of the creative objects in line with people's lifestyles by selecting the lotus, which is a plant related to rivers, and is important in religion. In the lotus, which is interconnected and aligned with Buddhism, and in harmony with a way of life that aligns with the river, creative works are found in various forms, connecting people in Buddhism, including sandstone carving. In this creation, digital technology tools and methods are used to collect data to create a 3D work piece. Photogrammetry is used to record detailed proportions and information and customization of 3D work pieces. In these steps, mobile phone-type tools are used to collect image data to create the 3D work or an application is used to customize 3D work pieces from a tablet device to create prototypes of sandstone sculptures from the artisans that remain today. This can be seen in creating, maintaining, and recording digital data, creation, and the integration of knowledge. This demonstrates that today's tools and portable devices can help create more creative pieces of work and preserve art and culture.

KEYWORDS

photogrammetry, 3D artifact, sand stone art, 3D mobile creative, mobile design tools

1 INTRODUCTION

Belief and religion have existed for thousands of years in this world and have been the cause for the creation of many works of art, depicting beautiful things and using the creative potential of humans from generation to generation. Creative arts are directly inspired by names and religions, especially in Buddhism, where

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representations of the Buddha have been created and used by Buddhists to commemorate him. The Buddha statues are something that Buddhists believe in. Therefore, techniques and methods have been used to create exquisite figurines by choosing methods according to the aptitude of the developers of each race using different characteristics and materials, especially in the northern region of Thailand, which used to be part of an important kingdom in the region, the Lanna Kingdom. Sandstone Buddha carvings or creative works related to beliefs and religions, especially Buddhism, are said to have originated from the Phayao craftsmen families. This was influenced by Chiang Saen art, which is regarded as a major civilization of the Lanna civilization areas, mixed with the Sukhothai art tradition, bringing wisdom and the craftsmanship that is unique to the people of Phayao in carving sandstone to form a Buddha statue, bringing faith art and science to create exquisite craftsmanship. And it is considered the only source in the Lanna Kingdom in Thailand today where sandstone is carved in this style and technique. It was influenced by the art that was powerful in the neighboring kingdoms, both Sukhothai and the original area, the Chiang Saen Kingdom, which was created in the 19th century BC and prospered until the end of the 23rd century BC, and gradually faded away in the end. Only the remains of these works can be seen today.

The study of real sandstone carvings and art is a challenge due to its weight, which makes moving it around difficult, and also the fracture and erosion of the sandstone materials, especially ancient sandstone. In addition, there is no record or knowledge of the sandstone art of ancient Phayao craftsmen. Referring to records or information is therefore one of the problems in studying sandstone art. The absence of any such records or manuals about the skills of the ancient Phayao sandstone carvers is widely known to researchers and archaeologists on the topic. Knowledge was transferred from generation to generation orally and through practice. Nowadays, this knowledge is limited to only the elderly craftsmen who continue to practice this art, which is another factor concerning the art. Much of it may be lost or decayed over time.

The creation and study of art and antiquities information has been developed along with the use of technology to support it, allowing access to learning. As well as being an inspiration in terms of aesthetics for the audience to see such works more, it is beneficial to use technology, especially multimedia technology, to recreate and disseminate these ancient art pieces. Tools such as 3D technology and multimedia modeling help to develop these art forms by recording data with 3D tools and technologies such as process photogrammetry. The use of 3D programs to create and modify 3D workpieces is widely popular in the conservation and study of art objects. It is easier to work with tools such as smartphones that are now capable of taking better pictures thanks to improvements in the sharpness of photography, processing, and preserving the details of the image. There are also applications that can be used to take pictures and process images obtained from a mobile phone camera into 3D works as well, although the details of the work piece are not as detailed as those processed in the computer. This gives opportunities for creativity and process workflow. Photogrammetry has caused more widespread distribution, which will affect a wider group.

Creative forms of design and digital art are now more accessible to people through evolving tools. There are many models. In particular, creative tools that can be used on mobile devices such as smartphones and tablets have become a big aid and are the main factors today as we see more and more design and creative professionals turning to these mobile tools. A digital drawing tablet (also known as a graphics pad) is a type of input device that allows users to draw images, pictures, and sketches

directly onto it. It can be a standalone electronic device or one that is displayed on top of another screen, such as a TV or computer monitor. This technology allows for natural creativity without the constraints of traditional paper-based tools such as size, frame, line thickness, and so on. Touch capabilities on a digital drawing tablet allow users to interact with their work in near real-time by using their fingers instead of pens and brushes. [1] shows the trend of using tools from smartphones and tablets to support more creativity and has the opportunity to grow more and more according to the popularity of using smartphones that is increasing. It depends on the increasing popularity of the market and the number of users, plus supporting factors. The use of technology from the aforementioned portable devices is considered a good way to maintain and inherit arts and culture, and bringing these values of arts and culture to extend and further study and create will also help. Let these arts and cultures be inherited and integrate with the lifestyle of the next generation. Technology can go along with it appropriately. Craftsmanship emphasizes direct material production, which can more fully express a product's authenticity. This research proposes a modular concept process construction model in which a feasible method (i.e., integration of product design, method and craft process) is used to bridge the gap between craft process and product design. Modern craftsmanship is produced using a manufacturing mechanism that incorporates four design characteristics: material, module, innovation, and living technology. [2] The creation and development of new works of art for the preservation and passing on of art is another important process that will help these guidelines and works of art to exist in conjunction with the way of life of people well. Each of these creations has applications that support the creation and improvement of design work. Especially the creation of 3D work that has been developed to be used on more and more portable devices and help with the creation and use of improved 3D programming tools too.

2 LITERATURE REVIEW

It can be said that today's technology and tools to record and create 3D objects from real data are diverse and it is easier to use and access due to the availability of simple tools in the camera. A photo taken in a camera or a smartphone can be used in conjunction with widely available computer programs. There are also specialized tools such as 3D scanners, equipment to analyze objects and to make 3D images, etc. Creating and storing 3D object data is possible, and is a necessary part and a reason to support and give a great push to art objects.

Many technologies, such as structured light, time-of-flight scanning, laser scanning, computed tomography, and photogrammetry have been developed and used in the past decades to digitize the 3d model of the human form. [3] Photogrammetry is now regarded as a competitive technology in the field of cultural heritage documentation and recording. Image-based measurement tools enable the creation of realistic 3D models, which can be used in a variety of applications, including archaeology. [4] In recent times, the accuracy and time of digital photogrammetry processing software has been evaluated. These articles discuss photogrammetric reconstruction of sites, including building architecture. Photogrammetry is useful in cultural heritage applications not only for accessibility through 3D modeling, but also for archaeological recording. [5] Photogrammetry is currently an effective tool for quickly and cheaply obtaining geometrical information from digital imagery. Nowadays, the derived photogrammetric product is almost always a 3D image model, and two distinct techniques for modeling objects coexist successfully: 'virtual'

reality and 'visual' reality. While the texture and object shapes in the former do not have to correspond to real objects, the 3D models in the latter are physical object replicas that help one understand their corresponding real objects. Based on the images used to texture both objects and environments, derived photogrammetric models can provide real measurements as well as virtual and visual realities. [6]

Aside from that, combining photography and digital processing techniques yields exhaustive, precise results. The resulting documentation is intriguing because it represents a hybrid of techniques that results in a multiform, dynamic final product. As previously stated, these features enabled us to obtain graphic products related to art preservation and the creation of promotional materials. [7]

Such tools and techniques are not only used for data recording, transmission, and education, but can also be used for development.

Point of view invariance using a 3D model during the restoration process results in the generation of restored 3D models of faces appearing in icons allowing models to be used in a variety of programs such as virtual reality, animations, and artistic trends. [8]

Creating photorealistic three-dimensional (3D) models of real-world scenes and objects is a difficult problem that necessitates advanced computer science and graphics knowledge. Virtual museums and historical documentation have benefited from systems that can reconstruct the 3D model of cultural artifacts. [9]

The scientific approach to art has been revitalized by 3D digital models. They have revealed themselves to be tools for the formulation of complex hypotheses to be investigated in prehistoric archaeology as testing and validation tools in some of their applications. [10]

Present graphic design and visualization technologies can create versatile 3D interactive-immersive platforms for the virtual recreation of Cultural Heritage monuments that can be used for learning, dissemination, and explanation of Cultural Heritage. [11]

An advancement of digital surveying techniques for historical buildings and cultural statues has enabled the creation of precise 3D models describing the geometry of those structures for use in heritage documentation, preservation, and archaeological interpretations. [12]

The 3D creation application, the use of such strategies or technologies to encourage honesty and connect thoughts and stories from the technological process is thus extremely important and required in the manufacturing and fabrication of components to aid in the completion and operation of this work. Computer technology has advanced significantly since then. 3D images created with the proper software are extremely realistic and appear to be photographs. They are employed in the fields of popularization, education, and research. Scientists have recognized the value of digital 3D imaging as a tool for hypothesis testing and communicating research findings to the public. [13]

The use of tools and the application of technological devices make it more convenient to operate in the data collection process by using a smartphone capable of taking pictures for use in Photogrammetry. It enables people to be creative and use that process to think and create, as well as record, processes. Photogrammetry has become very prevalent.

A preliminary investigation into the applicability of smartphone photogrammetry in real-world conditions was also carried out. The smartphone method has a high level of precision for all specimens. To achieve acceptable trueness and precision, the smartphone photogrammetry method can be used. [14]

Furthermore, the dense clouds of the digital camera had a higher point density nearly three times that of the smartphone. This difference resulted in better geometrical detail representation and higher mesh quality. When compared to

the smartphone, the final textured models from the digital camera were of higher quality and had a more photorealistic appearance. The dense clouds and textured models on the smartphone, on the other hand, were of acceptable quality with the processing time and memory utilization parameters of almost every processing step in the photogrammetric workflow being generally less. [15]

Furthermore, network communication capabilities enable timely upload of field measurement results for data preservation and further processing. In conclusion, smartphones have benefits that include, but are not limited to, convenience, speed, ease of use, and low cost. These advantages of smartphones outweigh those of DSLR cameras. More importantly, the rapid development of smartphones, such as the LiDAR on the iPhone 12 Pro, has expanded the scope of smartphone applications in measurement and photogrammetry. [16]

Smartphone photogrammetry produces results comparable to 3D scanners and multi-camera approaches. Furthermore, it is low-cost because data collection only requires a smartphone. The simplicity of the setup would allow for immediate implementation of the methodology. [17]

Combining knowledge and technological tools to create for conservation is a concept that can act as a guideline for the integration of arts, culture, and technology to facilitate a greater connection to the public. Adopting and combining modern and accessible tools and technologies allows for creativity and the preservation of culture and art. It offers a wide range of options for today's generation of tools that empower more creative and digital production [18]. Designers of learning environments can repurpose existing technologies to create rich pools of identity artifacts, which can support educators' modes of participation and, finally, their contributions to the cultures to which they relate.

Furthermore, recent 3D modeling and printing experiences have demonstrated the need for a new level of expertise to assist archaeologists, architects, engineers, restorers, and conservators who require the use of digital technologies related to instrumental survey, 3D modeling, and solid printing. [19]

As a result, it is clear that accurate and scrupulous design and manufacturing of the artifacts' supporting structures is critical for both their fruition and effective conservation. Modern techniques and technologies efficiently adopted in those industrial sectors provide a solution to meet this need. [20]

In particular, the use of mobile tools for creativity is a trend that is becoming more and more popular among digital designers today due to the development of both hardware and software. They support the creative use of the tools and mobile devices to design and create more digital images, video, audio, 3D images, and other digital art.

The use of digital technologies, by demonstrating how the affordances of digital tablets and drawing apps can be more supportive of collaborative creativity than more traditional resources used in drawing tasks. It encourages further exploration of digital and non-digital resources in order to better understand how specific affordances shape the participation frameworks that emerge in collaborative creative work. [21]

This article discusses a variety of ways that digital technology can facilitate the conditions for creative ideas and their implementation. To summarize, computing technologies application and devices have the potential to improve employees' socio-emotional and instrumental support by allowing them to connect with a large number of people both inside and outside the organization. As a result, we anticipate that the more computing devices employees use, the more they will feel supported and encouraged, and the more creative their ideas will be. [22]

Digital creativity is a developing discipline with enormous potential. Many different types of works of art are supported through digital representation by digital creativity technologies. These technologies also allow us to capture, store, manipulate, and output these representations in order to create media forms that we can interact with. This convergence in digital creativity is built on the unity of underlying representational form and technological processing. [23]

It drives creativity and mobile tools enable creativity to begin at the moment of inspiration. As soon as you have an idea, you can begin bringing it to life in a way that feels as natural as a pencil and sketchbook, but with the versatility and power of digital creation and a constant connection to creative assets and collaborators. That's a revolution that's gaining steam by the day, and we're thrilled to be a part of it. [24]

3 RESEARCH METHOD

The research method used in this study aimed to integrate tools of mobile phone, applications, and photogrammetry techniques with artisan collaboration to facilitate the design and production of sandstone artwork. The following paragraphs provide a detailed explanation of the research method employed.

This research employed a method that combined the study of historical sandstone artifacts, smartphone-based photogrammetry, PC software for image processing and 3D modeling, retopology techniques, and collaboration with artisans using an iPad device. The study involved investigating the origin and significance of sandstone carvings, capturing detailed data of the artifacts using smartphone cameras and photogrammetry, processing the collected photos using specialized software, refining the 3D models through retopology, and making further adjustments and collaboration with artisans using an iPad and relevant application. This integrated approach aimed to enhance the design and production of sandstone artwork while preserving cultural heritage and embracing modern technology.

Overall, the research method employed in this study encompassed the study of historical artifacts, smartphone-based photogrammetry for data collection, PC software for image processing and 3D modeling, retopology techniques for improved mesh quality, and the use of an iPad device for further adjustments and collaboration with artisans. By integrating traditional craftsmanship with modern technology, this research method aimed to enhance the design and production process of sandstone artwork, ensuring the preservation of cultural heritage while embracing contemporary approaches. Each step of the research process is detailed with the following workflow

3.1 Study of artifacts carved in sandstone for product development

A study of the origin and information of sandstone art used for design and use. Most of the ancient sandstone carvings were created by Buddhists. These artifacts were created in Phayao Province and can be found in the old town of Phayao. These sandstone works of art were abandoned and deteriorated in the late 23rd century BC after the decline of the city of Phayao. Lifting and moving these tasks is difficult because it is fragile. Including the weight, these sandstone carvings can be found commonly in ancient sites and places in Phayao city.

Bringing these artistic creations to use for creation and design should take into account the beliefs and suitability of that art object. In the area of Phayao and nearby

provinces, people still have strong respect for Buddhism and persist in people's way of life with Buddha statues that are carved images of the Lord Buddha that are being worshiped. The statues are passed on to people who believe in Buddhism very much. Buddha statue means a figurative figure or a representation of the Lord Buddha and is a work of art created as a response to and serve the needs of Buddhism, to depict material philosophy and as an offering to the Buddha [25]. Therefore, taking Buddha statues to modify or bring them for use in homes or utensils may be contrary to the traditional beliefs and faith of believers in Buddhism.

Fig. 1. The lotus design in Buddha art made of sandstone

Apart from the lotus, other depictions related to Buddhism are also found in the art of ancient sandstone carvings, such as statues of animals, stone tablets and other sandstone carvings. The lotus is inextricably coupled with the art of Buddhism. As shown in Figure 1, the base of the Buddha statue uses lotus flowers with various designs.

Lotus is an important flower in Buddhism and hence commonly found. The lotus flower pattern contains lotus petals that is elaborate, beautiful and delicate, reflecting the transfer of the craftsman's spirit into the work as an offering to the Lord Buddha. The Lotus Flower in Thai literature is a book that most Thais regard as a well-written book with a pleasing cadence in the use of words and rhetoric.

Phayao craftsmen develop the concept using the nature of lotus plants that have grow in rivers and other water bodies to create products using a water basin to develop Phayao handicrafts in ancient lotus patterns. In addition, the Phayao sandstone carvers use lotus flowers as the prototype to create other artistic forms such as decorative patterns and offerings, all of which are related to Buddhist teachings or rituals. The styles of craftsmanship of Phayao sandstone carvers have also been applied to create works that can be seen in educational sites related to Phayao sandstone art in various places.

An analysis shows the use of proportions and motifs of the lotus and the nature of the lotus as a guideline for designing works related to water and tools and utensils used in everyday life by the people. Saving data into 3D parts can help make this operation and process easier and more convenient. In doing this work, a multi-part process has been brought together to reach the goal of research by both scientific and technological steps and methods, as well as the analytical process of sandstone carving art. Ancient Phayao, including the beliefs and characteristics of the art that has been created, are analyzed to create a new piece of work through the following steps and methods.

The study and interpretation of works of art in line with people's ways, and lifestyles. The lotus-shaped water bowl forms the base of the Buddha statue and has a typical pattern characteristic of the Phayao sandstone carving art. These are vertical lines resembling lotus stamens found in most of the lotus carvings of Phayao sandstone art creations. In addition, the lotus is regarded as the queen of water plants because it grows and blooms beautifully in the water. The life cycle of the lotus is therefore clearly consistent and related to the water. The lotus flower is clearly associated with Buddhism, as can be seen from its use as a motif, as the base of the Buddha statue, or in architecture. The lotus is also an important symbol that appears in Buddhist culture and traditions, including the use of lotus symbols as a medium to convey dharma content and stories or events in the Buddha's history through various fields of art. [26]

Based on the information related to this research, the researcher uses this as one of the elements to create this work. Using the concepts interpreted from the data gathered from the study, a basin was created because of the relationship between the lotus and water, the lotus flower was identified as a foundation or support for Buddhism. The form of the product can reach a people of different age groups, even more than the original works of art that are located in areas related to Buddhism. The creation of this work that mentions the lotus and water is consistent and related to the vessel or a basin type water support, which is a common utensil that reaches people and still has a meaning consistent with the lotus in the original art that was created.

3.2 Photogrammetry process by shot from smartphone

The process of collecting data of objects of art with processes and methods to create work pieces using photogrammetry starts by capturing the perimeter of the stone carving using a smartphone. The smartphone serves as the primary platform for field measurements and activities, allowing geologists to accelerate data acquisition and promoting the emergence of common file formats and field data storage repositories to use the resulting photos in the process photogrammetry in the next step. [27]

Research findings confirm the dependability of the self-calibration approach used in this study for both cameras. They also claim that smartphones can be used directly to collect onsite photogrammetric data for 3D modeling and measurement extraction for construction management applications. [15]

The data from the test shows that the use of high-definition mobile phone cameras or the technology used today can be used in the experiment to collect data in the process. The researcher used Iphone 13 Pro phone to collect photographic data in this research.

Photogrammetry, on the other hand, can be used as a low-cost alternative for optical 3D imaging. Other iOS apps for 3D scanning that use LiDAR technology and allow

the creation of 3D datasets based on triangulated meshes and photographic textures are currently available. The LiDAR technology used in Apple mobile devices is a relatively new feature, and it is expected that this technology, as well as the associated apps, will advance rapidly in the coming years. High-resolution and high-quality optical 3D imaging methods and devices are typically expensive. [15]

3.3 Photogrammetry process by PC software

The photos taken during when recording data are processed into 3D shapes using a photo processing program. The researcher has chosen to use a program for image processing, the Agisoft Metashape program. The creation and process of the program consists of the following steps.

a. Align Photo is a process in which the program organizes prepared photos into a rough structure of the object. This process compares each photo and other images that are close to the object.
b. Build Dense point cloud is a process that takes quite a long time to process because the program has to process the image thoroughly to create the structure of the object from various reference points of the image. The program will process the image into a structure of millions of dots and the color of the collected object, along with a reference of the color dots from the resulting photograph, similar to the previous step, but with the resolution of more objects.
c. Build Mesh is a step in which the program will create a surface between each point to create a 3D outline, which is another important step to visualize the resulting structure as a 3D object similar to the initial objects obtained.
d. Build Texture, the process of processing and analyzing the surface image of a 3D object that collects data in the form of texture, is the last step of the program before completing the process of saving the work piece as a 3D object.

3.4 Retopology, a 3D mesh form of photogrammetry

When the work piece in the form of a 3D work piece is completed, the next step will be a study. The researcher has selected parts in the lotus from the 3D work piece obtained from the process step. Photogrammetry plays an important part in molding and designing the structure of the new piece based on the pattern and original structure as much as possible in order to maintain the style and identity of the art of the ancient Phayao family by modifying and adjusting parts of the 3D parts obtained to create a 3D model. In such a process, the researcher has brought the proportions of the 3D work piece to be improved and corrected in the 3D program using the Autodesk MAYA 2019 program. Modifications will made to make it suitable and then arranged and assembled with other work pieces to be beautiful. 3D modeling is quickly becoming an important tool for preserving and reproducing cultural heritage artifacts. Such technology also enables the acquisition of high spatial resolution data, which is required to improve the efficiency of the reproduction process. [28]

The 3D model is edited and adjusted based on the model obtained from photogrammetry. It is a high-resolution model and a complex 3D structure with no order in order to obtain a work piece that can be customized and edited. Compose 3D makes working on the pieces with programs easier. Retopology or recreated polygom to

obtain a cleaner layout is primarily used to improve the quality of the polygonization, mesh simplification to reduce and control polygonal complexity, and mesh parameterization to improve UV maps. [29]

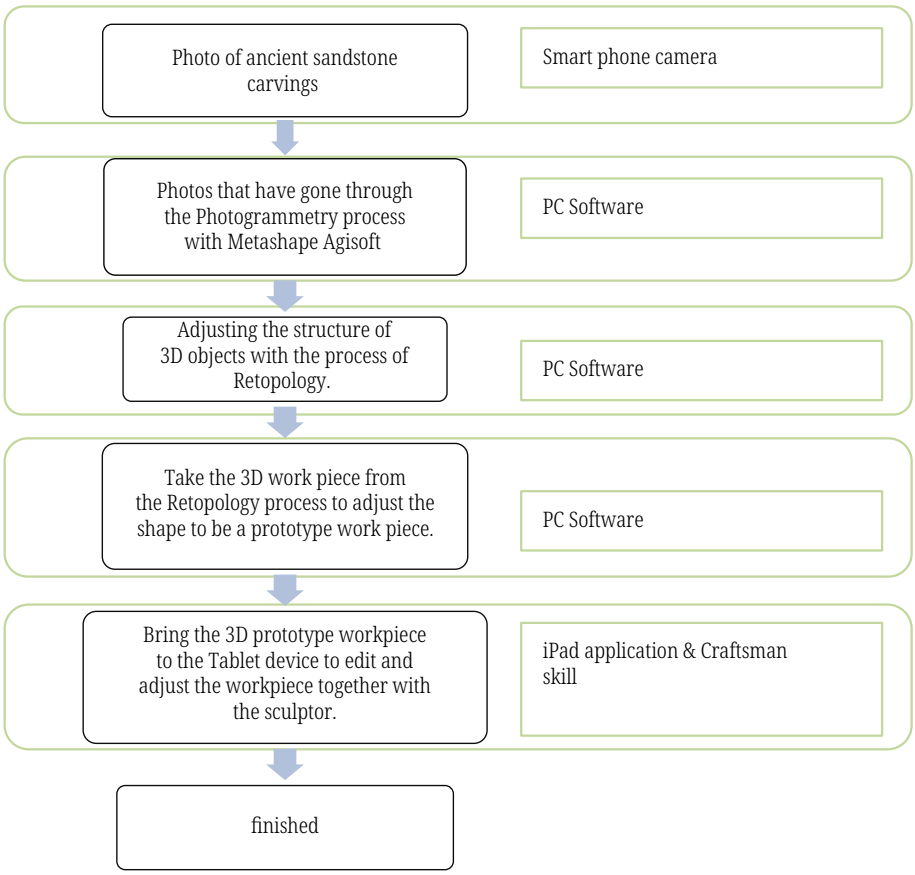

Fig. 2. Flow chart of research procedure with tool

3.5 3D improvement with iPad device

Once the prototype of the work piece in the form of a 3D work piece from editing and manipulating the structure according to the drawing of the bath is ready, the next step is for the researcher to take the model as a prototype to produce the actual pieces with sandstone carvings. The reference is the work of artisans who have inherited their specific techniques of sandstone carving with texture and specific characteristics. To make the new products similar to sandstone art in the past, the patterns obtained by recording the results with the 3D technique is used as reference. The resulting 3D prototype is imported and then exported as a file that supports 3D work improvement in the iPad device, to be used for adjusting the shape of 3D objects from the text. Propose and evaluate shapes from stone carvers through the Nomad application that has the ability to customize 3D work pieces, including editing and adjusting 3D proportions, emphasizing the working style of creating 3D models in the form of digital molding and embellishing with color. In addition, 3D files can be easily and conveniently transferred to other 3D programs. In this process, the researcher used the tool to adjust the proportions of the 3D work piece with the technician to improve the work piece structure in the pre-3D engraving.

The steps were modified to make them suitable for the stone carving process based on the nature of the stone to derive the desired style and the most suitable characteristics. A holistic knowledge of rural regeneration depending on multimedia and heritage requires a new vision based on a strong integration of approaches and tools. [30] The sandstone carver analyzed and assessed the possibilities from the original structure in order to select the suitable size of sandstone for production including the surface of the stone used to create a prototype piece. All of these processes cooperate both the skills and abilities of craftman and the process of using creative tools and technology from the charger in Figure 2 shown above.

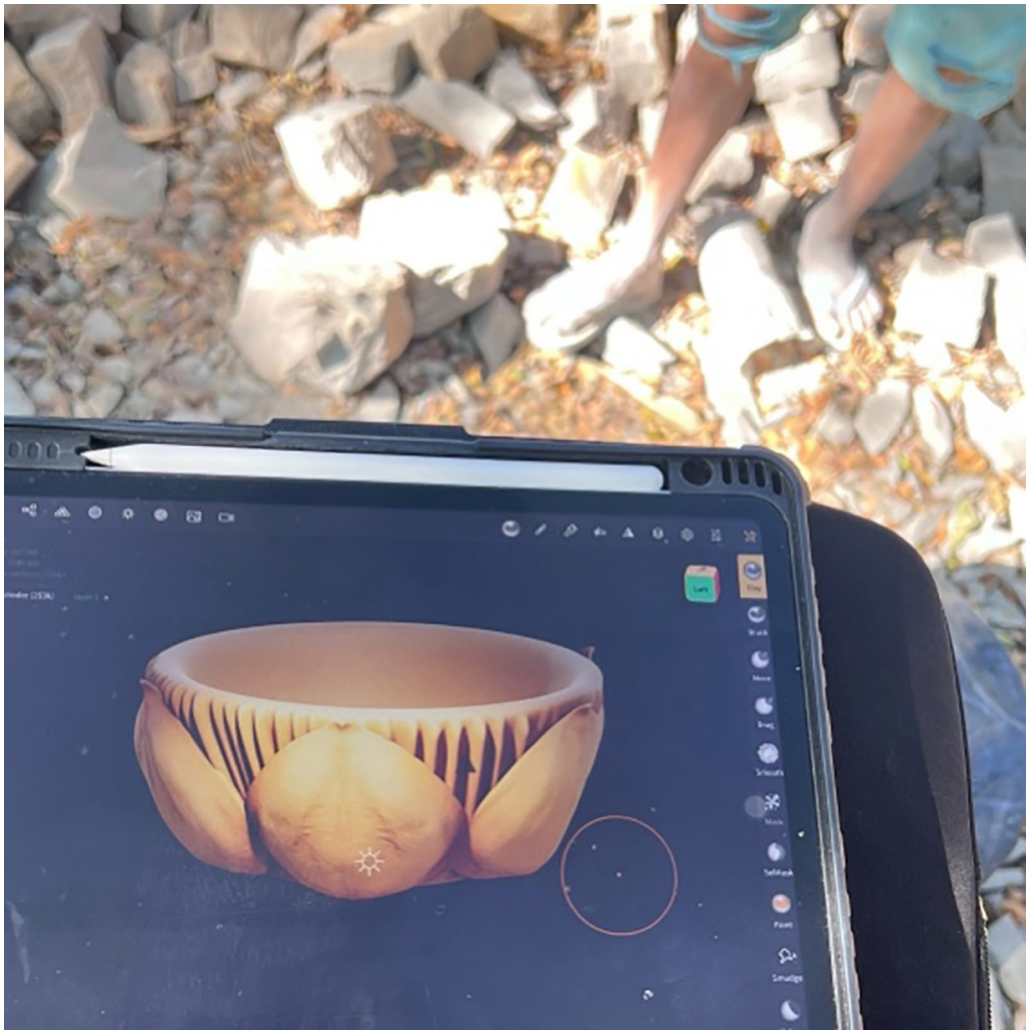

Fig. 3. Use of iPad for adjustment 3D model with Nomad application working with sandstone- craftsman in the process of craving sand stone

The sandstone carving is from the Phayao province, and carved by artists who inherited the knowledge that has been passed down from generation to generation to the present to creating works using skills and expertise. There was no technology or recording to transfer knowledge of this technique. This entire research is an initiative to create a small art work by using the talents and skills of each group of people who have been the link to the past to co-design, in addition to being a critical process in the creation of interventions focused on people, also enabling collaborative relationships in which trust, open communication, and mutual learning are important points

to work on for the process's success. This methodology is open to people's viewpoints and experiences, and it values everyone's information, and these steps are important when working on a project involving the preservation of cultural heritage. [31]

In this process, experts use the aforementioned application to work with artisans of this ancient craft; all of these artisans are elderly people who do not have much knowledge and expertise in technology or using a device such as a tablet that is considered a tool that has features that are easy to carry, has a large and clear display, and fast digital processing with better collaboration. In addition, the introduction of 3D images or data is also a facilitator of limitations in the creation and study of sand art that have problems with size and weight in the study.

Fig. 4. A final sand stone artwork

4 RESULT

Due to the production and creative process of stone carving, it is essential to use sandstone material specifically found in the province of Phayao. The size of the stone is crucial in creating and sculpting sandstone artwork, with a prototype based on an ancient Buddha sculpture with lotus patterns. The dimensions of the completed artwork are approximately 85 centimeters in width and 55 centimeters in height. It features a round top shape with a slightly curved and tapered base resembling a lotus flower. The created artwork has been derived and refined from the original prototype, with modifications made to the top area of the artwork to create a basin-like structure. The completed artwork measures 40 centimeters in width and 25 centimeters in height, adjusted proportionally and appropriately for practical usage as a water basin. As shown in Figure 4.

The design of the basin artwork is based on a 3D model created through a research process that involved data collection and subsequent processing using photogrammetry techniques. The model was then further refined, considering the structure, components, and proportions using 3D software before being implemented in an application for convenient design, modification, and customization on an iPad. This allows for easier on-site adjustments and modifications during the stone carving process. The users and stone carvers collaborated in analyzing the form

and possibilities of creating sandstone artwork, working together to modify the 3D model and refining the artwork during the collaborative process.

5 CONCLUSION

From the aforementioned work, a sandstone carving using the prototype from the 3D work piece resulted in a work piece similar to the basin shaped like a lotus as a base to support the Buddha statue by using the tools and technologies around us such as mobile phone photography to aid in the process of production and creation of works or the transfer of knowledge of art and culture. Photogrammetry was used to process the images of the ancient artifacts into 3D work pieces and to use them to edit objects with 3D programs. This was forwarded to a portable device, an Ipad, that currently supports applications to edit 3D work pieces. It can be used to improve the design for fieldwork in the production of work pieces and reach the accuracy and needs of sandstone carvers. Such procedures and methods can be made easier when tools such as mobile phones facilitate such operations. In addition, support for the use of 3D creative applications is like another part of the impetus for creators to play a role in terms of accessing art from cultures and other related things very easily even more. The creation of such work is educational, and helps to study the characteristics of traditional art and ancient artifacts.

Work piece data collection using technology helps with the process of improving and modifying parts of 3D objects by using digital multimedia tools to modify parts of 3D objects to become the prototypes of new objects and works. It is the original model for the construction of a new piece. In this case, it was a basin that is shaped like a lotus flower and is important in Buddhism. The synchronization of computer program tools and using the knowledge of ancient craftsmen to work together to create the process were critical. The resulting work piece has a pattern and appearance similar to that of the original lotus petal shape. It is not very similar to the prototype of the structure because of the nature of the stone used to build it. The original prototype size was different. The main factor of sandstone carvings in the ancient Phayao style is using a single piece of stone to carve the form, and not creating connections or assembling different portions to create the piece. Therefore, the initial characteristics of the sandstone used to create this still plays an important role in greatly affecting the work image. The result of the work piece obtained is the main purpose and the use of prototypes in the form of 3D structures for builders and sculptors of sandstone as examples is also a suitable option for creating work pieces because they can analyze the work and select stone models that are suitable for the design and be creative. In addition, such tools are used to adjust the designs to suit the workmanship and assess the suitability for the production method used. To create data and record the beautiful pattern of the sandstone art of Phayao craftsmen is another way to preserve such artwork to be used as a model. Such operations establish the benefits of using technology for simulation. Comparative selection by moving objects from the 3D program can be made easier and more convenient than ever by creating a better understanding of sandstone sculpting. It can be seen that the use of communication devices such as mobile phones and portable electronic devices such as tablets can aid in the preservation of arts and culture and creativity and is likely to play a role. In this issue, conducting more such research has also been found to be an important aid in connecting people.

Knowledge and creativity increased with efficiency and the development of these mobile devices, and the resulting output form has a function that can be used

by other groups of people. The benefit of producing this kind of work is in making art more accessible to people. This is another research that has linked ideas, skills and creativity of people in each generation in each era to create collaborative works, which is a concept that drives society to use capital in art, culture and technology appropriately.

6 LIMITATIONS

The research described has certain limitations that need to be acknowledged. Firstly, the lack of written records and manuals about the ancient Phayao sandstone carving technique makes it challenging to fully understand and replicate the traditional craftsmanship accurately. This limitation also extends to the scarcity of knowledge about the sandstone art of ancient Phayao craftsmen, leading to potential inaccuracies in the research. Furthermore, the research is focused on a specific region, the Lanna Kingdom in Thailand, and its ancient Phayao sandstone art. While this provides valuable insights into the local culture and heritage, the findings may not be directly applicable or representative of other ancient sandstone art traditions in different regions or cultures.

7 FUTURE RESEARCH

Conducting comparative studies between the traditional sandstone carving techniques and the results obtained using modern technology could provide valuable insights. This could involve analyzing the intricacies and nuances of ancient sandstone art forms compared to the digitally recreated ones, highlighting the strengths and limitations of each approach.

Investigating the impact of integrating modern technology into traditional art forms on the cultural heritage, local communities, and artisans' livelihoods would be valuable. Understanding how technology affects the dynamics of art preservation and dissemination in society can inform better strategies for sustainable cultural preservation.

Encouraging collaboration between historians, archaeologists, artists, technologists, and local communities could lead to more comprehensive research and ensure a holistic understanding of the cultural context and significance of ancient artworks.

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