

# Preserving Candi Kidal's Relief to Sustain a Cultural Heritage Site using ATUMICS Approach

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**Abstract.** Candi Kidal represents a cultural heritage structure that should be preserved. This temple structure is similar to the other temples in that it contains a foot section (Bhurloka), a body part (Bhuvarloka), and a summit portion (Swarloka). Some reliefs are read on the body using the Prasawya technique, and a story about the loyalty of a child named Garudeya to his mother, Winata, will appear. The story of a son freeing his mother from slavery is analogous to the Indonesian people's battle for freedom from Dutch colonialism. This study intends to introduce Garudeya's intangible reliefs at Candi Kidal and explain the moral message they embody. The Garudeya relief found in the Candi Kidal will be re-displayed on a sitting lamp as part of this research. The author did a site survey, interviews, questionnaires, and a literature review in this study. The author used the ATUMICS approach to create a prototype in the form of a sitting lamp, which aids in transforming traditions into contemporary contexts. The main focus of this study is on the concept of form, which is the transformation of Candi Kidal's silhouette into the shape of a sitting lamp. Furthermore, the lithophane technique, which converts a photograph into a 3D relief, is used on the body of the sitting lamp. As a result, the relief seen on Candi Kidal's body can be reproduced on the sitting lamp's body.

## 1 Introduction

Candi Kidal is a Hindu Shiva temple established in 1260 in Kidal Village, the eastern part of Malang Regency, East Java [1, 2]. The Kidal Temple structure is similar to other temples in that it contains foot section, body part, and summit section [3]. Garudeya and Medallion's relief is found in the Candi Kidal building's body. A relief of Garudeya carrying a jar of living water is found on the temple's east side. A relief of Garudeya carrying his mother, Winata, is found on the temple's north side. On the temple's north side, there is a relief of Garudeya carrying his mother, Winata. The three reliefs depict the Tirta Amerta legend or the dispersion of the water of life [4].

There are two approaches for interpreting the reliefs on the temple: Pradaksina and Prasawya [5]. Pradaksina is derived from the Sanskrit words *pra*, which means forward, and *Dakṣiṇa* indicates right [6]. The Pradaksina approach involves reading/surrounding from left to right or clockwise. This approach is used to honour the deity and as part of the worship event (Dewayajna) [5]. Lim and Setyani added the Prasawya approach, specifically reading from right to left or counter clockwise. This method honours the ancestors and is linked to the death ceremony (Pitrayajna). Candi Kidal is a Padharman, a temple built in honour of Anusapati, the second ruler of the Singhasari Dynasty [7]. Padharman's structure serves as a temple for worshipping already-holy ancestors. Hence relief reading is done using the Prasawya technique.

Candi Kidal's reliefs tell a story of Garudeya's attempt to free his mother from slavery when read with the Prasawya technique [1]. Garudeya's struggle to free his mother from slavery is closely tied to the Indonesian people's struggle against Dutch colonialism in Indonesia [8]. As a result, the Indonesian state symbol, Garuda Pancasila, conforms to the Garudeya history depicted on Candi Kidal reliefs [9]. As a result, this relief must be introduced to the younger generation using modern technologies. It causes the younger generation is now more familiar with the technology.

Preserving traditional culture can be done by changing it into a modern culture [10]. One of the preservation methods is the ATUMICS process. This method is an abbreviation for Artefact, Technique, Utility, Material, Icon, Concept, and Shape. The choice of the ATUMIC technique because it employs adaptable technology for achieving cultural heritage preservation. ATUMICS-based technology, such as the Engklek game [11], is preserving some cultural legacy. Every region in Indonesia has games that can be maintained by developing digital games. The ATUMICS method is also used in the 2019 3D film *Bejo Si Sinnom* [12]. From Sabang to Merauke, Indonesia boasts a diverse archipelago culture. Each region must emphasise the distinctiveness of its local culture. Product packaging, such as employing local wisdom on food packaging, can be used to implement [13].

This research aims to preserve Candi Kidal's culture by introducing the reliefs found in the temple. In the preservation process, 3D printer technology transforms

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pictures into relief. Furthermore, the use of local content intends to introduce Candi Kidal reliefs in the form of interior needs products such as sitting lamps.

## 2 Literature review

### 2.1 The history of candi kidal and its relief

Today, the pilgrimage custom has been steadfastly maintained [14]. According to Raj and Morpeth in [14], practically every religious tradition includes a pilgrimage trip ritual that encourages people to visit religious sites. The temple is one of the structures that Buddhists and Hindus visit on pilgrimage. Buddhist and Hindu heritage temples are examples of cultural heritage in Indonesia. Indonesia was a vibrant Buddhist cultural centre from the seventh to the fifteenth centuries AD, and the Borobudur temple is one of the most famous, built between 870 and 920 AD [15]. In the fourth century, Hindus arrived in Indonesia. Furthermore, Prambanan, the most famous temple, was built between 775 and 900 AD [16] using Merapi volcanic basalt-andesite lavas [17]. According to Sutarto's studies, this rock is relatively soft and easily formed.

The Vastu Purusha Mandala is a guideline for constructing the temple design [18]. The temples were constructed in a particular proportion. A Buddhist or Hindu temple divides the temple into three sections: the top, the body, and the foot [19]. The temple's summit is known as Arupadhatu in Buddhism and Swarloka in Hinduism. Buddhists call it Rupadhatu, while Hindus call it Bhuvarloka, which is placed in the temple's body. Buddhists call the lower portion Kamadhatu, while Hindus call it Bhurloka [20]. Candi Kidal is a Hindu temple dedicated to immortalizing (Dharmanya) and exalting people's spirits who have gained oneness with the divine. As a result, the temple is known as the Dharma or Sudharma temple. Furthermore, the deceased ruler is referred to as Dhinarma or deified. This deification, or Pendharmaan, states that the revered prior ruler is also the world's gods' avatar [1].

The reliefs found in the temple are decorative and tell stories. The source of the story is the Mahabharata and the Ramayana [2]. Relief in Candi Kidal is a story of Garuda, the main character in Garudeya, story adapted from Adiparwa Mahabarata, the book of beginning of Mahabarata [21]. Relief is a 2.5-dimensional artwork built on a plan by compressing a 3D model into a small area [22]. Because it sticks to a flat surface, the relief divides into 4, namely high relief, low relief, shallow relief, and sunken relief.

High relief, also known as Haut-relief in French and Alto-rilievo in Italian, is a style of painting in which certain elements stand out more than others, possibly completely detached from the background. This relief almost emphasizes an entire sculpture affixed to the wall surface's base [23, 24]. Low-relief, also known as Bas-relief in French and Baso-rilievo in Italian, is a type of depth compression in which the scene's depth range is reduced to a fraction of its original depth [23, 24]. The projection or depth of the engraving varies, but it usually

is only a few millimetres or less than half the depth of the carving dimensions. The third relief is shallow relief, which is shallower than low relief. Only thin strokes are utilized in the relief carving to remove the background material. The final relief is known as sunken relief, also known as intaglio or hollow-relief, and it is a type of sculptural artwork that involves cutting the model into a plane. The contour lines are essential in demonstrating the distinct stylization [25] typical in Egyptian art.

### 2.2 Cultural heritage preservation

The 3D artefacts such as sculptures, buildings, and high reliefs can be digitally restored using laser scanning and photogrammetry technology [26-28]. A final result is a 3D object that can be used to build a 3D prototype at any scale using a 3D printer [29]. Furthermore, 3D artefacts can be used on the website as 360o virtual displays [30]. Virtual and augmented reality need the development of 3D objects utilizing photogrammetry techniques [2] [31].

Moving items into 2D images in low relief can be accomplished by capturing photographs. By using a 3D printer, photos can be turned directly into 3D objects in the form of black and white reliefs [32]. Lithophane is a technology that turns 2D pictures into 3D relief objects. Several websites, like <https://3dp.rocks/lithophane/> and <https://lithophanemaker.com/>, offer services for transforming pictures into files that can be produced with a 3D printer. Several studies have used lithophane to process pictures in order to generate 2D images automatically, for example, using the Matlab software [33-34]. Photos can also be manually processed using computer tools such as Adobe Indesign or Corel Draw and object tracing techniques. Tracing produces a 2D vector picture file. This file can subsequently be used to generate 3D models with the help of a 3D printer [35]. Vector image files can also be used with a CNC router to apply to a flat plane. 2D vector picture files can be engraved on 2D planes such as medium density fiberboard (MDF) board [36], granite, or marble [37] using the same equipment.

### 2.3 ATUMICS method

Adhi Nugraha developed the ATUMICS technique as part of his dissertation study at Aalto University in Finland in 2012 [38]. The ATUMICS approach was described by Nugraha as follows:

1. An artefact (A) is a product or object at the foundation of a revitalization tradition.
2. The technique (T) refers to all types of making knowledge/techniques such as production techniques, procedures, and ways of making products, skills, equipment, and other facilities.
3. Utility (U) analyses a product's function and usability in terms of compatibility between the user's needs (user) and the product's usability/function.
4. Materials (M) refer to all sorts of materials derived from items, objects, and traditional products in general but not always- natural/natural materials such as wood, bamboo, clay, or stone.

5. Icon (I) refers to all types of images seen in nature, decoration, color, myth, civilization, and artefacts.
6. Concepts (C) are hidden aspects that exist outside of physical forms and objects; this element is thought to be the most resistant to extinction.
7. Shape (S) is an object's performance, appearance, or physical properties, such as size, gestalt, and shape.

## 2.4 Related work

Several prior researchers conducted studies on cultural heritage preservation. Its goal is to ensure the long-term viability of cultural heritage. Digital preservation in the form of documentation has been applied to model making at the Church of San Nicolas [26], creating cultural heritage into the virtual model [27], and applying 3D scanning using a low-cost camera [28]. Laser scanning and photogrammetry result in 3D objects that are used to create 3D prototypes using a 3D printer [29], the virtual exhibition [30], virtual reality, augmented reality [2], and mixed reality [31].

Furthermore, for the preservation of the reliefs on the site's walls, some researchers have carried digital transfers. Lithophane is a technology that automatically generates 2D images into 3D relief has been done using Matlab [33-34] and website [32]. The making of 3D models using a 3D printer obtained from 2D images [35] and duplicating 2D relief images on the MDF board [36], granite and marble [37].

Several prior researchers have used the ATUMICS technique in cultural preservation, such as the production of a digital Engklek game [11], the usage of Javanese Character costumes in the 3D film Bejo Si Sinom [12], and the application of local wisdom in food packaging [13].

## 3 Methodology

A survey, interviews, and the distribution of a questionnaire were used to collect data for this study. The author first investigated Candi Kidal's location at Rejokidal Village, Tumpang District, Malang Regency, some 20 kilometres east of Malang city. The author employed the second approach of interviewing a temple officer to get primary data about the building of the Candi Kidal, the materials used, and the interpretation of the reliefs. The third method is spreading the questionnaire to the general public, both in and out of Malang. Data from respondents were also collected to determine whether or not they had visited Candi Kidal. In this method, 74 respondents, or 62.2 percent, were from Malang, while 37.8 percent were from elsewhere. Candi Kidal piqued the interest of 94.6 percent of those polled. 95.9 percent of respondents said it was vital to include cultural heritage information on interior products.

The initial study focus is on the long-term sustainability of cultural heritage. Its mission is to revive local cultural heritage through interior products packaged in a modern way. Simultaneously, secondary data on preservation, the use of technology in preservation, and the application of technology in

prototype goods were acquired through a literature review. Candi Kidal is the study's topic, and she offers an excellent moral message for the next generation. Furthermore, the history included in this temple is linked to the symbol of the Indonesian state, implying that both fought for independence from colonialism.

This research's output, the sitting lamp, is one of the products designed using the ATUMICS approach. Candi Kidal's overall silhouette inspired the design of the sitting lamp. The lamp, like the temple, is divided into three parts: head, body, and foot. The head and foot are created in Sketchup and printed on a 3D printer. Photograph the reliefs on the four sides of the Kidal Temple using lithophane technology while standing on the lamp's body. The design and shape employed is a rectangle, with reliefs from Candi Kidal's four sides, including historical stories on each side.

The first questionnaire is used to select sitting lamps; as many as 66 percent of respondents demand the interior product to include functions such as recording time, planting media, and lighting. Using the ATUMICS approach, the author builds a product based on the questionnaire results. Furthermore, the respondent will evaluate the product using a questionnaire to determine whether it performed its function, is aesthetically pleasing, and includes an aspect of cultural heritage preservation.

## 4 Results and discussion

Developing prototypes employing cutting-edge technologies allows for the long-term preservation of cultural material. The ATUMICS approach will create the prototype series of steps from start to finish. It starts by determining the artefact, the technique used, the function of the research object, the selected material and icon, and the concept and shape implemented.

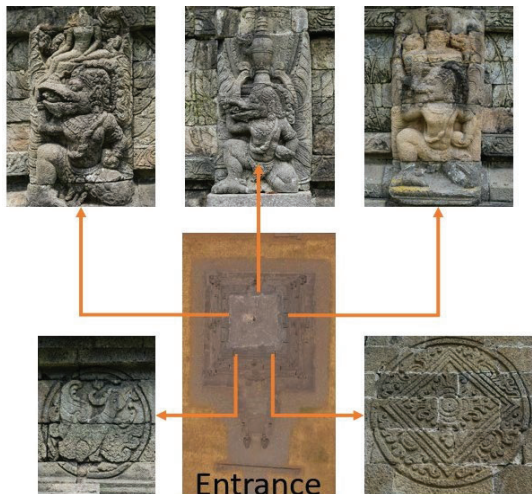
### 4.1 Artefact

Identifying the cultural heritage artefacts that will be conserved is the first step in developing a prototype product. The Kidal Temple was chosen as the object because it attempts to preserve Indonesian cultural history, particularly that of the people of Malang, East Java. Introducing the Temple's history to the next generation will show them that their ancestors were great people. They can produce complex structures, symmetrical patterns, and perfectly organised patterns. As a result, it is hoped that today's next generation will be as energetic as their forefathers, a creative generation aided by more advanced and current technical achievements.

The reliefs on Candi Kidal's walls, notably the Garudeya and Medalion reliefs, were chosen. The medallion can be found near the temple's west entrance. On the south side of the temple, there is a relief of Garudeya carrying a serpent. A relief of Garudeya holding an urn can be found on the east side of the temple wall, while a sculpture of Garudeya cradling his mother, Winata, can be found on the north sidewall. This Garudeya sculpture represents a character who shares



the concept of the Garuda Pancasila national symbol. The four reliefs are depicted in Figure 1.

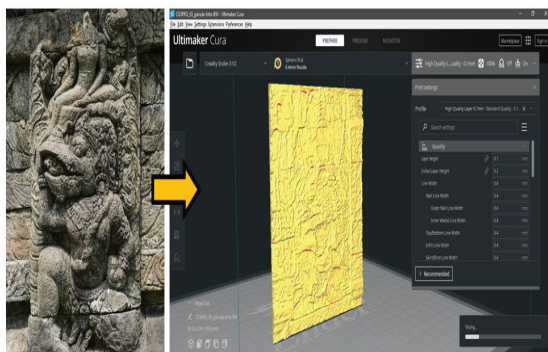


**Fig. 1.** The relief of medallion and garudeya at candi kidal.

#### 4.2 Technique

In the process of creating a miniature temple, in the shape of a sitting lamp with a 3D printer, separated into three components: the legs, torso, and head. Because the body employs lithophane technology, making a sitting lamp in its entirety is unattainable. As a result, the head and legs are created independently. There are various reasons why the lithophane process is used to create the temple's body. The first reason is that the surface of the reliefs on the temple walls has various flaws in several places, making it impossible to read the reliefs accurately. The second reason is that the temple's body focuses on the existing reliefs. For these two reasons, the reliefs are photographed and replicated as reliefs using a 3D printer and the lithophane technique.

Ultimaker Cura is the software used in the reconstruction of this temple relief. The production stages are straightforward. This software opens high-resolution photos and then determines the settings for the material printing process. Next, determine the print direction vertically to achieve the best results. The final step is to instruct the 3D printer machine to print. Figure 2 depicts the processes in the printing process, from pictures to reliefs.



**Fig. 2.** Ultimate cura software to convert relief images into print-ready 3D objects.

Following the completion of the printing process, the final result is viewed using a light positioned on the back of the object. When the relief is visible, it will appear like a black and white photo. However, some prints produce less detailed reliefs. It is due to several factors, including the thickness when printing is too thick or too thin. The configuration of each photo print into relief is different in each case. In this study, the author uses the default settings, namely the maximum thickness (height) of 2.5mm and the minimum thickness (base) of 0.4mm. The second cause is a low photo resolution, which results in less detailed printing. Figure 3 depicts the relief print created using a 3D printer, as well as the lighting conditions.



**Fig. 3.** The original relief (left) and the appearance when exposed to the light behind it (right).

#### 4.3 Utility

The primary purpose of making this prototype is as a medium for introducing temple reliefs in the form of a sitting lamp. The author made a questionnaire related to various accessories for the interior. From the results of the questionnaires distributed, respondents determined that interior products should have additional functions such as timekeeping, planting media, and lighting, with a total of 66.2% of respondents. Thus in this study, the author determines a prototype product that has a function for luminance. The author determines the sitting lamp as lighting and, at the same time, has an aesthetic function in the form of a miniature temple. The emphasis on the relief on Candi Kidal is visible and detailed on the prototype's body, as seen in Figure 4.



**Fig. 4.** A sitting lamp that performs as lighting as well as introduces candi kidal's reliefs.

#### 4.4 Material

Based on its utility as a sitting lamp, the suitable material to use is one that can be penetrated by light. Because it has a rather intricate design, making it with a glass medium will be pretty challenging. It will be tough to produce optimal and precise outcomes when employing glass materials to create prototypes with a small shape and much detail. Making this prototype with acrylic material is still doable. However, it requires advanced expertise and will be tricky for a newbie. As a result, polylactic acid is a possible material for constructing this small Kidal Temple (PLA). It is the most often used thermoplastic in extrusion 3D printing. It is cheap, biodegradable, and melts at a low printing temperature, making it excellent for printing.

The author employs PLA+ to construct temple reliefs from photographs. PLA+ is a term usually applied to PLA variations whose material qualities have been improved by applying additives other than those found in its original composition. PLA+, to be clear, is still PLA because its core makeup is the same. The ingredients are merely a boost.

#### 4.5 Icon

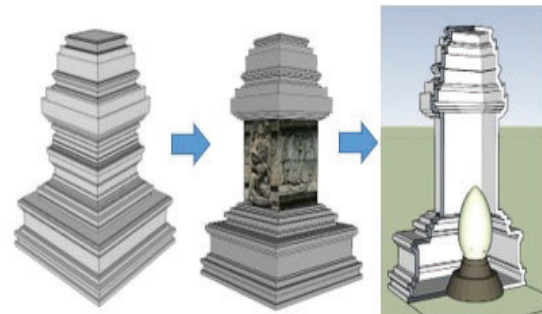
Anusapati was the second ruler of the Singosari Kingdom. He is a faithful son to his mother. It is represented in Garudeya's story, devoted to his mother, Winata, depicts the child's love for his mother. Candi Kidal's stone walls have reliefs that tell this tale. As a result, the author chooses the characters Garudeya and Medallion as prototype symbols. The lithophane technique transforms the original shape of Garudeya and Medallion characters into relief. They contain relatively complicated and elaborate themes.

#### 4.6 Concept and shape

The relief developed and implemented through technology was the concept employed in creating the sitting lamp prototype. The author tied it up by utilizing technology in its manufacture, as indicated in the previous paragraph, based on the original objective of developing a prototype, namely as an introduction to reliefs for the younger generation. Relief will show when the lamp inside the lamp is turned on. Additional information will emerge on the cell phone screen when Augmented Reality (AR) technology is added to the smartphone and directed to the relief in the form of black and white. AR technology can display information in text, motion, or a game. The next study will go into the specifics of this AR technology course.

The prototype form concept refers to Candi Kidal's silhouette in its two sections: the foot and the summit. While the author simplifies the silhouettes and details on Candi Kidal's body section in the form of straight lines on the body of the sitting lamp prototype, its goal is to bring up the reliefs of the Kidal Temple in detail using the body of the sitting lamp. The overall shape of the sitting lamp is not massive, but there is a cavity in the middle. It aims to be able to place the lamp in the center

of the lamp. Figure 5 depicts the metamorphosis of the Candi Kidal silhouette into the shape of a sitting lamp.



**Fig. 5.** The candi kidal shape has been simplified to create a sitting lamp.

The main focus of this research is on the concept of form, which is the transformation of Candi Kidal's silhouette into the form of a sitting lamp. Furthermore, the transfer technique from a photo to a 3D relief is used on the sitting lamp's body. It aims to show Candi Kidal's relief represented on the body of the sitting lamp. Table 1 summarises the seven ATUMICS methodologies and step-by-step prototyping utilized as a comparison. It can be compared the Candi Kidal as a Cultural Heritage with a prototype as a preservation attempt in the form of interior accessories by reading the table.

**Table 1.** Comparing candi kidal relief with product development.

Artefact (A)	Traditional	Modern
Technique (T)	Chiseling into natural stone is used to create the temple's decorations.	The method of producing the product is computerized
Utility (U)	King <u>Anusapati's Padharman</u> in the form of a Temple	Interior decorations in the shape of a sitting lamp patterned after a smaller temple prototype and embellished with reliefs.
Material (M)	Andesite stone	Polylactic acid (PLA) plus
Icon (I)	<u>Garudeya and Medallion</u>	<u>Garudeya and Medallion</u>
Concept (C)	Carvings and details that are intricate	Embedding Augmented Reality technology, the relief functions as a marker
Shape (S)	The design and sculptures of the temple are rich in meaning and ingenuity, with elaborate decorations in every section	Transforming the silhouette of Candi Kidal and the relief in the form of a sitting lamp

## 5 Conclusion

Candi Kidal has been preserved as a cultural heritage site by the government, which has preserved the temple's object. In addition, digital documentation and historical research are carried out to maintain the temple's long-term viability. Studies and research continue to be carried out to get a complete source. It aims to introduce the temple's history, the stories on the wall, and the purpose of making the temple.

The temple's physical preservation is achieved through another approach, such as manufacturing interior accessories in a sitting lamp formed of Candi Kidal's silhouette. In addition to serving as lighting, this product also serves as an interior decoration. This intangible object introduces Malang culture through the Garudeya relief, which has a connection to the national

symbol of Garuda Pancasila. Furthermore, this relief contains a moral lesson in the shape of a historical story that describes the struggle of a son to free his mother from injustice. The message arrives from the reliefs on the Candi Kidal.

The ATUMICS process is used to produce the sitting lamp, which provides for preservation. The first step is to determine the artefact in the form of Candi Kidal. Next, determine the technique used in producing using a computerized system. The following method is utility, and it determines the function of the prototype product as lighting and interior accessories. The fourth step is to determine the material used in the form of PLA + because the technique of making the product uses computerized. The next step is to determine the Garuda and Medallion icons applied to the lamp's body. The following method determines the concept of a product that carries the theme of augmented reality that uses relief as a marker. The last method is to determine the shape that departs from the silhouette of Candi Kidal. The final product obtained from this method is one of the sustainability efforts on cultural heritage using today's modern preservation techniques.

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