(Online) ISSN 2712-0554
Heritage and Sustainable Development *Original Research*
Vol. 7, No. 2, 2025, pp.1213-1228
https://doi.org/10.37868/hsd.v7i2.1513

Forging resilience: Sustaining traditional blacksmithing in the Barito watershed, Central Kalimantan

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Received Jul. 24, 2025
Revised Nov. 17, 2025
Accepted Nov. 26, 2025
Online Dec. 2, 2025

Abstract
The creation of iron tools emerged in response to human needs for cultivating agricultural land and making weapons. Iron-making sites along the upper Barito River in Central Kalimantan, Indonesia, indicate iron manufacturing from the 16th to the late 19th century. The historic iron industry, while still existing through blacksmithing, has markedly diminished in both quantity and quality. This study seeks to examine the determinants affecting the sustainability of blacksmithing and to develop suitable conservation solutions. Data were gathered by observation and interviews, and thereafter analyzed descriptively with SWOT analysis. The results demonstrate that the accessibility of tools, the blacksmiths' commitment to preserving the heritage, and the farmers' position as consumers are essential elements in the continuation of blacksmithing traditions. Robust documentation and preservation techniques are crucial to guarantee the continuity of this endangered cultural legacy. Such initiatives must incorporate indigenous agricultural knowledge in marshy regions where farmers till the soil using *tajaks* crafted by local blacksmiths. The *tajak*, a farming implement utilized in wetlands, has become an essential component of the Dayak people's identity in Kalimantan.

Keywords: Blacksmithing, Agricultural, Tradition, Local wisdom, Montallat River, Kalimantan

1. Introduction

The Montallat River, a tributary of the upper Barito River in Central Kalimantan, sustains the Dayak Taboyan community, which has historically relied on agriculture as its primary means of subsistence. For decades, they have utilised iron implements—such as the *mandau* (local machete), axes (*belayung*), and spears (*sarapang*)—for agriculture, fishing, and hunting. These implements, frequently produced by local blacksmiths, embody the community's agricultural way of life and their indigenous technological expertise [1], [2].

In prehistoric times, iron was a valuable metal utilised for weaponry and agricultural tools [3]. Historical records and archaeological data indicate that an iron-smelting industry flourished in the upper Barito region from the 16th century until its downfall approximately 160 to 200 years ago [4]–[6]. In this setting, blacksmithing was essential for transforming smelted iron into functional tools, employing traditional forging techniques to

eliminate impurities and yield resilient bar iron [7], [8]. Despite the cessation of the smelting sector, blacksmithing continues as a cottage business, albeit more marginalized and in decline.

Prior research has analyzed agricultural transitions and traditional metalworking in Kalimantan from multiple viewpoints. Archaeological evidence from the upper Barito and Montallat Rivers indicates that iron-smelting businesses thrived from the sixteenth to nineteenth centuries, establishing the basis for local tool production [4], [6]. Ethnographic research on the *mandau* and other iron implements reveals that these instruments fulfil utilitarian functions while also representing cultural identity and symbolic significance for the Dayak people [9], [10]. Simultaneously, global research has highlighted the agricultural engineering in development with basic blacksmithing, underscoring the necessity for sustainable training and enhancements in workplace safety [11], [12].

Agricultural methods in the Barito watershed include dryland farming in elevated regions and wetland rice production adjacent to the rivers. Farmers continue to rely on traditional iron implements for land preparation and crop management, underscoring the enduring significance of locally manufactured blacksmith equipment in rural existence [13]. The close connection between blacksmithing and agriculture is evident, as farmers rely heavily on implements crafted by blacksmiths. Nevertheless, only a limited number of socio-cultural studies have examined blacksmithing traditions in Kalimantan. This encompasses investigations into the ethnographic significance of blacksmithing as a means of cultural continuity in Ketapang, West Kalimantan [14], the implementation of closed furnace technology with blowers [11], the utilisation of hammer machines and carbonisation technology [15], productivity assessments of blacksmiths in South Sumatra [16], and the modernisation of production tools in Sulawesi [17]. Dunham [18] emphasised that the advancement of blacksmithing in Java signifies an endeavour to enhance skills and inventions based on indigenous knowledge, which can beneficially influence the rural economy. This discovery strengthens the assertion that technological adaptation informed by traditional knowledge can facilitate sustainable economic growth.

Contemporary challenges, such as competition from mass-produced tools, insufficient institutional support, and waning interest among younger generations, endanger the viability of traditional blacksmithing in the upper Barito region, leading to a consistent decrease in both the quantity and quality of practitioners. Under these circumstances, this research seeks to investigate the elements that affect the sustainability of blacksmithing in the interior of Kalimantan, particularly along the Montallat River. This study aims to identify and analyse the factors affecting the sustainability of traditional blacksmithing, including motivation, local agricultural knowledge, technology, and stakeholder attitudes. These factors are classified via SWOT analysis into internal components (strengths and weaknesses) and external components (opportunities and threats). The SWOT analysis serves as the foundation for formulating strategic suggestions aimed at advancing blacksmithing industries via culturally grounded innovation in agricultural practices. This research is innovative in its comprehensive use of SWOT analysis, merging technological, economic, and cultural viewpoints to enhance the sustainability of blacksmithing as a locally rooted, agriculture-oriented heritage enterprise.

2. Research method

This research is based on field data obtained through direct observation, surveys, and interviews with selected informants. Observations of informants' practices, tools, and experiences provided valuable insights into the resilience of traditional blacksmithing as a cultural and economic activity within the local agrarian context. The survey also used questionnaires distributed to all 19 blacksmiths in villages along the Montallat River. A questionnaire was utilized to collect data on the factors affecting the sustainability of traditional blacksmithing processes among a cohort of local artists. The names of the blacksmiths, as respondents (with the consent of the individuals involved), along with their locations, are displayed in Table 1.

Table 1. Blacksmith craftsmen along the Montallat River, Gunung Timang District

No.	Name	Education/age (year)	Location/village
1.	Deransyah	Elementary school /66	Pelari RT 02

No.	Name	Education/age (year)	Location/village
2.	Darunsyah	Elementary school /65	Pelari RT 01
3.	Edi Suharto	Junior high school /68	Pelari RT 02
4.	Walotes	Elementary school /56	Pelari RT 02
5.	Danang/Aky	Junior high school /37	Sengkorang
6.	Kardius	Elementary school /60	Payang Ara
7	Galung	Elementary school /70	Payang Ara
8.	Yunus	Elementary school /52	Kandui, RT 04
9.	Satriatun Esadam	Elementary school /65	Pandran Jari, Kandui RT 06
10.	Yulianto	Elementary school /72	Pandran Jari, Kandui RT 06
11.	Museus	Elementary school /65	Pandran Jari, Kandui RT 06
12.	Kairul	Elementary school /70	Majangkan
13.	Kudirman	Junior high school /47	Malungai RT 02
14.	Hengky/Baang	Elementary school /54	Malungai RT 01
15.	Awalman	Junior high school /45	Malungai RT 02
16.	Gardiason	Elementary school /45	Malungai RT 01
17.	Beny Arisandi	Elementary school /45	Malungai RT 02
18.	Petronius	Elementary school /42	Malungai RT 03
19.	Hendrawan	Elementary school /45	Malungai RT 03

In-depth interviews were conducted with blacksmiths, community leaders, and local officials to explore various aspects of the blacksmithing tradition, including motivations for entering the profession, sources of raw materials, types of tools used, product variations, production time and labor, income levels, as well as the involvement of stakeholders in preserving and developing this craft. Community leaders and local officials were selected because they represent the local population, have close ties with the blacksmiths, and have a deep understanding of local sociocultural dynamics.

A qualitative approach was applied to analyze the sustainability factors of blacksmiths, supported by simple statistical techniques such as tabulation and percentage analysis. Descriptive statistics were used to summarize and present the findings, which served as the basis for data verification and interpretation [15], [16], [17].

The factors affecting blacksmithing sustainability were qualitatively analyzed through the following steps: constructing a cross-tabulation of respondents' answers regarding sustainability factors, calculating the percentages of these factors, and interpreting the influences on blacksmithing sustainability based on the calculated percentages for each factor. Triangulation was performed by comprehensive interviews with informants and an examination of synthesized secondary material.

The blacksmithing development strategy was established based on questionnaire responses from 19 blacksmith respondents, assessed through a SWOT framework. The SWOT framework is executed in three phases: identifying internal and external factors, assigning weights to each element based on significance (scale 1–4), and establishing strategic priorities using matrix analysis. Validation is conducted by triangulation by comparing interview data, field observations, and documentary sources to confirm data consistency and trustworthiness.

3. Literature review

Cultural heritage includes monuments and tangible artefacts, as well as the traditions, knowledge, and skills employed in the creation of traditional crafts [18], [19]. In this context, blacksmithing constitutes a form of traditional knowledge transmitted throughout generations. As a form of traditional technology, blacksmithing contributes to the production of essential agricultural tools, such as sickles, hoes, knives, and machetes, which remain vital to rural farming communities [20], [21]. Dunham characterises historic blacksmiths as "blacksmith-farmers," emphasising their dual function in tool production and agricultural engagement. This conceptualisation illustrates the relationship between the blacksmithing profession and agricultural techniques,

especially in distant regions where industrial tools are less available. This integration highlights that blacksmithing is not just a craft but a livelihood system interconnected with agricultural sustainability.

From a cultural perspective, blacksmithing carries values related to history, local identity, and technical knowledge. Historical significance is reflected in centuries-old iron tools, which serve as evidence of local technological development [10]. Cultural identity is maintained through the continuation of inherited techniques and tool forms, while innovations in product design—such as the integration of local motifs—offer potential for broader economic and tourism benefits [22]. The continuity of blacksmithing techniques and tool forms as cultural identity is evident in Yogi's research in the Pawan River Basin in West Kalimantan, where local blacksmiths still employ forging techniques using the *ububan* (traditional double piston) as a heat blower [14]. These findings indicate that blacksmithing functions as both a cultural expression and an adaptive economic activity.

Numerous studies have investigated initiatives to enhance blacksmith production and efficiency. This encompasses the utilisation of closed furnaces equipped with blowers, mechanised forging apparatus, and carbonisation methods to enhance durability [11] mechanized forging tools, and carbonization techniques to increase durability [23]. Researchers [24] found that while factors such as age, education, and experience did not significantly affect productivity, work ethic played a key role in determining income and output levels. The modernization of blacksmithing tools in South Sulawesi has resulted in substantial enhancements in production capacity and economic welfare [25]. However, these studies tend to emphasize technical efficiency, with limited attention to how modernization aligns, or conflicts with, cultural sustainability.

The government must step in to help boost income and production, in addition to the craftsmen. Coordination and policymaking, development facilitation, and investment stimulation are the three ways the government can fulfill its duties [23]. The government can commodify blacksmithing by enacting laws to draw in investors as part of its stimulating function. However, since commodification offers both advantages and disadvantages, care must be taken. The commodification initiative led to both touristification and economic inequality, as was the case with farm tourism in southeast Estonia [26].

From an anthropological perspective, blacksmithing also embodies environmental and technological adaptation. Koentjaraningrat [27] notes that technology reflects human efforts to organize life and adapt to nature. Traditional technology, such as blacksmithing, is intertwined with local wisdom, defined by Daeng [28] and Mafongoya & Ajayi [29] as a system of knowledge, practice, and belief that emerges from long-term interaction with the environment. Meliono [30] further emphasizes that local wisdom is embedded within collective social processes, forming the basis for community resilience and identity. According to these criteria and notions, blacksmithing techniques and products in the Barito River Basin have developed to address the varied requirements of the community, including both upland farmers in the highlands and lowland farmers in the wetlands. Tools produced for dryland agricultural land preparation include machetes and a *mandau*, which are used for slashing and cutting during the planting season. Meanwhile, rice paddy preparation in the lowlands uses different tools, namely *sundak* and *tajak*, which are used to turn the soil. The characteristics of rice paddy soil in the lowlands differ from those in the highlands, where lowlands (swamps) contain layers of pyrite. Land preparation using a hoe is intended to minimize the impact of land preparation on plant growth [31], [32].

Despite these valuable insights, most previous studies focus primarily on cultural and technical dimensions, offering limited exploration from socio-economic or environmental perspectives. Few studies, for instance, examine how blacksmithing supports local livelihoods, contributes to the rural economy, or adapts to ecological challenges such as resource scarcity. Integrating multidisciplinary viewpoints—from social, economic, environmental, and cultural studies—can therefore provide a more comprehensive understanding of blacksmithing as both a cultural practice and a sustainable livelihood strategy [12], [33]. Accordingly, this research employs a comprehensive strategy that integrates cultural heritage and sustainable development concepts. It rigorously analyzes the functioning of blacksmithing within technological, economic, and social frameworks, framing it as an adaptive heritage practice that enhances cultural resilience and rural sustainability.

4. Results and discussion

4.1. The iron industry in the interior of Kalimantan

Archaeological investigations have identified 26 ancient iron-smelting locations within the Teweh and Montallat sub-watersheds, both tributaries of the Barito River in Central Kalimantan. These locations, referred to locally by the Dayak Tawoyan community as *buren,* are distinguished by the presence of slag heaps, iron ore fragments, tuyere, and ruins of smelting furnaces. The furnaces are often bell- or cone-shaped, with a height of roughly one meter [6], [34].

Ethnographic and experimental studies indicate that iron production in this region comprised several distinct phases: ore extraction, furnace and tuyere construction, ore fragmentation, charcoal fuel preparation, and smelting the ore at temperatures of 1538°C to isolate iron from its impurities. This was succeeded by the transformation of raw iron into bars via repeated heating and hammering to eliminate remaining minerals [6], [34].

Historical records corroborate this archaeological evidence. In the mid-19th century, German geologist C.A.L.M. Schwaner recorded eleven operational smelting furnaces along the Montallat River. He observed that iron ore was extracted from the river and adjacent hills, and that Montallat iron was extensively marketed across southeastern Kalimantan [5]. However, by the end of the 19th century, the local iron industry had declined due to the influx of cheaper imported iron, particularly from China [4]. Despite the cessation of smelting over a century ago, the practice of blacksmithing persists in the region. Currently, craftsmen manufacture agricultural implements and weaponry with repurposed iron and waste metal. Numerous Dayak families continue to maintain heirloom weapons—such as *mandau*, machetes, and spears—fabricated from Montallat iron, highlighting the enduring legacy of this regional metallurgical history.

4.2. Agriculture's local wisdom

Burning shrubs and using the ash as fertiliser is how Dayak farmers in Kalimantan's interior engage in dryland agriculture. Regulations set forth by the Indonesian government restrict land burning to no more than two hectares and necessitate consent from the local village officials. To stop the fire from spreading, the Dayak community uses their local knowledge to build *beje* ponds, build firebreaks, and keep a close eye on the fire while it burns [35]–[37].

Compared to fertilisers based on urea, the ash generated is thought to be more environmentally friendly and acts as an organic fertiliser that improves the soil. High concentrations of nitrogen and phosphorus found in urea can seep into adjacent bodies of water, causing nutrient pollution, algal blooms, and ecological deterioration. To preserve the environment and water supplies while preserving agricultural output, farmers, legislators, and environmental activists must follow specific criteria [38].

Wetland (swampland) farming in the lowlands and dryland farming in the uplands are the two main types of agricultural activities in Kalimantan. Although rice is the main crop in both systems, farmers also grow a wide range of other food crops, including peanuts, cucumbers, sour eggplant, chillies, cassava, sweet potatoes, bananas, breadfruit, maize, bamboo shoots, and other spices. Communities depend on hunting forest creatures, including birds, squirrels, and wild boars, as well as fishing in rivers, to supply their nutritional needs [13]. Iron implements, mainly machetes of various sizes and single-edged and three-pronged spears (*sarapang)*, have long been used in farming, fishing, and hunting in the upstream Barito region. In addition to being useful, these tools are a part of the community's hereditary wisdom that has been passed down through the generations [2], [13].

In marshy lowland, native agriculturists utilize a unique long-handled machete called a tajak to clear vegetation and prepare the terrain [39]. The *tajak*, like a hoe, is substantial and necessitates adept manipulation. Its use is crucial for reducing disruption to the pyrite (FeS_2) stratum beneath the soil, which, if exposed, can adversely affect plant roots [32], [40]. The pyrite is located 25-100 cm from the soil surface [38], whereas land preparation

using a tajak is solely for weed removal, and if the soil surface is disturbed by the tajak, it occurs only to a depth of 5-15 cm [41]. Currently, the tajak's existence is threatened by the presence of hand tractors that can work faster and turn the soil at a depth of around 15 cm [42].

Another traditional tool, *sundak,* is widely used in tidal farming systems. Made from iron or ironwood plates, it is used for digging canals, shaping planting beds, and constructing *tembokan*—artificial raised mounds designed to improve drainage and soil fertility. A typical *sundak* is about 15 cm wide and 50 cm long. Farmers use it to cut soil blocks measuring approximately 20 x 40 cm, which are then stacked to form *tukungan* mounds enriched with humus. These mounds are ideal for cultivating crops such as grafted citrus [43].

The products of local blacksmiths in Kalimantan primarily consist of *mandau* and various types of machetes used in agriculture, particularly for land clearing and tree felling before planting. Various machete kinds fulfill distinct purposes: slashing machetes for huge trees, parang peuruh for medium-sized timber, and logging machetes for small branches and twigs [2]. The robust demand for conventional iron implements emphasizes the intimate relationship between local agricultural practices and the blacksmithing industry.

4.3. Blacksmithing along the Montallat River

The Montallat River, extending roughly 91 kilometers across the Gunung Timang District, hosts numerous traditional blacksmith settlements. Of the 16 settlements situated along the river, six maintain active blacksmiths: Malungai, Majangkan, Kandui, Payang Ara, Pelari, and Sengkorang (Figure 1). Malungai Village, the furthest downstream settlement, possesses the highest concentration of blacksmiths, totaling seven known artisans. This section delineates prominent blacksmiths and their techniques from specific villages.

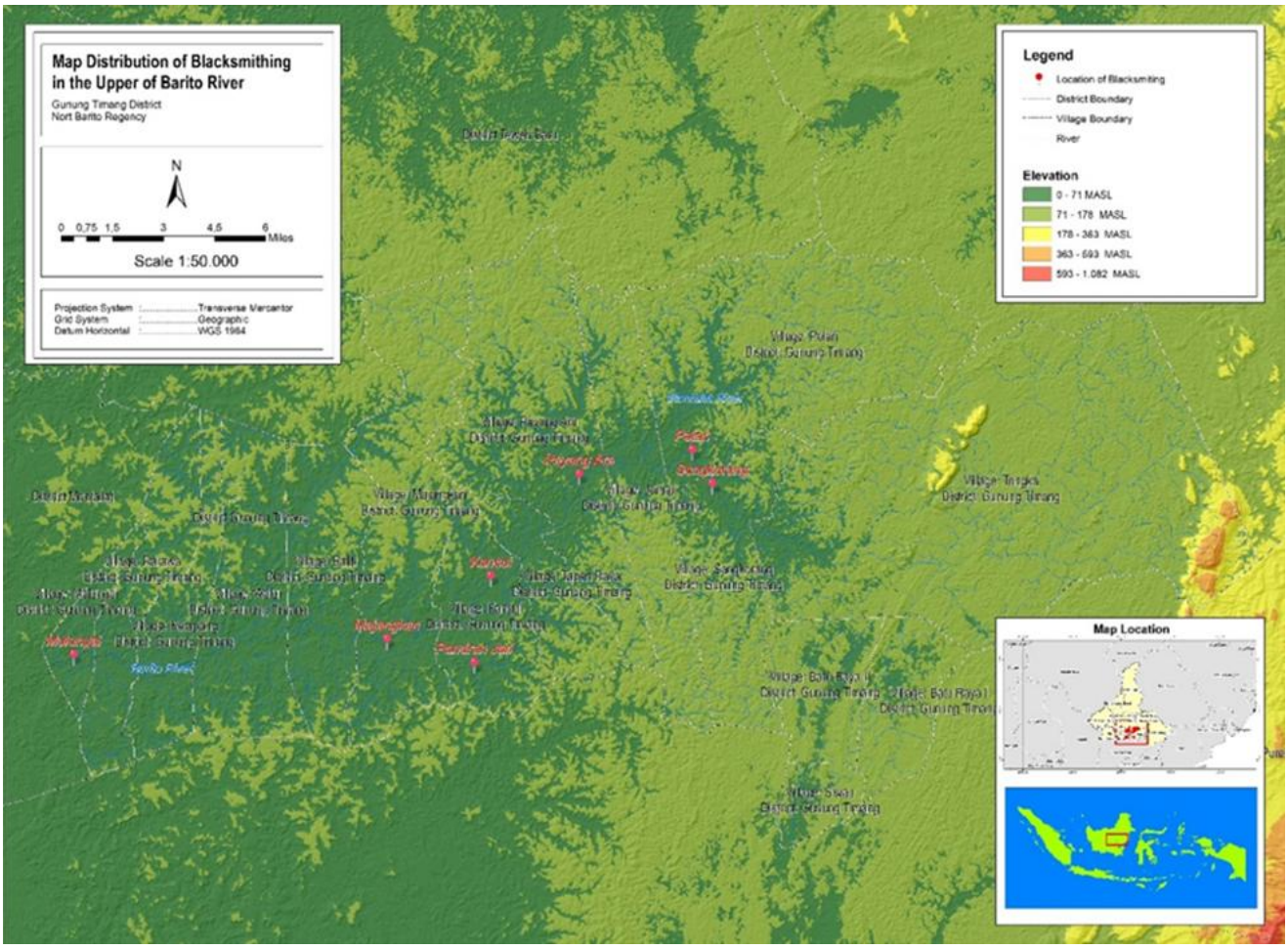

Figure 1. Map illustrating the distribution of blacksmithing craftsmen along the Montallat River, a tributary of the Barito River (Source: author)

4.3.1. Malungai Village

Malungai Village is located at the lower reaches of the Montallat River and is recognized for four historical iron-smelting sites: Buren Mangu, Buren Uwir, Buren Lupak, and Buren Malembah. The principal sources of income for its inhabitants consist of rubber tapping and tidal rice cultivation. Blacksmithing persists in this location, especially in the production or honing of agricultural implements.

Kudirman (47), a renowned blacksmith, manufactures *mandau*, machetes, and *badik* (short machetes) according to local requests (Figure 2, left). He operates from a little workshop adjacent to his residence, utilizing a homemade air blower constructed from PVC tubing or, occasionally, an electric blower. He can manufacture four machetes in a single day. The handles, often crafted from meranti wood, exhibit various motifs according to customer demand. The entire set (blade and handle) is priced at approximately IDR 200,000.

Another craftsman, Hengki Wingklis (54), acquired blacksmithing skills through apprenticeship and underwent government training in 2014 while residing in Buntok. His apparatus comprises a hammer, grinder, drill, and air blower. Upon his return to Malungai in 2018, he recommenced solo work. Utilizing scrap metal (from automobiles, chainsaws, etc.) and charcoal as fuel, he generally manufactures five machetes every day, yielding a profit of IDR 400,000–500,000 each day.

Other blacksmiths in Malungai—namely Gardiason, Awalman, Beny Arisandi, Petronius, and Hendrawan—primarily specialize in tool sharpening, referred to locally as gilding, a service particularly sought after prior to the planting and harvest seasons. The cost for machete sharpening varies between IDR 20,000 and 25,000. The forging process entails metal cutting, furnace heating, shaping via repeated hammering, and finishing through grinding and gilding. Most blacksmiths do not own branding stamps, and their items are sold straight from their residences.

4.3.2. Majangkan Village

Majangkan, situated 7 km from Kandui, the sub-district capital, has historical ties to ironworking, evidenced by sites such as Buren Wira and Buren Barimba. Only one blacksmith persists: Khairul (72), who has engaged in the craft for generations. He operates on the veranda of his residence, utilizing a conventional wind pump constructed from PVC pipe and fueled with *halaban* wood charcoal. He sharpens 5 to 6 machetes daily, charging IDR 15,000 to 20,000 per machete. Certain villagers continue to retain antiquated blacksmithing implements, such as the *pesusan* wind pump constructed from *malahoi* wood.

4.3.3. Pelari Village

Once inhabited by numerous blacksmiths, Pelari Village currently hosts only a handful of remaining artisans. Deransyah, aged 67, is among them. He specializes in the honing of *mandau* or machetes per request. His workshop employs a double-piston blower constructed from PVC pipe. In the sharpening procedure, the blade is heated over charcoal, coated with salt on the cutting edge, and subsequently quenched in water. This process is reiterated until the blade attains sufficient sharpness to penetrate ironwood. The fee for his sharpening service is IDR 20,000 per blade.

Other artisans in the village, Walotes (52), Darunsyah, and Edi Suharto (69), persist in blacksmithing on a limited scale, frequently by request. Their implements, such as rail forges and double pistons, remain housed in workshops adjacent to their residences. Other craftsmen in the village, Walotes (52), Darunsyah, and Edi Suharto (69), still pursue their blacksmithing work on a limited scale, often based on requests. Their equipment, such as rail forges, double pistons, and simple furnaces, is kept in workshops adjacent to their homes. Nearly every blacksmith on the Montallat River has a basic workshop (Figure 2, right).

Figure 2. Machetes with their sheaths produced by Kudirman from Malungai Village (left). Danang's blacksmith basic workshop and equipment in Sengkorang Village (right) (Source: Hartatik 2024)

4.4. Analysis of determinants of blacksmithing sustainability

Numerous interconnected factors, such as motivation, access to tools and raw materials, income potential, labor availability, product varieties, and institutional influence, determine the sustainability of blacksmithing techniques along the Montallat River. Utilizing survey and interview data from 19 blacksmiths, each element was evaluated and quantified on a scale from 1 (little influence) to 4 (significant influence). The findings are encapsulated in Table 2, and the percentage is depicted in Figure 3.

Table 2. Factors affecting blacksmithing sustainability

No.	Respondents	Factors*							Total
		F1	F2	F3	F4	F5	F6	F7	
1.	Deransyah	4	2	4	2	2	3	2	
2.	Darunsyah	4	2	4	2	2	3	2	
3.	Edi Suharto	2	2	2	2	2	2	2	
4.	Walotes	4	2	3	2	2	3	2	
5.	Danang/Aky	2	4	4	4	4	2	2	
6.	Kardius	3	4	4	4	4	3	2	
7	Galung	4	2	2	2	2	2	2	
8.	Yunus	2	4	2	2	4	2	2	
9.	Satriatun E.	4	4	3	3	4	3	2	
10.	Yulianto	2	2	3	2	2	3	2	
11.	Museus	3	2	3	2	2	2	2	
12.	Kairul	3	2	3	2	2	2	2	
13.	Kudirman	3	4	4	4	4	4	2	
14.	Hengky/Baang	3	4	4	4	4	4	4	
15.	Awalman	3	2	3	2	3	2	2	
16.	Gardiason	3	3	3	2	3	3	2	
17.	Beny Arisandi	3	2	3	2	2	2	2	
18.	Petronius	3	2	3	2	2	3	2	
19.	Hendrawan	3	2	3	2	2	2	2	
	Total	58	51	60	47	52	48	40	356

*F1= motivation, F2= raw materials, F3= equipment, F4 = labor, F5= product type, F6= income, F7 stakeholder role.

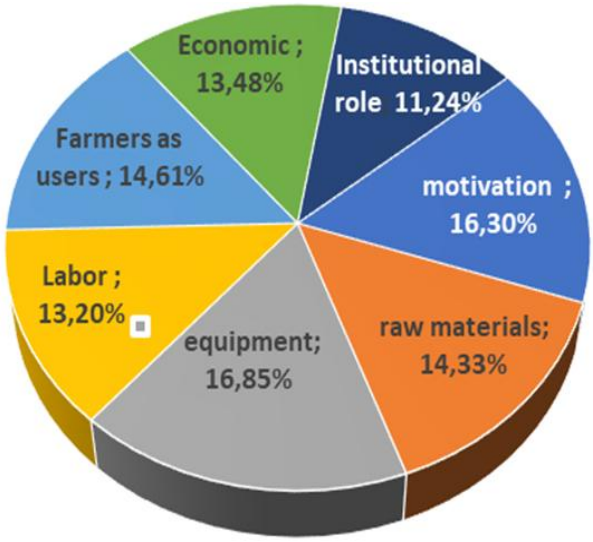

Figure 3. Percentage of factors affecting blacksmithing sustainability in the Montallat Sub-watershed

Of the seven characteristics examined, the accessibility of blacksmithing equipment proved to be the most significant. Instruments include the double piston (functioning as an air blower), furnace, hammers, anvils, and grinders are important for manufacturing. Numerous tools are heirlooms transmitted through generations. Blacksmiths cannot operate without functional equipment, as demonstrated by Deransyah in Pelari Village, who was compelled to cease work for several weeks due to a malfunctioning grinder.

The second most significant factor is the impetus to perpetuate the practice. In several instances, blacksmithing is seen as a secondary occupation, and not all artisans are inclined to transmit the technique to their offspring. The absence of generational continuity presents a significant risk to the preservation of the tradition.

Third, the presence of local farmers as consumers significantly supports blacksmithing activity. Farmers rely on machetes, axes (*belayung)*, and other tools for land clearing, crop planting, and rubber tapping. These tools are ordered directly from blacksmiths or sharpened regularly, especially before planting and harvest seasons. The availability of raw materials is another key consideration. Most blacksmiths obtain scrap metal from local workshops or customers who bring their materials. However, unlike in some regions such as South Kalimantan, there is no stable supply network from outside the area.

Although economic returns are significant, they are not robust enough to guarantee sustainability. The local market is inundated with mass-produced tools from Java, South Kalimantan, Brazil, and China, which are more economical than domestically manufactured items. Factory-produced machetes are priced between IDR 75,000 and 100,000, and artisanal machetes crafted by local blacksmiths range from IDR 150,000 to 250,000. Owing to this price discrepancy, the majority of blacksmiths conduct sales exclusively from their residences and infrequently through markets.

The institutional role of local government or other stakeholders is negligible. Blacksmiths frequently remain unregistered in official occupational records, as many primarily identify as farmers. As a result, they are omitted from development initiatives or support provided to small enterprises. This absence of transparency obstructs chances for training, funding, and formal acknowledgment [2], [44].

4.5. Blacksmithing enhancement strategies

Despite these challenges, blacksmithing continues to be a culturally significant endeavor that embodies the community's historical identity and adaptive traditions. Similar to other traditional crafts in underprivileged regions, it is at risk of extinction without support through documentation, innovation, and official acknowledgment. UNESCO (2003) underscores that the preservation of traditional crafts necessitates concurrent strategies: official and informal training programs to impart skills to younger generations, and

development initiatives that connect traditional knowledge to wider economic and social advantages. In the absence of integration into daily life and value chains, preservation initiatives are likely to be merely symbolic rather than lasting.

A sustainability strategy for blacksmithing must be established by evaluating multiple facets of the art. A SWOT analysis was employed to classify the internal (strengths and weaknesses) and external (opportunities and threats) variables affecting the sustainability of the blacksmithing sector. A questionnaire was administered to 19 blacksmiths and subsequently assessed by SWOT analysis. The determinants affecting the sustainability of the blacksmithing industry were evaluated, prioritized, and examined. The examination of internal and external factors was displayed in matrix format, with weights allocated to variables indicating their impact on the blacksmithing industry. The weights were allocated from a total of 0.5, distributed across values from 0.5 (very significant) to 0.0 (not essential). The ranking value was determined by rounding the average ranking of the 19 respondents, obtained from the interview and questionnaire answers. The evaluation employed a scale ranging from 5 (outstanding) to 1 (extremely weak), with intermediate ratings of 4 (good), 3 (sufficient), and 2 (weak). The score was derived from the multiplication of weights and rankings to calculate the total score for both internal and external criteria [45], [46].

Table 3. Internal and external factor matrix

No.	Internal Factor and External Factor	Weight	Rating	Score
(1)	(2)	(3)	(4)	(5)
A.	Internal Factor			
	Strength (S)			
1.	Motivation of blacksmiths to preserve traditions	0,22	4	0,89
2.	Economic value/income	0,11	4,05	0,45
3	The technical value of blacksmithing as a mineral compaction technique	0,17	3,74	0,62
	Total	0.50		1,96
	Weakness (W)			
1.	Equipment and technology are straightforward	0,21	3,84	0,82
2.	Difficulty getting quality raw materials	0,14	3,68	0,53
3.	Lack of human resources and innovation	0,14	3,74	0,53
	Total	0.50		1,88
B.	External Factor			
	Opportunity (O)			
1.	The existence of farmers as users of blacksmith products	0,17	4,16	0,69
2.	People's fanatical attitude towards blacksmith products	0,17	3,89	0,65
3.	The existence of local government (cooperative and small industry service) as a supervisor	0,11	3,89	0,43
4.	Marketing in the global market (online)	0,06	2,56	0,14
	Total	0,5		1,92
	Threat (T)			
1.	The rise of manufactured products at lower prices	0,21	4,58	0,98
2.	Work trends in cities/companies	0,14	3,89	0,56
3.	Minimal attention and guidance from the government	0,07	3,95	0,28
4.	The number of farmers has decreased due to the ban on burning	0,07	3,42	0,24
	Total	0,50		1,98

The development strategy for traditional blacksmithing was devised utilizing a space matrix to ascertain its present status and prospective trajectory for future advancement. The data utilized for the space matrix were obtained from the disparity between the aggregate scores of internal variables and the disparity between the aggregate scores of external factors, as illustrated in Table 4. The estimation results of internal and external factors reveal that the development status of blacksmithing is situated in Quadrant II (Figure 4), suggesting that development efforts in the Montallat sub-watershed encounter multiple risks while simultaneously exhibiting

significant strengths. In these circumstances, a competitive approach is advised, focusing on optimizing current capabilities to alleviate or avert risks [46], [47].

Table 4. The difference between internal and external factors

Factors	Score	Difference
Strength – Weakness	1,96 – 1,88	0,08
Opportunity – Threat	1,92 – 2,06	-0,14

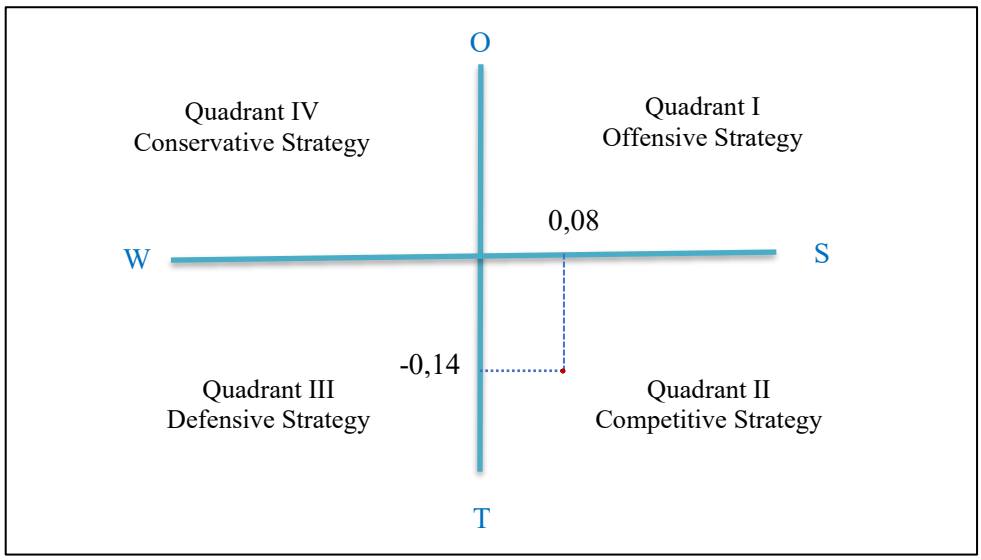

Figure 4. Blacksmith development space quadrant

The next stage in determining the strategy and key success factors for the development of blacksmithing should be more focused on the implementation of the competitive strategy.

- Strategic 1: Acknowledgment of blacksmithing as an established profession

The foremost strategic objective is to formalize blacksmithing as a recognized vocation in both the populace and governmental documentation. Presently, the majority of blacksmiths are classified as farmers, leading to a shortage of specialized programs aimed at their trade. The absence of institutional visibility has resulted in insufficient technical assistance, training, and financial support from local authorities and other stakeholders [48].

Precise occupational data is crucial for establishing policies, alliances, and training initiatives. Official acknowledgment would facilitate the incorporation of blacksmithing into local economic development strategies and cultural preservation initiatives.

- Strategic 2: Enhancing capital via equipment upgrading

Restricted access to tools and antiquated equipment are significant impediments to production. Enhancing blacksmith capital—particularly through the modernization of critical instruments like blowers, grinders, and anvils—is crucial for augmenting productivity and product quality. This can be accomplished through collaboration with local governments, private-sector corporate social responsibility programs, and vocational initiatives.

Experiences from locations like Massepe in South Sulawesi illustrate that technology markedly improves output and bolsters the economic resilience of traditional blacksmiths [25]. Facilitating infrastructure development is essential to enable the craft to compete with mass-produced options.

- Strategic 3: Advocating for sustainable agriculture as a consumer foundation

Blacksmithing in the area is intricately linked to agricultural cycles. Consequently, endorsing sustainable agriculture practices—especially among Dayak farmers—is crucial for sustaining a steady consumer market for blacksmith items. Conventional slash-and-burn methods (ladang) are essential for maintaining soil fertility, although they have increasingly faced criminalization due to contemporary environmental rules. A sophisticated policy framework is required to differentiate between extensive land burning and smallholder practices based on indigenous knowledge.

Policies that allow controlled burning for local food production—while prioritizing fire safety and environmental stewardship—can safeguard the livelihoods of both farmers and blacksmiths [36], [37]. Despite the elevated cost of locally produced blacksmith goods compared to imported alternatives, local residents, particularly farmers, choose them due to their superior thickness, sharpness, and the ability to be resharpened repeatedly.

- Strategic 4: Differentiating products through cultural identity

To maintain competitiveness, blacksmiths must differentiate their goods from mass-produced equivalents. Integrating local decorative themes, such as traditional carvings on *mandau* handles, might augment the cultural significance and marketability of blacksmith items. Creating high-quality, culturally integrated tools fosters economic development and aids in the preservation of local identity. This strategy echoes findings from blacksmiths in Central Java who exported tools decorated with batik motifs [49], and aligns with the broader view that heritage-based crafts can support both tourism and creative industries [50], [51].

This research suggests that the development of blacksmithing, rooted in local wisdom, not only sustains economic livelihoods but also sustains cultural knowledge and adaptive strategies. Integrating this perspective into blacksmithing conservation efforts is essential to maintaining the relevance and resilience of traditional industries in contemporary rural communities. An Indonesian example can be seen in the case of batik, which is recognized as an intangible cultural heritage. Indarti et al. demonstrate that, with the application of targeted strategies and effective monitoring mechanisms, the batik industry in the Dolly area of East Java has the potential to achieve long-term sustainability and generate positive social impacts [52]. Globally, similar approaches have been adopted in various contexts. For instance, in the Himalayan region, the conservation of traditional waterwheels incorporates technical training alongside sustainable livelihood initiatives [53]. Likewise, Dinh and Thi [54] integrated local architectural wisdom into their efforts to develop traditional housing models for ethnic minorities in Thanh Hoa Province, Vietnam, thereby supporting cultural preservation, landscape conservation, environmental protection, and poverty reduction.

This research employs a novel integrative approach that amalgamates technological, economic, and cultural factors to elucidate the sustainability of traditional blacksmithing. This study emphasizes blacksmithing not merely as a technical craft or minor industry, but as an adaptable cultural system intricately connected to agricultural livelihoods and indigenous knowledge. This viewpoint enhances the overarching dialogue on intangible cultural heritage by highlighting livelihood-oriented conservation methods that bolster cultural resilience and communal identity.

6. Conclusions

The sustainability of traditional blacksmithing along the Montallat River is influenced by a mix of internal and external influences. The primary significant elements encompass the accessibility of necessary equipment, the blacksmiths' determination to persist in the profession, and the sustained demand from local agricultural communities. Additional important factors include access to raw resources, varieties of products, income possibilities, and the restricted function of supporting institutions. This study emphasises the close relationship between blacksmithing and the agricultural practices of the Dayak culture. Conventional implements, including machetes, *mandau*, *tajak,* and *sundak,* are essential for agriculture, land cultivation, and resource exploitation in both swamp and upland regions. Consequently, blacksmithing should not be seen solely as a technical ability,

but rather as an essential component of the region's socio-economic framework and environmental adaptation methods.

Preserving the blacksmithing tradition necessitates a cohesive strategy. This plan encompasses the formal acknowledgement of blacksmithing as a professional entity, the facilitation of equipment modernisation, the safeguarding of traditional agricultural techniques, and the advancement of product innovation grounded in local cultural identity. The absence of focused assistance significantly heightens the danger of decline, attributable to ageing practitioners, insufficient regeneration, competition from produced equipment, and inadequate institutional participation. This research confirms that blacksmiths are essential contributors to maintaining local livelihoods and safeguarding knowledge inherent in traditional farming systems. Enhancing this craft not only bolsters local economies but also helps preserve Kalimantan's cultural and technological heritage. Scientifically, this research contributes to the broader discourse on intangible cultural heritage management by demonstrating how traditional crafts support local knowledge and cultural identity. Practically, this research contributes to the conservation and documentation of intangible cultural heritage, as well as the integration of local knowledge to support cultural resilience and sustainable rural economies.

This study substantiates Dunham's claim that blacksmithing is closely tied to the agricultural sector, with blacksmiths being integral to the farming community. These findings provide a practical framework for safeguarding living traditions through heritage-oriented adaptive economic methods that can be emulated across various local craft sectors worldwide.

Declaration of competing interest

The authors declare no conflict of interest.

Funding information

No funding was received from any financial organization to conduct this research.

Acknowledgements

The authors would like to express their sincere appreciation to the anonymous reviewers whose constructive feedback significantly improved the quality of this article. Special thanks are also extended to members of the research team, the local blacksmithing communities along the Montallat River, and local government officials for their invaluable assistance and participation during fieldwork.

Author contribution

All authors contributed substantially to the development of this manuscript. Hartatik served as the primary author, leading the research design, data collection, and manuscript drafting. Wasita and Nugroho Nur Susanto contributed to the study, including literature review, data collection, and data analysis. Bambang Sulistiyanto and Frandus provided critical input and contributed to the interpretation of data and refinement of the manuscript. All authors have reviewed and approved the final version of the manuscript.

Ethical approval statement

Ethical approval does not apply to this research.

Informed consent

Informed consent for the publication of personal data in this article was obtained from the participants.

References

[1] T. Riwut, *Maneser panatau tatu hiang menyelami kekayaan leluhur*. Palangkaraya: Penerbit Pusaka

Alam, 2003.

[2] Hartatik, "Strategi pengembangan situs buren berbasis Ekologi budaya dan pandai besi sebagai industri alat-alat pertanian di Sub-DAS Montallat, Kabupaten Barito Utara," Universitas Lambung Mangkurat, 2024.

[3] S. Somadikarta, A. Soegiarto, T. Abdullah, P. Sochaczewski, and J. Miksic, *Indonesia Heritage- Early Modern History*. Jakarta: Buku Antar Bangsa-Grolier International Inc., 1996.

[4] A. Reid, *Asia Tenggara dalam kurun niaga 1450-1680 jilid 1(Southeast Asia in the age of commerce 1450-1680). Volume 1, translated by Mochtar Pabotinggi.* Jakarta: Yayasan Pustaka Obor Indonesia, 2011.

[5] D. C. A. L. . Schwaner, *Borneo beschsuving van het stroomgesied van den Barito*. Amsterdam: P.N. van Kampen, 1853.

[6] Hartatik, Sunarningsih, N. M. E. Fajari, and H. O. Sofian, "New discoveries of ancient iron smelting sites in Kalimantan," *Anthropoogie*, vol. 127, no. 3, p. 103163, 2023. https://doi.org/10.1016/j.anthro.2023.103163

[7] P. Crew, "The experimental production of prehistoric bar iron," *Historical Metallurgy*, vol. 25, pp. 21–36, 1991. https://d1wqtxts1xzle7.cloudfront.net/57223136/Crew_1991_Experimental_Bar_Iron_XP27-libre.pdf?1534847

[8] D. Killick, "From ores to metals," in *Archaeometallurgy in global perspective: methods and syntheses*, B. W. Roberts and C. P. (eds.). Thornton, Eds. New York: Springer Science & Business Media, 2014, pp. 11–45. https://doi.org/10.1007/978-1-4614-9017-3

[9] K. Okamura and A. Matsuda, "New perspectives in global public archaeology," *New Perspectives in Global Public Archaeology*, 2011. https://doi.org/10.1007/978-1-4614-0341-8

[10] S. Rahardjo and H. Muluk, *Pengelolaan warisan budaya Indonesia*. Jakarta: BPSD Budpar, Kementerian Kebudayaan dan Pariwisata., 2011.

[11] I. Sodikin, J. Waluyo, and Y. Pratiwi, "Rancang bangun tungku pemanas untuk pande besi yang ramah lingkungan guna meningkatkan kapasitas produksi alat pertanian," in *Simposium Nasional ke 15 RAPI*, 2016, pp. 458–463. [Online]. Available: https://publikasiilmiah.ums.ac.id/handle/11617/8078

[12] J. . Stokes, "Agricultural engineering in development : Basic blacksmithing — A training manual," *FAO Agricultural Services Bulletin, Food and Agriculture Organization*, 1992.

[13] E. D. Nopemberini, "Ketahanan pangan masyarakat perladangan di Kabupaten Barito Utara (studi kasus Kecamatan Gunung Timang)," *Journal Socio-Economic Agricultural*, vol. 14, no. 2, pp. 12–18, 2019. https://e-journal.upr.ac.id/index.php/j-sea/article/view/476.

[14] Ida Bagus. P. P. Yogi, "Teknologi tempa logam pada masa lalu di Daerah Aliran Sungai Pawan, Kalimantan Barat (Sebuah Pendekatan Etnoarkeologi)," *Kapata Arkeologi*, vol. 12, no. 2, pp. 137–146, 2016. https://ejournal.brin.go.id/kapata/article/view/12114.

[15] T. Winarsunu, *Statistik dalam penelitian psikologi pendidikan*, Cet. ke-8. Malang: UMM Press, 2017.

[16] D. Stockemer, *Quantitative methods for the social sciences*. Switzerland: Springer, 2019. https://doi.org/10.1007/978-3-319-99118-4

[17] B. M. Miles and A. M. Huberman, *Qualitative data analysis: an expanded sourcebook*, 2nd ed. Thousand Oaks, CA: Sage, 1994.

[18] UNESCO, *Convention for the Safeguarding of the Intangible Cultural Heritage*. 2003. [Online]. Available: https://ich.unesco.org/doc/src/18440-EN.pdf

[19] H. Deacon, L. Dondolo, M. Mrubata, and S. Prosalendis, *The subtle power of intangible heritage: legal and financial instruments for safeguarding intangible heritage*, First publ. Chicago.: Human Sciences Research Council. Social Cohesion and Integration Research Programme. Research Monography, 2004. https://books.google.co.id/books?hl=en&lr=&id=7EtJdNgBvBUC&oi=fnd&pg=PP6&dq=H.+

[20] R. Fahri, "Upaya pengembangan industri pembuatan alat-alat pertanian (pande besi)," Universitas

Muhammadiyah Malang, 2016.

[21] A. S. Dunham, *Pendekar-pendekar besi Nusantara. Kajian antropologi tentang pandai besi tradisional di Indonesia*, 1st ed. Bandung: PT. Mizan Pustaka, 2008.

[22] L. Di Pietro, R. Guglielmetti Mugion, and M. F. Renzi, "Heritage and identity: technology, values and visitor experiences," *Journal of Heritage. Tourism*, vol. 13, no. 2, pp. 97–103, 2018, https://doi.org/10.1080/1743873X.2017.1384478

[23] Khairil, Irwansyah, H. S. Edhy, and S. Rizal, "Fundamental study on the carbonization characteristics of low rank coal under low temperature and its application on traditional blacksmith," *Advanced Material Research*, vol. 576, pp. 615–618, 2012. https://doi.org10.4028/www.scientific.net/AMR.576.615.

[24] Irmeilyana;, Ngudiantoro;, A. Desiani, and S. Al Farisy, "Analisis karakter yang mempengaruhi produktivitas pandai besi di desa limbang jaya menggunakan analisis jalur," *Talenta Conference Series: Science and Technology*, vol. 2, no. 2, pp. 1–12, 2019, [Online]. Available: https://doi.org/10.32734/st.v2i2.465

[25] Sukardi, Jumadi, and Najamuddin, "Perubahan alat-alat produksi pandai besi Kecamatan Tellu Limpoe Kabupaten Sidenreng Rappang 1990-2017," *Attoriolog Jurnal Pemikiran Kesejarahan dan Pendidikan Sejarah*, vol. 18, no. 1, pp. 21–35, 2020.

[26] E. Bardone, K. Rattus, and L. Jääts, "Creative Commodification of rural life from a performance perspective: A study of two south-east Estonian farm tourism enterprises," *Journal of Baltic Studies*, vol. 44, no. 2, pp. 205–227, 2013. https://www.jstor.org/stable/pdf/43213143.pdf.

[27] Koentjaraningrat, *Pengantar ilmu antropologi*. Jakarta: PT Rineka Cipta, 2009.

[28] H. J. Daeng, *Manusia, kebudayaan dan lingkungan. Tinjauan antropologis*. Yogyakarta: Pustaka Pelajar, 2000.

[29] P. L. Mafongoya and O. Ajayi, "Indigenous knowledge and climate change overview and basic proposition," in *Indigenous Knowledge Systems and Climate Change Management in Africa*, 1st ed., P. L. Mafongoya and O. Ajayi, Eds. Wageningen: CTA, 2017, pp. 17–28. https://books.google.co.id/books?hl=id&lr=&id=CJs-

[30] I. Meliono, "Understanding the Nusantara thought and local wisdom as an aspect of the Indonesian education," *TAWARIKH: International Journal for Historical Studies*, vol. 2, no. 2, pp. 221–234, 2011. https://www.journals.mindamas.com/index.php/tawarikh/article/download/392/390.

[31] R. Q. Muslim and S. Ritung, "Distribution of pyrite depth and soil properties in fresh water swampland in North Candi Laras Sub-district, South Kalimantan Province," in *IOP Conference Series: Earth and Environmental Science*, 2021, vol. 648, no. 1, p. 012041. https://doi.org/10.1088/1755-1315/648/1/012041

[32] I. Khairullah and M. Saleh, "Teknologi budidaya tradisional padi varietas lokal di lahan rawa pasang surut (Studi kasus di Kalimantan Selatan)," *J. Pertanian Agros*, vol. 22, no. 2, pp. 168–179, 2020. https://e-journal.janabadra.ac.id/index.php/JA/article/viewFile/1131/755.

[33] K. Oginawati, N. S. Al Faiqah, Suharyanto, R. A. Regia, and M. Amin, "Indoor PM2.5 and heavy metal composition in blacksmithing factories: A pilot study in Bandung Regency, Indonesia," *Urban Science*, vol. 8, no. 4, pp. 1–13, 2024. https://doi.org/10.3390/urbansci8040230

[34] Hartatik, H. O. Sofian, Sunarningsih, N. . Susanto, and R. . Sulistiyo, "The sustainability of the iron industry based on local wisdom in the Barito watershed," in *ICSTSI 2020 IOP Conf. Series: Materials Science and Engineering 980, 012046*, 2020, pp. 1–11. https://doi.org/10.1088/1757-899X/980/1/012046

[35] A. Akbar, "Studi kearifan lokal penggunaan api persiapan lahan: studi kasus di hutan Mawas, Kalimantan Tengah," *J. Penelitian Sosial dan Ekonomi Kehutanan,* vol. 8, no. 3, pp. 211–230, 2011.

[36] J. Stefvia, D. Risalah, S. Sandie, S. Bahri, and E. T. Lestari, "Eksplorasi etnomatematika dalam sistem

perladangan pada budaya Suku Dayak Nanga Mahap," *Teorema: Teori dan Riset Matematika*, vol. 7, no. 2, p. 393, 2022.

[37] Mardawani, Suparno, and S. Suseka, "Kearifan lokal berladang dalam perspektif filosofi hidup dan pemenuhan kebutuhan Suku Dayak di Sintang," *Journal Pekan*, vol. 7, no. 2, pp. 168–185, 2022.

[38] K. Vu Ngoc and G. T. Minh Duc, "Statistical assessment of agricultural fertilizer impacts on water quality and environmental sustainability," *Heritage and Sustainable Development*, vol. 7, no. 1, pp. 401–414, 2025. https://doi.org/10.37868/hsd.v7i1.1217

[39] D. Cahyana and Y. Destina, *Tajak*, vol. 15, no. April. 2016. [Online]. Available: http://balittra.litbang.pertanian.go.id/index.php/berita/trivia-rawa/1771-trivia-rawa- 15-tajak 28 April 2016. Berita

[40] I. Dewi, M. Syuaib, and T. Mandang, "Studi ergonomi pada penyiapan lahan sawah lebak menggunakan alat tradisional tajak di Kabupaten Banjar Kalimantan Selatan," *Jurnal Keteknikan Pertanian*, vol. 25, no. 2, p. 138095, 2011.

[41] M. Noor, D. Cahyana, and M. Sarwani, *Trivia Rawa: Serba-serbi Instrumen Pertanian dan Perikanan Rawa*. Yogyakarta: Gadjah Mada University Press, 2024.

[42] R. Fathony, "Uji kinerja traktor tangan dengan perbedaankedalaman pembajakan, bentukan mata bajakdan shin terhadap slip roda," Universitas Sriwijaya, 2024.

[43] D. Nursyamsi, M. Noor, and Haryono, *Sistem surjan model pertanian lahan rawa adaptif perubahan iklim*. Jakarta: IAARD Press, 2015.

[44] E. A. Rahman, *Kabupaten Barito Utara dalam angka*. Muara Teweh: Badan Pusat Statistik Kabupaten Barito Utara/Statistics of Barito Utara Regency, 2023.

[45] E. E. Osuna and A. Aranda, "Combining SWOT and AHP Techniques For Strategic Planning," in *ISAHP*, 2007, pp. 1–8. https://isahp.org/uploads/combining-swot-and-ahp.pdf.

[46] F. Rangkuti, *Analisis SWOT*, Cet. XXII. Jakarta: Kompas Gramedia, 2016.

[47] T. Leiber, B. Stensaker, and L. C. Harvey, "Bridging theory and practice of impact evaluation of quality management in higher education institutions: a SWOT analysis," *European Journal of Higher Education,* vol. 8, no. 3, pp. 351–365, 2018. https://doi.org/10.1080/21568235.2018.1474782

[48] R. K. Mitchell, B. R. Agle, and D. J. Wood, "Toward a theory of stakeholder identification and salience: defining the principle of who and what really counts," *Academy of Management Review,* vol. 22, no. 4, pp. 853–886, 1997. https://journals.aom.org/doi/abs/10.5465/amr.1997.9711022105.

[49] W. Hidayat, "Hasil produksi pandai besi lereng Merbabu diekspor ke Eropa," Magelang, 2020. [Online]. Available: http://beritamagelang.id/tokoh/produksi-pande-besi-lereng-merbabu-ekspor-ke-eropa-1

[50] D. Tranter, "Safeguarding Australian heritage trade skills," *International Journal of Intangible Heritage*, vol. 05, pp. 88–97, 2010. https://www.ijih.org/retrieve/volumeDtl/60.

[51] P. G. Gould and P. Burtenshaw, "Archaeology and economic development," *Public Archaeol.*, vol. 13, no. 1–3, pp. 3–9, 2014. https://doi.org/10.1179/1465518714Z.00000000075

[52] I. Indarti, L. H. Peng, U. Wahyuningsih, M. Martadi, and Y. Yulistiana, "Can batik craft products in the red-light area improve sustainable social and economic impact? A case study of the largest former prostitution area in Southeast Asia," *Heritage and Sustainable Development,* vol. 6, no. 2, pp. 791–812, 2024. https://doi.org/10.37868/hsd.v6i2.649

[53] N. J. Thongdok and V. P. Sati, "Tools and techniques involved in the manufacturing of traditional watermills (chhoskor) in West Kameng district, Arunachal Pradesh," *International Journal of Intangible Heritage*, vol. 19, pp. 100–108, 2024. https://www.ijih.org/retrieve/volumeDtl/1150.

[54] T. N. Dinh and H. L. Thi, "Models of residential space for ethnic minorities in Thanh Hoa Province associated with sustainable livelihoods," *Heritage and Sustainable Development*, vol. 6, no. 1, pp. 127–144, 2024.