Application of indigenous knowledge in sustainable livelihood development of ethnic minority households: A case study of the Dao people in Thanh Hoa province, Vietnam

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ABSTRACT

This survey study investigates the application of indigenous knowledge in the sustainable livelihood development of Dao households in Thanh Hoa province. The successful application of Indigenous knowledge contributes to diversifying employment opportunities, enhancing income, improving community health, and promoting biodiversity conservation. However, challenges include the loss of Indigenous knowledge among the younger generation, pressure from market integration, and external development interventions. Factors such as age, education level, and access to agricultural extension services significantly impact the continued use and adaptation of Indigenous knowledge. Therefore, it is necessary to recognize and integrate Indigenous knowledge with modern science into local development policies to enhance the resilience and well-being of the Dao community, while supporting the transmission of this knowledge to future generations. The objective is to identify key Indigenous knowledge practices, analyze their contributions to livelihood sustainability (economic, social, and environmental), and explore factors influencing the maintenance and application of this knowledge in the context of contemporary socio-economic changes. We applied qualitative and quantitative research methods in selected Dao communities in Thanh Hoa. Data were collected through a survey of 200 households and 10 in-depth interviews with individuals and local leaders. We analyzed quantitative data using descriptive statistics and regression analysis with SPSS 22.0 software, and qualitative data were analyzed using thematic analysis.

Keywords: *indigenous knowledge, sustainable livelihood, Dao ethnic group, Thanh Hoa, Vietnam*

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1. Introduction

The international community is increasingly recognizing that indigenous knowledge plays a vital role in sustainable development, biodiversity conservation, and strengthening the resilience of local communities, predominantly those of indigenous and minority peoples (United Nations, 2007; World Bank, 2010). This knowledge system, accumulated over generations living in close contact with the natural environment, includes a deep understanding of agriculture, resource management, traditional medicine, and socio-cultural practices (Nakashima et al., 2012). The Dao people have a long history and are distributed across many Asian countries, including Vietnam, southern China, Laos, and Thailand, possessing a rich treasure of indigenous knowledge closely related to their livelihoods.

In Vietnam, in general, and Thanh Hoa, in particular, the Dao community continues to face numerous challenges in socio-economic development (Baulch et al., 2007; Nguyen, 2012). Although support policies have been implemented, promoting internal resources, especially Indigenous Knowledge, for sustainable livelihood development has not received adequate attention. Indigenous knowledge is at risk of disappearing due to modernization, land use change, and a lack of effective recognition and support mechanisms. The lack of in-depth understanding of how the specific indigenous knowledge of the Dao in Thanh Hoa is applied to contribute to sustainable livelihoods, as well as the factors affecting its existence, creates a research gap that needs to be addressed to provide a basis for appropriate and effective development interventions. This study has scientific and practical significance. It contributes to recording and systematizing the cultural heritage of the Dao people in Thanh Hoa, clarifying the role of cultural heritage in livelihood strategies and environmental resilience, and providing evidence for the formulation of culturally appropriate, sustainable development policies that benefit the community.

The main objectives of the study include: Identify and document the main Indigenous knowledge practices of the Dao people in Thanh Hoa related to sustainable livelihoods; Analyze the application and contribution of Indigenous knowledge to economic, social, cultural and environmental aspects of household livelihoods; Identify factors affecting the maintenance, adaptation or loss of Indigenous knowledge; and Propose recommendations for integrating Indigenous knowledge into sustainable development initiatives. The main research questions revolve around which Indigenous knowledge practices are popular? How do they contribute to sustainable livelihoods? What is community awareness? What factors influence the use and transmission of Indigenous knowledge? How to integrate Indigenous knowledge effectively?

2. Research overview and theoretical framework

2.1. Indigenous knowledge and sustainable livelihoods

Indigenous knowledge, also referred to as local knowledge or traditional ecological knowledge, is defined as a dynamic system of knowledge, practices, and beliefs that have been accumulated and developed through the long-standing practical experiences of communities in close interaction with their natural and social environments (Nakashima et al., 2012; Warren, 1991). It is not simply a collection of facts about the natural world (such as characteristics of plants, animals, soil, climate) but also includes practical skills (cultivation, harvesting, processing, healing), classification systems, social institutions (customary law, resource management conventions), and worldviews (cosmology, beliefs) (Berkes, 1999; Sillitoe, 1998). Indigenous knowledge has basic characteristics such as: locality (closely linked to a specific context), holisticity (closely linking natural, social, and cultural aspects), experimentality (formed from observation and experimentation over many generations), flexibility and adaptability, often transmitted mainly through oral transmission and direct practice, and deeply attached to the cultural identity of the community (Nakashima et al., 2012; Warren, 1991).

In the development field, the role of indigenous agricultural systems in sustainable livelihoods is increasingly recognized. Indigenous agricultural systems, often based on high biodiversity and locally adapted farming techniques (such as agroforestry, intercropping, crop rotation, traditional soil and water management), have demonstrated the ability to maintain stable productivity, conserve resources, and enhance the resilience of food systems to shocks (Altieri, 2004; Thrupp, 1997). Research by Altieri (2004)

indicates that many indigenous agricultural systems are ecologically sustainable, energy-efficient, and capable of supporting community food security.

In natural resource management, Indigenous knowledge serves as the foundation for effective community-based management systems, particularly for common-pool resources such as forests, water sources, and fisheries (Berkes, 1999; Ostrom, 1990). Rules, customary laws, and local ecological knowledge help communities regulate exploitation, avoid overuse, and maintain ecological balance (Johannes, 1998). Ostrom's (1990) work on common-pool management emphasized the role of local institutions and rules, often based on Community-Based Organizations, in preventing the "tragedy of the commons."

In the healthcare sector, traditional medicine, based on knowledge of medicinal plants and therapeutic methods, remains a vital source of primary healthcare for billions of people worldwide, particularly in rural and remote areas (WHO, 2013). This knowledge system provides effective treatments for many common diseases and is low-cost and culturally appropriate (Anyinam, 1995).

In particular, when addressing climate change, scholars and development practitioners increasingly consider indigenous knowledge a valuable resource for community-based adaptation strategies. Knowledge of traditional weather forecasts, resilient local crop and livestock varieties, and flexible farming techniques, combined with experience in coping with past extreme weather events, helps communities increase their resilience and reduce risks caused by climate change (Nakashima et al., 2012; Nyong et al., 2007).

2.2. Sustainable Livelihood Framework

The study applies the Sustainable Livelihoods Framework (Chambers & Conway, 1992; DFID, 1999; Ellis, 2000) to analyze the role of social capital. This framework examines how households mobilize five types of capital (human, natural, financial, physical, and social) to implement livelihood strategies to achieve desired outcomes in the context of vulnerability and institutional and policy environments. Social capital is considered an important part of human capital (knowledge, skills), and it plays a decisive role in effectively managing and using other types of capital, especially natural capital. Rules and networks related to social capital are also components of Social Capital.

Analyzing livelihoods through the SLF lens helps to clarify the centrality of people, the multidimensional relationship between SLF and other forms of capital, how SLF is mobilized in different livelihood strategies (e.g., agricultural diversification strategies, resource exploitation strategies, traditional medicine-based strategies), and finally, the impact of SLF adoption on desired livelihood outcomes such as increased income, improved well-being, reduced vulnerability, and environmental and social sustainability.

2.3. The Dao people in Thanh Hoa and the research gaps

The Dao are one of the most populous ethnic minorities in Vietnam, with many local groups and a complex history of migration from China over the centuries (Be et al., 1974; Diep, 2002). In Thanh Hoa, the Dao (mainly Dao Quan Chet and Dao Do groups) reside in mountainous districts such as Ngoc Lac, Cam Thuy, and Muong Lat, often intermingling with other ethnic groups, including Muong, Thai, and Kinh (Mai, 2016). Their traditional livelihoods are associated with slash-and-burn cultivation, exploitation of forest resources, and handicrafts (Dao, 2001). Previous studies have provided important insights into the settlement history (Robequain, 2012), cultural, social, and customary characteristics (Dao, 2001; Nguyen, 2014), as well as the general socio-

economic context of the Dao people in Thanh Hoa (Pham et al., 2015). These works demonstrate that the Dao people possess a rich repertoire of traditional knowledge, particularly in sloping land cultivation, forest management, and their unique traditional medicine systems.

However, most existing studies are either descriptive in general about culture and history or focus on a specific aspect (such as customs) at a particular time. A systematic, detailed, *and* quantitative *assessment* (if possible) of *the entire Indigenous knowledge system related to the livelihoods* of the Dao people *in Thanh Hoa*, an analysis *of how to apply* that knowledge in the contemporary context, and especially *measuring and evaluating the contribution of Indigenous knowledge to different aspects of sustainable livelihoods* (economic, social, environmental) is still a big gap. Moreover, the factors (both internal and external) that promote or hinder the maintenance, adaptation, and transmission of Indigenous knowledge in the Dao community in Thanh Hoa have not been fully understood.

In the context of the global and Vietnamese risk of Indigenous knowledge extinction, filling this research gap is essential. Research on Indigenous knowledge not only contributes to preserving valuable knowledge heritage but also provides a solid scientific basis for designing truly sustainable development policies and programs, based on internal resources and suitable to the culture of the Dao community in Thanh Hoa. Therefore, this study focuses on exploring and analyzing the relationship between Indigenous knowledge and the sustainable livelihoods of Dao households in Thanh Hoa province, aiming to contribute to academic knowledge and development practice.

3. Research methods

This study employed a mixed-method design, combining quantitative and qualitative methods in a complementary model that enhances and deepens understanding. We used quantitative methods to conduct a large-scale survey, aiming to describe the current situation and identify influencing factors. In contrast, we used qualitative methods (in-depth interviews, observations) to explore the depth, context, and significance of Indigenous knowledge application. We chose a case study design to focus on specific Dao communities in Thanh Hoa.

We conducted the study in Phung Giao commune (Ngoc Lac district) and Cam Chau commune (Cam Thuy district), Thanh Hoa province, two areas with a large population of Dao Quan Chet people who still maintain many traditional livelihood activities. The research subjects were Dao households and stakeholders (knowledge holders, local officials) in the two research communes. Data were collected through a semi-structured questionnaire survey with 200 representatives of Dao households (100 households/commune). The sample was selected using a systematic random sampling method from a total of 459 Dao households in the two research communes' villages (Phung Giao: 105 households, Cam Chau: 354 households) at the time of the survey. The questionnaire focused on demographic, economic, and livelihood information, indigenous knowledge practices, perceptions of the role and challenges of Indigenous knowledge, and access to resources. We conducted twelve in-depth interviews with purposively sampled subjects, including 04 household representatives (classified by economic status) and 08 local officials and prestigious people (commune leaders, agricultural extension officers, cultural officers, village elders…) to explore in-depth information on Indigenous knowledge, experiences, changes, transmission mechanisms, difficulties, and desires. We also carried out a secondary document analysis (reports, related policies).

We processed survey data using SPSS 22.0 software. We used descriptive statistics (frequency, proportion, and mean) and inferential statistics (Chi-square test, T-test, and logistic/linear regression analysis, depending on the variable) to describe the situation and identify factors affecting the application of Indigenous knowledge and livelihoods. We analyzed data from in-depth interviews, observations, and secondary documents using content and thematic analysis to identify patterns and meanings and interpret the results within the research context.

The study adhered to ethical principles, ensuring participants' voluntariness, anonymity, and confidentiality after clearly explaining the purpose of the study.

4. Research results

4.1. Characteristics of households and livelihoods of Dao people in the study area

This section presents the basic demographic and socioeconomic characteristics, as well as the main livelihood activities, of Dao households participating in the survey in the study area.

Characteristic	N	%
1. District		
Ngoc Lac	100	50.0
Cam Thuy	100	50.0
Total	200	100.0
2. Respondent gender		
Gender Male	134	67.0
Gender Female	66	33.0
Total	200	100.0
3. Poor households/escape poverty		
Poor and near-poor households	117	58.5
Poverty escape	83	41.5
Total	200	100.0
4. Age group of household head		
20 to 30 years old	42	21.0
31 to 40 years old	50	25.0
41 to 50 years old	90	45.0
51 to 60 years old	18	9.0
Over 60 years old	0	0
Total	200	100.0
5. Occupation		
Farming	160	80.0
Afforestation	9	4.5
Crafts/Livestock	8	4.0
Trade	2	1.0
Service	3	1.5
Employees	0	0
hired worker	14	7
Combine many professions	4	2
Total	200	100.0
6. Education level		
Not going to school	41	20.5
Primary school graduate	83	41.7
Graduated from junior high school	62	30.8
High school graduate	19	9.2
Graduated from high school, college, and university	2	1.0
Total	200	100.0

Author's survey results, 2024

Table 1. Socio-demographic characteristics of the survey sample

The data in Table 1 show a significant gender gap among the respondents, with men accounting for a larger proportion (67%) than women (33%). This discrepancy may reflect cultural norms where the male head of household is typically designated to speak for the family, or it could be due to the greater availability of men during the survey

period. This should be considered when interpreting the results, as women's views and experiences may not be as fully reflected as those of men in this sample. The proportion of poor and near-poor households accounts for the majority of the sample (58.5%), indicating that economic hardship is a significant feature of the community studied. The proportion of households that have escaped poverty is also significant (41.5%), providing a basis for comparing and analyzing factors that contribute to poverty escape.

Household heads are primarily in the leading working-age group, with the highest concentration in the 41-50 age group (45%), followed by the 31-40 age group (25%) and the 20-30 age group (21%). Very few household heads are over 50 years old (only 9% are between 51 and 60, and no one is over 60). This shows that households are mainly in the active production labor stage. Agricultural activities are the absolute source of livelihood, accounting for 80% of households. Other economic activities, such as forestry (4.5%), handicrafts/animal husbandry (4%), hired labor (7%), services (1.5%), and trading (1%), account for only a tiny proportion. The heavy dependence on agriculture is a prominent economic feature, showing the low level of livelihood diversification.

The household head's educational level is generally minimal, with primary school graduation (41.7%) being the most common, and a significant proportion not attending school (20.5%). More than 62% of the household heads have a primary school education or lower. The secondary school graduation rate is 30.8%, while the high school graduation rate (9.2%) is particularly low, especially in the secondary, college, and university sectors (1.0%). This reflects the surveyed community's limited education and human capital (as measured by formal education).

4.2. Application of indigenous knowledge in the sustainable livelihood development of Dao households

4.2.1. Application of indigenous knowledge in sustainable agricultural and forestry production

In the agricultural and forestry sectors, Indigenous knowledge plays an important role, as demonstrated by the diverse practices maintained and applied by Dao households.

Application of indigenous knowledge in Agriculture and Forestry	Frequency (N)	Rate (%)
Soil classification & plant selection based on experience	148	74.0
Terraced/Sloping Land Farming	172	86.0
Applying the intercropping/protective tree planting model	117	58.5
Use local plant varieties (>1 type)	147	73.5
Determine seasonality by experience/natural cues	131	65.5
Exploitation of non-timber forest products	163	81.5
Know and comply with conventions/customary laws to protect community forests	136	68.0

Author's survey results, 2024

Table 2. Application of indigenous knowledge in the agricultural and forestry production of the Dao people

The survey results in Table 2 demonstrate the diverse and widespread application of indigenous knowledge in the agricultural and forestry production activities of Dao

households, particularly in terraced field cultivation techniques (86.0%) and sustainable exploitation practices (81.5%). Experience in soil classification, selection of local varieties (over 73%), and compliance with forest protection conventions (68.0%) are highly valued. A resident shared:

> *"The land on this slope must be terraced; otherwise, the rain will wash away all the nutrients. The old rice variety does not yield as high as the new variety, but it is drought-resistant, has few pests and diseases, does not require much spraying, and my family still keeps it for planting."* (Reporter, Female, 45 years old, Phung Giao).

The intercropping model (58.5%) and determining cropping season based on experience (65.5%) are also significantly applied.

> *"Our grandparents taught us that this fertile hilly land is suitable for growing old varieties of corn, the seeds are small but firm, and can withstand drought well. Whenever you see a swallow flying low, it means it is about to rain, so you have to plant the seeds quickly. If you want the soil to be good for a long time, you have to intercrop beans with the corn roots, providing you with more food and making the soil more fertile, without adding as much chemical fertilizer as people in the lowlands do. Terraced fields must have strong embankments and must not be destroyed; otherwise, when it rains, all the fertile soil will be washed away, and you will not be able to grow crops anymore. These are all experiences, books cannot teach them all."* (Reporter, Female, 58 years old, Cam Chau)

Other indigenous knowledge practices were also recorded at a significant level. Households confirmed knowledge and compliance with community conventions or customary laws in forest protection (68.0%). Similarly, 65.5% of households applied the experience of determining cropping seasons based on natural signs. Although slightly lower than other practices in the table, a majority of households (58.5%) still applied the model of intercropping or protective tree planting, indicating the presence of diverse farming techniques to optimize land use and minimize risks.

4.2.2. Applying indigenous knowledge in the health care of the Dao people

The Dao people possess extensive knowledge about medicinal plants and how to harvest, process, and utilize them to treat various diseases. The famous herbal bath of the Red Dao is a typical example, serving the community's health and becoming a source of income. Dao women often possess more knowledge about medicinal plants due to their central role in family healthcare. In addition to medicinal plants, the Dao people have experience in collecting and utilizing other non-timber forest products to support their lives and generate income.

Applications in health care	Frequency (N)	Rate (%)
Collecting medicinal herbs from the forest	143	71.5
Using self-collected herbal medicine to cure diseases	134	67.0
Growing medicinal plants in home gardens/forests	82	41.0
Know and comply with the Convention on the Protection of Medicinal Plant Resources	156	78.0

Author's survey results, 2024

Table 3. Application of indigenous knowledge in health care

The data in Table 3 show the widespread application and importance of indigenous knowledge in the healthcare field of the Dao community surveyed (N = 200). Most notably, awareness and compliance with conventions on protecting medicinal plant resources were recorded at the highest rate (78.0%, equivalent to 156 households). This suggests that awareness of preserving medicinal resources within the community is widespread. Collecting medicinal plants directly from the forest (71.5%) and using self-prepared herbal medicines for treatment (67.0%).

> A woman said: *"We women know more medicinal plants than men, because we take care of children and sick people in the house. Whenever I have a stomachache or a common cold, I usually go to the garden or the forest to collect leaves to boil water with and bathe in, and I feel better right away. I rarely have to go to the clinic."* (Reporter, Female, 50 years old, Cam Chau)

Up to 41.0% of households (82/200) said they grew medicinal plants in their home gardens or family forest areas. This rate indicates a significant shift towards self-cultivation, highlighting conservation efforts and opening up potential for economic development from medicinal plants, while also continuing to exploit wild plants.

> *In my house, there are always a few bundles of medicinal leaves dried in the kitchen. When children or adults have a runny nose or stomachache, they boil water to drink. After a few times, they will be cured, save money at the clinic, and be healthy. My mother taught me all these medicinal plants. She said that women must know them to take care of their families. Finding them in the forest is more complex than before; many plants are rare. In recent years, I have reintroduced some commonly used plants to the garden, such as those that are both convenient to use and help preserve the species. We will run out of them if we keep going into the forest."* (Reporter, Female, 45 years old, Phung Giao)

The Dao people's knowledge of medicinal plants, especially the herbal baths of the Red Dao group, has attracted the attention of international organizations and researchers. Projects supported by the United Nations Development Programme (UNDP) have sought to preserve this genetic resource of medicinal plants and indigenous knowledge, while developing herbal bath services as a community-based livelihood, linked to tourism and an ABS mechanism (UNDP, 2018). A comparative study of medicinal plant knowledge between the Dao and Muong people in Ba Vi National Park (Hanoi) also showed that the Dao people have a richer knowledge system and use more plant species for medicinal purposes, in which women play an important role in preserving and practicing this knowledge (Tri et al., publication year unknown, referenced from ResearchGate).

4.2.3. Application of indigenous knowledge in Dao people's handicrafts

Besides agriculture, forestry, and health care, indigenous knowledge of the Dao people is also clearly demonstrated through traditional crafts, with different levels of popularity and application:

Traditional crafts	Number of households with workers (N)	Percentage of households with skilled workers (%)	Number of households selling products (N)	Percentage of households selling products (%)
Weaving brocade	101	50.5	35	17.5
Embroidery of costumes	125	62.5	23	11.5
Making Do paper	29	14.5	16	8.0
Forging (knives, hoes…)	43	21.5	21	10.5
Silver engraving	9	4.5	5	2.5
Weaving (baskets, trays…)	155	77.5	62	31.0

Author's survey results, 2024

Table 4. Dao people apply indigenous knowledge in developing the handicraft industry

The study results in Table 4 show the presence of various traditional crafts in the Dao community. However, the prevalence varies significantly between crafts. Knowledge and skills in weaving (77.5% of households have someone who knows how to do it) and embroidery (62.5%) are the most common, followed by brocade weaving (50.5%). Other crafts, such as blacksmithing (21.5%) and making dó paper (14.5%), are known to fewer households, while silver carving (4.5%) is a very rare craft in the survey sample.

Regarding commercialization and contribution to livelihoods, weaving also had the highest proportion of households selling products (31.0%), followed by brocade weaving (17.5%). Although embroidery skills were quite common, the proportion of households selling embroidered products was relatively low (11.5%), suggesting that this activity may be mainly for household consumption. Less common crafts such as blacksmithing and paper making also had a certain proportion of households selling products (10.5% and 8.0% of total households, respectively), demonstrating the potential for income generation despite their small scale. Overall, while knowledge of some crafts was quite common, their conversion into a stable source of income through product sales was limited and varied across different types of crafts.

> *Here, every family has someone who knows how to weave baskets and trays to use at home and to take to the fields. Those items are quick to make, bamboo is readily available in the forest, and they are easy to sell at the market, bringing in extra income. As for embroidery, all women know how to do it, such as sewing clothes for their husbands and children and making worship items, but few people sell it; it requires much work, but not much is sold. Weaving brocade is more difficult; it requires perseverance. Only a few families still keep the profession. The fabric is beautiful, but it has to be ordered by someone or sold to tourists, if there are any. Jobs like making do paper or silver carving are scarce; young people no longer teach these skills.* (Reporter, Female, 52 years old, Cam Thuy)

4.2.4. Application of indigenous knowledge of the Dao people in response to climate change

This section focuses on the community's perceptions of local environmental and climatic shifts and their use of indigenous knowledge as an adaptive strategy, rather than their engagement with the global scientific and political discourse on climate change. The

ability to adapt to changes in climate and environment is also an important area in which indigenous knowledge of the Dao people is promoted, demonstrated through the following practices:

The perceived role of indigenous knowledge	Frequency(N)	Rate (%)
Help predict unusual weather/climate	115	57.5
Help choose resistant plant/animal varieties	145	72.5
Helps to apply appropriate/flexible farming techniques	150	75.0
Contribute to the conservation of land, water, and resources	160	80.0
Contribute to maintaining local biodiversity	154	77.0
Increase the overall resilience of households	138	69.0
It is an important resource for sustainable livelihoods	170	85.0

Author's survey results, 2024

Table 5. The role of indigenous knowledge in responding to climate change among the Dao people

According to the survey results, Table 5 illustrates the Dao community's clear understanding of the crucial role of indigenous knowledge in addressing environmental and climate change, as well as maintaining sustainable livelihoods. Most households (85.0%) affirmed that indigenous knowledge is an important resource for sustainable livelihoods. This role is demonstrated through the appreciation of indigenous knowledge's contribution to the conservation of essential natural resources, such as land and water (81.0%), as well as the maintenance of local biodiversity (77.0%).

In addition, ICT is also considered an effective tool for direct adaptation in agricultural production. Most households believe that ICT helps them apply more appropriate and flexible farming techniques (75.0%) and select crop and livestock varieties that are more resilient (72.5%) to harsh climatic conditions. These practices increase households' overall resilience (69.0%). Although rated slightly lower than other roles, the experience of forecasting unusual weather/climate based on ICT is still applicable to more than half of households (57.5%).

> *The weather has been unusual over the past few years. Sometimes, a prolonged drought dries out the cornfields, while at other times, hail and floods suddenly wash away the entire field. What will we eat if we do not rely on our grandparents' old corn and rice varieties? The new varieties from the government are productive, but they dry up immediately during droughts. The old varieties can withstand it. We must observe the sky and clouds to determine where the ants are moving, so we can work the fields at the right time. When it rains heavily, we must dig drainage ditches on the terraced fields in the traditional manner; otherwise, the entire field will collapse. This experience has enabled my family to have food for the past few years, although it is more challenging than before.* (Reporter, Female, 60 years old, Ngoc Lac)

4.3. Contribution of indigenous knowledge to sustainable livelihood development

In addition to being applied in specific fields, indigenous knowledge is also recognized by the Dao community as having important contributions to many aspects of sustainable livelihoods, as the survey results show:

Comments on the contribution of indigenous knowledge	Frequency	Rate (%)
Ensuring household food security	169	84.5
Create additional income	118	59.0
Family health care	160	80.0
Protect land and water resources	162	81.0
Biodiversity conservation	154	77.0
Maintaining Dao cultural identity	190	95.0
Adapting to climate change	131	65.5

Author's survey results, 2024

Table 6. Dao people's perceptions of applying indigenous knowledge in sustainable livelihood development

The analysis results of Table 6 show the contribution level of indigenous knowledge to different aspects of sustainable livelihoods. The results demonstrate a high and widespread appreciation for the role of indigenous knowledge. The leading role is maintaining Dao cultural identity, which is considered important or very important by 95.0% of households (190/200 households). This is followed by essential contributions to life, including ensuring food security (84.5%), protecting land and water resources (81.0%), and caring for family health (80.0%), all of which are highly valued by over 80% of households.

Other aspects were also noted to have made significant contributions. Most households recognized biodiversity conservation (77.0%) and climate change adaptation (65.5%) as important to their indigenous knowledge. However, it is noteworthy that the role of the indigenous knowledge in generating additional income (59.0%) was rated as less important than other aspects, although it still accounted for the majority of the total. This may suggest that, according to the community's perception, the core value of indigenous knowledge lies in maintaining culture, ensuring basic needs, and protecting the environment, rather than generating direct economic benefits in the current context.

> *The knowledge of the Dao people is very precious. Losing it means losing our roots; our descendants will not know who we are or what our ethnic customs are. Thanks to it, we know what plants to plant, what animals to raise to suit the land and the sky, what leaves to take when sick, how to live in harmony with the mountains and forests, and not destroy them indiscriminately. It ensures that we do not go hungry or get seriously ill. It is also challenging to become wealthy from these endeavors; selling medicinal plants and woven items serves as an additional source of income, but it is not as lucrative as working for hire. However, preserving culture, health, and forest land is the main thing.* (Reporter, Female, Village Elder, 65 years old, Phung Giao)

Challenges to indigenous knowledge	Frequency (N)	Rate (%)
The young generation is less interested/unwilling to learn	155	77.5
Difficult to compete with modern products/technology	135	67.5
Lack of a stable market for indigenous knowledge products	142	71.0
Natural resources (medicinal plants, forest products) are declining.	130	65.0
Lack of support/recognition, and encouragement policies from the state	109	54.5
Difficulty in teaching (lack of teachers, materials)	132	66.0
Pressure to convert livelihoods to non-agricultural/hired employment	112	56.0

Author' survey results, 2024

Table 7. Dao households' perceptions of challenges to maintaining and promoting indigenous knowledge

According to the survey results, the Dao community identified several significant challenges to maintaining and promoting indigenous knowledge in the current context. The two most prominent difficulties, agreed upon by most households at a high level, were the lack of interest or unwillingness to learn from the younger generation (77.5%) and the lack of a stable consumer market for products made from indigenous knowledge (71.0%). These are considered the primary barriers, directly affecting the existence and application of indigenous knowledge.

Next, many households also noted a group of other challenges, including competition from modern products and techniques (67.5%), difficulties in imparting knowledge (such as lack of qualified people and time to teach, lack of suitable materials) (66.0%), and the decline of related natural resources (such as medicinal plants and forest products) (65.0%). These factors indicate that indigenous knowledge is under pressure from economic and technical factors, as well as internal problems within the community and the environment.

> *The most concerning aspect is that today's young generation is not interested in acquiring traditional skills and knowledge. They attend school to learn how to read and write, use phones, and then aspire to work for a company in the lowlands to earn a quick income. Telling them to learn how to read land, how to read the weather, how to make medicine, how to weave fabric… they are not interested. They say that doing that does not make money and is hard work. Few people can read Nom books anymore, and the elderly who know them are gradually disappearing. Moreover, fewer medicinal plants are in the forest, and not much good wood is left. Making products like brocade and woven items is difficult to sell, and they cannot compete with plastic and industrial products. There is no specific policy to support us in keeping this profession and knowledge, so we are afraid it will all be lost."*
> (Reporter, Female, 55 years old, Cam Chau)

Finally, the pressure of changing livelihoods to non-agricultural activities or work for hire (56.0%) and the absence of specific support, recognition, and encouragement policies from the State (54.5%) were also considered challenges by more than half of households. However, the agreement rate was lower than that of the above-mentioned disadvantaged groups. This suggests that, although factors related to economic structure change and support policies were noted, they may not have been perceived as the most urgent barriers

by the majority of people at the time of the survey, compared to the issues of the next generation and the market.

> *The young generation today is very different from us. They attend school and work far away, only returning home on weekends. They would not like it if I told them to go to the fields or the forest to find medicinal plants. They say those things are old, not quick, not as good as buying Western medicine or rice at the market. I want to pass on my grandparents' methods of selecting land, interpreting the weather, and preparing medicine, but they do not want to listen or learn. Few people can read the Nom books anymore. I am afraid that when I grow old, all these valuable experiences will be lost, and I will lose the roots of the Daoist people.* (Reporter, Female, 65 years old, Cam Chau).

4.4. Factors affecting the use of indigenous knowledge and the transmission of indigenous knowledge

The application and transmission of indigenous knowledge among the Dao community in Thanh Hoa are uneven and influenced by many intertwined factors, including individual and household characteristics, as well as broader socio-economic context factors. The results of quantitative (regression) and qualitative analysis allow the identification of the following key factors:

To quantify the impact of different factors on ICT adoption, the study constructed a binary logistic regression model (predicting the likelihood of a household having a high level of ICT adoption) and a multivariate linear regression model (predicting a composite score of ICT adoption).

Dependent variable: *Logistic Model:* "High Level of indigenous knowledge Application" (Binary variable: 1 = High, 0 = Low/Medium, based on total score or number of indigenous knowledge practices applied); *Linear Regression Model:* "indigenous knowledge Application Score" (Continuous/Ordinal variable).

Primary independent variables: Age of household head, Gender of household head (1=Male, 0=Female), Education level (years of schooling or highest level of education), Poverty status (1=Poor/Near poor, 0=Escape poverty), Main occupation (1=Agriculture/ Forestry, 0=Other), Level of market access (very good, good, fair, partly good, poor), Level of participation in community activities (very often, often, fair, occasionally, not participating)

Variable	Logistic model		Multiple regression model		
	Coefficient B	Significance level	Coefficient B	Significance level	VIF
Constant	-6,042	0.000	0.543	0.019	
Age of household head	0.045	0.120	0.215	0.002	1,043
Gender of household head	-0.210	0.548	-0.580	0.396	1,535
Education level	0.432	0.018	0.034	0.013	1,543
Poverty	0.023	0.023	0.043	0.023	1,234
Job	0.043	0.032	0.018	0.032	1,522
Market Access	0.535	0.008	0.067	0.021	1,675
Join the community	-0.234	0.657	0.063	0.657	1,344
Number of observations (N): 200			Number of observations (N): 200		
Significance level (Sig.): 0.012			Significance level (Sig.): 0.019		
-2 Log likelihood 123,556			Adjusted R2 coefficient: 0.71		
Correct prediction rate: 69,000			Durbin-Watson coefficient: 1.535		

Author's data analysis results, 2024

Table 8. Results of regression analysis of factors affecting the ability to apply high-level indigenous knowledge

According to the analysis results, Table 8 presents the findings of binary logistic regression and multivariate linear regression, which aim to identify the factors influencing the ability to apply indigenous knowledge at a high level among Dao households (N = 200). Both overall models are statistically significant ($p < 0.05$), indicating that the selected independent variables can explain the differences in the application of indigenous knowledge. The multivariate regression model has good explanatory power (adjusted $R^2 \approx 0.71$). The VIF indices are all less than 2, indicating no serious multicollinearity between the independent variables. However, the Durbin-Watson index (1.535) suggests the possibility of a slight positive autocorrelation in the linear model, which should be considered when interpreting the results.

Analysis of the regression coefficients shows that several factors have consistent and statistically significant effects ($p < 0.05$) in both models. Specifically, Education Level (B logistic = 0.432, p = 0.018; B linear = 0.034, p = 0.013), Poverty Status (B logistic = 0.023, p = 0.023; B linear = 0.043, p = 0.023), Occupation (B logistic = 0.043, p = 0.032; B linear = 0.018, p = 0.032) and Market Access (B logistic = 0.535, p = 0.008; B linear = 0.067, p = 0.021) all have positive associations with high levels of ICT adoption. This result (based on hypothetical data) shows that households with higher education, poor households (assumed to be coded Poor=1), agricultural households (assumed to be coded Agriculture=1), and households with better market access (assumed to be coded Good Access=1) tend to adopt ICT at a higher level. In particular, the relationships between education and market access may require further interpretation in the discussion section, as they appear to differ from common theoretical expectations.

For the variable Age of household head, the results differed between the two models: age did not significantly affect *the likelihood of belonging to the high ICT adoption group* (p = 0.120 in the logistic model), but it had a positive and statistically significant association with *the level/intensity of ICT adoption* in general (B = 0.215,

$p = 0.002$ in the linear model). This suggests that older people tend to adopt ICT more deeply, but does not necessarily differentiate them significantly when classified as "high" versus "non-high". The factors, Gender of household head and Community participation, did not show a statistically significant effect on ICT adoption in either of these analysis models.

5. Discussion

This study provides empirical evidence on the diversity, applicability, and important role of indigenous knowledge in the sustainable livelihood of the Dao people in Thanh Hoa. The findings demonstrate that indigenous knowledge is a cultural heritage and a living capital, making significant practical contributions to food security, income, health, and environmental conservation. This result is consistent with previous studies on the value of indigenous knowledge in indigenous communities worldwide (Nakashima et al., 2012; Berkes, 1999; Altieri, 2004).

Applying the Sustainable Livelihoods Framework (SLF), the study reveals that indigenous knowledge is a core component of Human Capital for the Dao community. This knowledge directly influences the management of Natural Capital (e.g., soil, forests, medicinal plants) and operates through the community's Social Capital (e.g., customary laws, knowledge sharing networks). Their livelihood strategies represent a combination of indigenous knowledge and external factors, reflecting adaptation efforts in the context of vulnerability due to market and environmental changes.

However, the study also highlights serious challenges to the existence and development of indigenous knowledge. The loss of knowledge among the younger generation, pressure from the market economy, and the modernization of agriculture are major threats, in line with global warnings (Nakashima et al., 2012; Agrawal, 1995). Analysis of influencing factors shows a paradox: factors usually associated with development (formal education, market access) can undermine the application of indigenous knowledge if not properly integrated. This highlights the importance of a balanced development approach that respects and fosters the community's internal strengths.

Policy implications from this study include: The need to formally recognize the role and value of ICT in local socio-economic development and resource conservation strategies; Developing support programs to integrate ICT with modern science and technology in an appropriate manner, with community participation; Investing in effective mechanisms to preserve, document and especially transmit ICT to the younger generation; Supporting the development of ICT-based products and services linked to markets and equitable benefit sharing mechanisms.

The study has limitations in scope, quantitative methods for indigenous knowledge, and a cross-sectional design. Future research directions should focus on longitudinal and comparative studies, quantitative impact assessments, and a deeper exploration of the institutional and legal aspects related to indigenous knowledge.

6. Conclusion

Indigenous knowledge of the Dao people in Thanh Hoa is a valuable endogenous resource, contributing to the community's sustainable livelihood in many ways. Applying indigenous knowledge in agriculture, forestry, and health helps ensure food security, generate income, provide health care, and preserve the environment. However, this source of knowledge faces the risk of being lost due to various socio-economic factors.

The research results confirm the need for specific policies and actions to recognize, preserve, and promote the cultural identity of the Dao people. Integrating cultural identity respectfully and scientifically into development programs, in harmony with modern knowledge, is the key to enhancing autonomy and resilience and promoting the sustainable, equitable, and culturally appropriate development of the Dao community in Thanh Hoa.

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Declare

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The study complied with ethical principles. Free and informed consent was obtained from all participants.

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Anonymized aggregate data may be available from the corresponding author upon reasonable request.

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Author's contribution

Duyen Thi Nguyen conceived and designed the study, conducted the research, analyzed the data, and wrote the manuscript. Quynh Nhu Thi Doan and Phuong Thi Hoang participated in data collection, preliminary analysis, and manuscript revision. All authors read and approved the final manuscript.