Research paper

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Bayan Timur Traditional House: Traditional Architecture Documentation Strategy with Conventional Approach and Digital Technology

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Abstract

This study develops a hybrid protocol to document the Bayan Timur traditional house compound in North Lombok, a living customary settlement where access to buildings is governed by adat. Conventional techniques (semi-structured interviews with customary leaders, freehand sketching, and manual measurement) were combined with digital techniques (high-resolution photography, smartphone-based LiDAR scanning, and 3D modelling) and were verified against a comparative survey of the adjacent Karangsalah compound. Three findings are reported. First, a coverage matrix shows which technique records which data category – dimensional, material, terminological, and philosophical – and where each technique fails. Second, the limits of digital documentation here are cultural as much as technical: sacred interiors and roof structures could not be scanned, and these gaps had to be closed through sketching, interviews, and comparison. Third, the study formulates a five-stage hybrid protocol – customary permission and community involvement, conventional recording, digital capture, cross-source verification, and hybrid dissemination – that is transferable to other customary settlements. The study positions architectural documentation not as a purely technical exercise but as a negotiated practice in which the custodian community determines what may be recorded and shared.

Keywords: Architecture documentation, Bayan Timur, cultural preservation, hybrid protocol, Vernacular architecture

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Introduction

Culture is developed and passed down over time to sustain human civilisation (Khalid 2021). However, cultural heritage is highly vulnerable to the threats of globalisation, technological development, economic upgrading, and political and economic dynamics (Avrami, Mason, and Torre 2000). One of the most observable forms of cultural heritage is traditional architecture, a tangible manifestation of cultural values and local knowledge of the order and relationship between humans and the surrounding environment and nature (Fitriya, Antariksa, and Sari 2010). Traditional buildings serve as a physical manifestation of human philosophies and lifestyles of the past (Herrero-Tejedor et al. 2023). In Indonesia, traditional houses not only function as places to live but also as symbols of cultural identity, social spaces, and centres of traditional activities that embody a philosophy of life and the community's spiritual values (Lukita, Tulistyantoro, and Kattu 2016). One example of a traditional house rich in culture is the Bayan Timur Traditional House, located in Bayan Village, North Lombok Regency, West Nusa Tenggara Province, a village that upholds nature and culture (Vitasurya et al. 2024).

Bayan Timur Traditional house

Like other traditional houses on Lombok Island, the Bayan Timur Traditional House not only reflects the rich history and traditions of the ancestors but is also built in accordance with the customary order and local beliefs of the Bayan community (Susilo and Umniati 2021). The composition of the Bayan Timur Traditional House arranged in a unit area or group of buildings (compounds) and organized to include several main elements such as Bale Beleq as a gathering place for ceremonial activities or traditional ceremonies; Geleng, which is a building for storing crops or valuables; and various types of Bale and Berugaq with their respective functions ranging from social activity spaces, residences of traditional leaders, receiving guests, and others figure 1.



Figure 1
Bayan Timur compound house

In addition to its functional and spatial program, another unique aspect of the Bayan Timur Traditional House lies in its use of traditional materials and construction systems. The timber and bamboo structures, woven bamboo cladding, and thatched roofs used as building materials proved resilient in the face of the massive seven-magnitude earthquake that shook Lombok in 2018 (Susilo and Umniati 2021). This resilience is reinforced through traditional joining techniques figure 2, and bonding without using nails or modern materials, which have been passed down through generations as a form of local wisdom in building adaptive, environmentally friendly, and sustainable shelters in disaster-prone areas

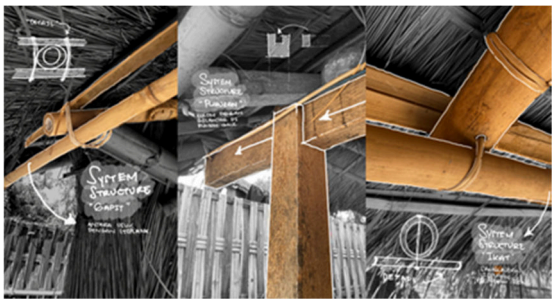


Figure 2
Various connection techniques in Bayan Timur traditional house

In this context, the Bayan Timur Traditional House is inseparable from the Bayan community's historical narrative, local knowledge, and cultural sustainability. Therefore, preservation efforts through detailed physical documentation are important so that this architectural heritage is passed on orally. However, it can also become a concrete source of learning for future generations.

Research urgency

The preservation of traditional houses often faces various challenges, including the pressures of modernisation that change the community's social conditions, a lack of economic support and community participation in the village, and a lack of documentation and understanding of customs and culture (Khairunniza and Handani 2024). Conventional knowledge inheritance systems, which rely on verbal transfer and hands-on practice, risk losing important details due to the absence of systematic recording or archiving. On the other hand, although digital approaches are increasingly used, limited access to certain elements, such as interiors or invisible philosophical symbols, often restricts the breadth of data collected. These two challenges point to the need for a more comprehensive effort to document Bayan Timur traditional houses in a holistic way, encompassing their physical aspects and philosophical values.

Without structured documentation, the sustainability of traditional architectural heritage in Bayan Timur is threatened by social change, modernisation, and the loss of intergenerational knowledge transfer. Thus, this research urgently bridges the gap between conventional and digital preservation methods. Standardised protocols for documenting and managing information related to traditional architecture are also necessary to preserve cultural heritage (Mora et al. 2021).

Research on the digital documentation of built heritage has developed rapidly over the last decade, from HBIM-based data modelling for conservation planning (Mora et al. 2021; X. Li et al. 2025), through terrestrial and mobile LiDAR for recording objects that are difficult to reach (Maté-González, Di Pietra, and Piras 2022; Herrero-Tejedor et al. 2023; Ulvi and Hamal 2024), to virtual and augmented reality for public dissemination (Kyrlitsias et al. 2020; Szekely et al. 2023; Barrile et al. 2022). Most of this work, however, addresses monumental, institutionally managed, or no-longer-inhabited heritage, where the object can be approached, measured, and published without restriction.

Studies of Sasak vernacular architecture in Lombok, in turn, have examined mass and spatial order (Susilo and Umniati 2021), the semiotics of dwelling space (Lukita, Tulistyantoro, and Kattu 2016), the conservation of settlement patterns (Fitriya, Antariksa, and Sari 2010), and homestay typology in Bayan Village (Vitasurya et al. 2024), but they treat documentation as a means rather than as an object of inquiry. Work at the scale of a historic quarter, such as the point-cloud survey of the Suleymaniye district in Istanbul (Benli and Kan 2017), is closer to that of a compound, yet it, too, assumes an object that can be approached and measured without restriction.

The gap addressed here lies between these two bodies of work: how to document a customary settlement that is still ritually inhabited, in which parts of the object are deliberately closed to outsiders and a substantial part of its meaning exists only in oral transmission. In such a setting the completeness of a record is determined not by sensor capability but by customary permission. The novelty of this study is therefore methodological. It proposes a hybrid protocol that treats conventional techniques not as a fallback for missing equipment but as the instrument that covers precisely what digital capture cannot reach, and that positions the custodian community as co-author of the record rather than as its object.

Research objectives

Three questions guide this study. First, which categories of data on the Bayan Timur traditional house can be recorded using conventional techniques, and which using digital techniques, and where do each fail? Second, how do customary norms and field conditions shape the limits of documentation? Third, what protocol can integrate both approaches so that the compound's physical, terminological, and philosophical dimensions are recorded coherently and remain accessible to the Bayan community itself?

Building on these questions, this research aims to develop a comprehensive documentation system for the Bayan Timur traditional house, covering material elements, traditional joining techniques, building structure, and the cultural and philosophical values embedded in these elements. The results are expected to contribute in three ways: as a reference for preserving traditional culture under the pressure of modernisation, as teaching material that enriches students' understanding of vernacular architecture, and as a verified basis for developing culture-based tourism in Lombok that remains under community control.

Methods

This study used a descriptive qualitative approach with documentation as its principal method. The work was carried out in the Bayan Timur hamlet compound, Bayan Village, North Lombok Regency, in September-November 2024. The unit of observation was the traditional house compound, comprising 11 buildings: Bale Beleq, Geleng, and several Bale and Berugaq. Fieldwork was conducted by a five-person documentation

team over 30 days and was preceded by a formal request for permission to the customary leader of Bayan Timur. All recordings and the publication of the images in this article are subject to the limits agreed in that permission.

Conventional recording comprised three techniques. Semi-structured interviews were held with 5 informants, with the customary leader of Bayan Timur hamlet, Mr. Raden Kertomono, as the principal source. The interview guide covered the function of each building, the rituals accompanying construction and renovation, local terms for building elements and systems, the philosophy underlying the compound layout, and the relation between building materials and customary belief. Freehand sketching produced 7 sheets recording joinery, bamboo weaving patterns, roof form, proportion, and texture. Manual measurement, using laser distance meter, recorded the principal dimensions of each mass and of the structural components that could be reached.

Digital recording used high-resolution photography with iPhone Pro Max 14, 3D scanning with the LiDAR sensor of iPhone Pro Max 14 operated through Polycam, and 3D modelling in Sktech Up. Six scanning sessions were carried out, with an effective sensor range of five metres and a resulting point cloud of around 400MB. Dimensional deviation of the scan against the manual measurement was 2.5. The models were exported in DAE format for the digital repository.

Two verification steps were applied. A comparative survey was conducted at the neighbouring Karangsalah compound, selected because it adjoins Bayan Timur, shares the same cultural roots, and maintains living customary ties; it supplied data on elements that could not be recorded at Bayan Timur. A literature review on the history of Bayan Village and on Sasak vernacular architecture provided the second check. Data from interviews, sketches, measurements, and scans were then analysed qualitatively in three steps: transcription and thematic coding of the interviews into four categories, namely dimensional, material, terminological, and philosophical; cross-source verification, in which every local term and philosophical statement was confirmed by at least two sources – informant, comparative site, or literature; and the construction of a coverage matrix mapping each technique against the categories it could and could not record (table 1). This matrix is the analytical instrument from which the hybrid protocol proposed below is derived.

Results and discussion

Bayan Timur traditional houses are an important part of the cultural heritage, representing the community's traditional values, philosophy, and local wisdom. This documentation process not only records the building's physical structure but also the cultural context and values passed down orally from generation to generation.

Conventional documentation

Manual documentation of traditional buildings is still possible, especially for small-scale buildings (Rahadian and Nurhidayah 2020). Interviews were the first stage in the documentation process of the Bayan Timur

Traditional House. The interview stage involved Bayan Timur Hamlet's customary leader, Mr. Raden Kertomono, who was the main resource person (figure 3). The interview method was conducted in a semi-structured manner to explore information in the form of explanations of the function of spaces in traditional houses, traditional rituals carried out in the process of building or renovating traditional houses, local terms related to elements and systems in traditional houses, the philosophy behind the layout of the house, and the relationship between building materials and local beliefs (for example, certain types of wood are considered sacred or should not be used for certain parts of the building).



Figure 3
Interview with Traditional Leaders



Figure 4
Combination of documentation and freehand sketching techniques

Interviews are an important stage in the documentation process, as not all information related to the Bayan Timur Traditional House has been documented in modern literature. However, a further process is needed to translate and find equivalents in other languages to avoid different interpretations of local terms associated with the Bayan Timur Traditional House.

Manual sketching is a conventional method in documentation but is still relevant in cultural documentation. Manual sketching involves the documentarian's body and five senses. It encourages the documentarian to develop a deep understanding and analytical thinking about the object, making the invisible aspects visible (Akboy-Ilk 2016). Sketching helps the documentarian "get inside" the object and record shapes, textures, and other details crucial to discovering and understanding the object of observation (Imam, Bakr, and Anany 2016).

Sketching focuses on the details of building elements, such as structural joints, wall weaving patterns, roof shapes, building proportions, and materials and textures (figure 4).
Sketches are very useful for capturing specific perspectives of the building and for documenting parts that are difficult to capture with digital tools, such as ornaments or details in narrow or dark areas. The results of manual sketching can serve as the basis for digital illustrations or a guide for the physical reconstruction process of a traditional house when needed.
Manual measurements provide a quantitative picture of the building's proportions. This measurement data will be useful for technical documentation and conservation purposes. Manual measurement is essential for obtaining precise dimensions that enable the creation of accurate blueprints. It is also helpful for creating replicas, restorations, or architectural visualisations on an appropriate scale. However, in vernacular buildings that use natural materials from the surrounding environment, building dimensions may vary depending on the availability of materials. As such, the results of these measurements are not absolute.

Digital documentation
Digital recording allows the data generated to be conserved and further processed. Digital documentation of the Bayan Timur Traditional House was conducted in three stages, namely 2D photography, 3D scanning using LiDAR on Polycam software, and 3D modeling.
2D photography is done to record the physical elements of the building in detail, such as photos of the whole building, ornaments, and building materials separately. Photographs visually describe the building structure figure 5. These photographs serve as a direct reference for design and archival storage.



Figure 5
2Dphotography techniques

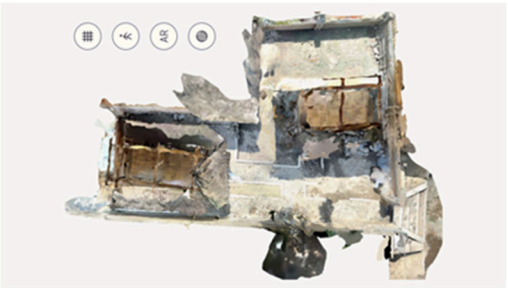


Figure 6
Example of LiDAR scan results

3D scanning with LiDAR produces a 3D model that captures a precise, complete impression of the outer and inner spaces at actual dimensions. LiDAR is easy to apply in the field and requires relatively little time during data collection (Maté-González, Di Pietra, and Piras 2022). This documentation facilitates the visualisation of traditional houses from various viewpoints and enables further visual data processing in a virtual environment to support preservation.

3D modelling was conducted as part of the digital repository development. Beyond its function of representation, a point cloud can be edited and operated on as a working model rather than a fixed image (Urech et al. 2020), which is what allows the repository to serve preservation rather than merely store it. 3D digital modelling, combined with LiDAR scanning results, can expand the range of virtual exploration, allowing people to learn about and observe the Bayan Timur Traditional House without visiting the site.

Coverage and complementarity of the techniques

Read together, the conventional and digital techniques do not duplicate one another; each cover what the other cannot. Table 1 maps the four data categories to the techniques applied and explains how each gap in the record was closed.

Table 1
Coverage matrix of conventional and digital documentation techniques

Data category	Conventional technique	Digital technique	The gap and how it was closed
Compound layout and mass composition	Sketch and measurement record the relative position of Bale Beleq, Geleng, Bale, and Berugaq	Photography and LiDAR record the compound envelope in actual dimensions	Covered; the two sources corroborate each other
Dimension and proportion	Manual measurement gives precise dimensions of accessible parts	LiDAR gives dimensions within a five-metre sensor range	Parts beyond sensor range closed by sketch and manual estimate
Structure and joining technique	Sketching records joints, bindings, and weaving patterns in narrow or dark areas	Macro photography records the surface and material conditions	Joints inside the sacred core remain unrecorded; closed by comparative study at Karangsalah
Roof and upper structure	Observation and sketch from ground level only	Not scannable; climbing the building is not permitted by adat	Closed by sketch and comparative study; an extension pole is recommended for future work
Interior of the sacred core house	Not accessible; described verbally by the customary leader	Not accessible	Closed by interview description and comparative study; declared as a gap in the record

Data category	Conventional technique	Digital technique	The gap and how it was closed
Local terminology	Interview records terms and their referents	Not applicable	Requires cross-source verification and a consistent glossary; risk of mistranslation
Ritual and philosophical meaning	An interview is the only instrument	Not applicable	Recorded in writing to prevent distortion and loss in digital transfer
Material condition and damage monitoring	Visual observation without a periodic record	Scan not yet configured for monitoring (X. Li et al. 2025; Y. Li et al. 2023)	Open; requires periodic rescanning with a fixed reference

The matrix identifies two categories in which digital capture is structurally unable to substitute for conventional work: what cannot be reached physically, namely the roof and the sacred core, and what has no physical form at all, namely terminology, ritual, and the philosophy of the compound layout. These are precisely the categories that carry the compound's cultural value. The same pattern of complementarity is reported in laser-scanned historic districts, where details that the point cloud could not resolve, such as cracks, cavities, and deformation, had to be closed with calibrated detail photography (Benli and Kan 2017). Documenting a living customary settlement, therefore, cannot be planned as a scanning campaign. The scan records the measurable envelope, while the meaning of that envelope is obtained only through the words and the consent of its custodians.

Comparative study

The Bayan Timur Traditional House includes a compound considered sacred. As a result, several buildings cannot be accessed, leaving the information collected incomplete. Therefore, a comparative study was conducted to complete the required data.



Figure 7
Comparative study in Dusun Karangsalah

A comparative study of compound traditional houses was conducted in Dusun Karangsalah (figure 7). Dusun Karangsalah was chosen as the location for the comparative study because it is directly adjacent to Bayan Timur, shares the same cultural roots, and still maintains ongoing traditional ties. This comparative study process helps validate the data and document the building elements of the Bayan Timur Customary House, provides insights, especially into building elements that cannot be documented in the Bayan Timur Customary House, and explores the interrelated cultural and historical contexts.

The aspects compared and the results of each comparison are set out in table 2. The comparison is used to complete the record, not to claim identity between the two compounds; where an element at Bayan Timur could not be observed directly, the Karangsalah equivalent is recorded as a reference and marked as such in the repository.

Table 2
Comparison of compound elements at Bayan Timur and Karangsalah

Aspect compared	Bayan Timur	Karangsalah	Implication for the record
Compound layout	Consists of 11 buildings, usually used as the center of traditional ceremony for 4 Dusun	Consist of 4 main buildings each represents the type and function in the compound	Bayan Timur traditional house shows the complete compound layout with specific function of each building
Bale Beleq	Core house interior and roof closed to outsiders	Core house interior could be observed and recorded digitally; roof is allowed to be recorded manually	Karangsalah data used as a reference for elements closed at Bayan Timur
Roof construction and material	Documentation using digital tools is restricted	Documentation using digital tools is restricted	Data related to roof construction and material are limited, data collected from semi-structured interview
Joining technique	Documentation focused on exterior joining technique	Documentation focused on interior joining technique	Digital documentation from Bale at Karangsalah used to adding interior joining technique data

Advantages of digital technology

Using digital technology in the documentation process makes digital data easier to archive and access for various purposes, such as education, research, and cultural preservation. Digital documents facilitate collaboration with other digital data and increase the accuracy of building identification (Adianti, T. Adishakti, and Hadi Rahmi 2021). Current developments in digital technology enable the presentation of documentation results that provide an immersive experience for observers using digital devices, such as Virtual Reality (VR) and Augmented Reality (AR) (Kyrlitsias et al. 2020; Szekely et al. 2023). VR cannot replace the real experience (Barrile et al. 2022; Khalid 2021). However, it is expected to increase public interest in traditional architecture such as the Bayan Timur Traditional House.

Challenges in digital documentation

The field process revealed constraints that had not been anticipated during planning. They are summarised in table 3 as cultural, technical, and institutional constraints, each with its implications for the resulting record and the response applied or recommended.

The community in Bayan Sub-district remains strong in local wisdom values

and traditional rituals (Wardi et al. 2023). It is necessary to be flexible in communication techniques and to anticipate changes in documentation techniques that are considered inappropriate for local communities to minimise rejection. Traditions, customs, and philosophical values that are upheld also result in access restrictions on some parts of the Bayan Timur Traditional House building, for example, not being able to enter certain areas inside the core house and not being allowed to climb to document the roof digitally. These conditions resulted in incomplete data. 3D scanning using LiDAR has a maximum sensor distance of 5 (five) meters (figure 8), so data collection from the top of the building cannot be done due to access restrictions on vernacular buildings (Ulvi and Hamal 2024).



Figure 8
Limitations of LiDAR scanning

For similar programs in the future, it is recommended that an extension tool be developed to more easily and clearly document the upper part of the building. In this case, the limited access to digitally document the building can be overcome with manual sketching techniques, as has been done by the documentation team.

Constraint	**Implication for the record**	**Response applied or recommended**
Cultural: access to the sacred core and to the roof is restricted, and some recording techniques are considered inappropriate by the community	Interior and upper structure incompletely recorded	Flexible communication, adjustment of technique, substitution by sketch and comparative study
Technical: effective LiDAR sensor range of five metres (Ulvi and Hamal 2024)	Upper parts of the building not captured	Extension pole for the device; supplementary sketch from ground level
Technical: Polycam requires specific hardware and produces very large data volumes	High investment and storage cost, a known barrier to the adoption of 3D data (Benli and Kan 2017)	Shared institutional hardware; hybrid offline and online storage
Technical: limited export formats	Difficulty integrating new 3D data with existing 2D data and with HBIM workflows (Benli and Kan 2017)	Export standard agreed at the outset; conversion to an open format

Table 3
Constraints in documenting a living customary settlement and the responses applied

Constraint	Implication for the record	Response applied or recommended
Technical: weak internet on site	Cloud storage unreliable during fieldwork	Offline backup as the primary store, cloud as secondary
Knowledge: terminology and philosophy are transmitted orally	Risk of distortion or loss when translated into digital form	Cross-source verification; a consistent glossary of local terms recorded in writing
Institutional: published data may be used commercially without community consent	Risk of infringing the community's cultural rights	Registration of cultural property rights and access levels in the repository
Institutional: the repository is more legible to academics than to the community	Digital divide between the owners and the users of the record	Non-digital version of the repository, training, and a user-friendly presentation

Two of these constraints (table 3) are not technical problems that can be solved with technical solutions. Publishing compound data in an open repository carries the risk that outsiders will exploit it commercially without the Bayan community's consent, so registration of cultural property rights must precede publication rather than follow it. And a repository that is legible to academics but not to its owners reproduces the very asymmetry that documentation claims to redress; non-digital formats, a glossary in the local language, and a user-friendly presentation are therefore part of the deliverable rather than an afterthought. The digitisation process also requires expert operators, and the limited number of qualified staff is a recurring obstacle to 3D documentation (Benli and Kan 2017), which is why training community members with the qualifications to operate the tools and process the data is a condition for the record to be sustained locally.

Strategies for overcoming challenges in digital repositories

The essence of empowering village communities is done by developing community independence through increasing knowledge, skills, and abilities (Pradhipta, Pusparani, and Nofiyanti 2021) for example, in preserving vernacular buildings that become cultural heritage. The challenges described in the previous section can be overcome with the following steps: community involvement, technology education, hybrid approaches, partnerships, and cultural rights protection policies.

The involvement of local communities at every stage, from documentation to data management in digital repositories, can increase awareness, responsibility, and a sense of ownership of cultural property. Training on the documentation process and on the use of digital tools enables the community to continue the work independently, while cultural asset management regulations are needed to sustain conservation and restoration (Borin and Donato 2020).

Combining conventional methods with digital technology is ultimately the decisive strategy: in practice, the two support each other, thereby making the record of the Bayan Timur Traditional House more complete. The same hybrid principle applies to presentation, extending the reach of the information to academics and to the wider public alike.

Cooperation between local communities and educational institutions, government, and cultural organisations remains necessary to support financing, infrastructure, and data validation.

Limitations and further research

Three limitations should be noted. The record of the Bayan Timur compound is deliberately incomplete: the interior of the sacred core and the roof structure are described rather than measured, and the substituted data from Karangsalah, although the two share cultural roots, cannot be treated as identical. The dimensional accuracy of smartphone-based LiDAR has not been validated against a survey-grade instrument; heritage surveys using terrestrial laser scanning routinely achieve millimetre-level positional accuracy (Benli and Kan 2017), a level of accuracy this workflow does not claim. Finally, the protocol is derived from a single compound with a single comparative site; testing it in other customary settlements and configuring the scan for periodic damage monitoring remain areas for further research.

Conclusion

The documentation of the Bayan Timur traditional house shows that conventional and digital techniques are complementary rather than alternative. Digital capture records the measurable envelope efficiently and in actual dimensions, but it stops at two boundaries: what cannot be reached, namely the roof and the sacred core, and what has no physical form, namely local terminology, ritual, and the philosophy of the compound layout. Those boundaries are set by customary norms as much as by sensor specification, so the completeness of a record in a living customary settlement is a matter of negotiated permission rather than of equipment.

From this finding, the study proposes a five-stage hybrid protocol – customary permission and community involvement, conventional recording, digital capture, cross-source verification, and hybrid dissemination – in which conventional techniques are assigned precisely to what digital capture cannot reach, and remaining gaps are declared rather than interpolated. The contribution is threefold: a transferable documentation procedure for customary settlements, teaching material that shows students how to read and measure vernacular architecture, and a verified basis for culture-based tourism in Bayan that remains under the control of its community. Understood in this way, documentation is not an archive of a building but a record of the relationship between a community and the space it inhabits.

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