

The Development of an Ontology for Information Retrieval about Ethnic Groups in Chiang Mai Province

Phichete Julrode¹

Department of Library and Information Science
Faculty of Humanities, Chiang Mai University
Chiang Mai, Thailand

Thepchai Supnithi²

Principal Researcher (LST) Employment
National Electronics and Computer Technology Center
Pathumthani, Thailand

Abstract—This study aims to develop the semantic ontology of information knowledge about ethnic groups by analyzing information from the collection of documentary sources from libraries, research, and the museum for learning about people on the highlands located in Chiang Mai Province. The study is based on the classification theory of ethnic groups in Chiang Mai Province with the intention of establishing the relationship between knowledge structure regarding ethnic groups. The study procedures consist of three stages: 1) Establishing ontology requirements from online data to analyze the data of the keyword from the research database of Chiang Mai University Library's Online Information Resource Database (OPAC) and Ratchamangkhalaphisek National Library, Chiang Mai to group the words by studying information resources in Thai language, such as books, textbooks, research papers, theses, research articles, academic articles, and reference books related to ethnic groups. Stage 2) Designing classes, defining main classes, subclasses, hierarchies, and properties in order to establish the relationship of data in each class using the Protégé program. Stage 3) Ontology evaluation, which is divided into two parts: an expert's evaluation of the suitability of the ontology structure using the Inter-Class Relational Accuracy Assessment Scale and an examination of ethnic grouping data. The findings reveal that specifying, definition, scope, and objectives of development are appropriate (average score = 0.97) in three areas: grouping and ordering of classes within the ontology (score value = 0.98), defining affinity names and class properties (score value = 0.96), and suitable overall ontology content (score value = 0.97).

Keywords—Information retrieval; ontology development; ethnic groups; knowledge organization; Chiang Mai

I. INTRODUCTION

The term "Ethnic Group" refers to a group of people who have a long history in Thai society, with different aspects and having their own culture and customs. It is a group in which the population is related to one another, sharing the same racial characteristics, culture, traditions, and language, and is devoted to the conservation, development, and inheritance of ancestral land and ethnic identity from one generation to the next. Ethnicity is the classification of people and their relationships between different groups in society based on cultural differences and inferiority in political power, society, and the economy. However, it may not be a minority that has a smaller population than a society [1], [2], [3]. Formerly, ethnic groups

were diverse and settled in various provinces throughout Thailand [4]. There are currently 67 ethnic groups in 56 provinces with a total population of around 6,100,000 people. Settlements are categorized into four types as follows:

1) The highland ethnic groups, or "hill tribes", consist of 13 groups: Karen, Hmong (Miao), Yao (Mien), Lisu (Lesu), Lahu (Muser), Akha, Lua, Tin, Khmu, Chinese Hor, Tong Su, Kachin, and Palaung (Dara-ang).

2) Ethnic groups that settled on the plains consist of 38 groups, namely Mon, Tai Lue, Tai Song Dam, Tai Yai, Tai Khuen, Tai Yong, Tai Ya, Tai Yuan, Phu Tai, Lao Krang, Lao Ngaew, Lao Ka, Lao Ti, Lao Wiang, Saek, Sere, Prang, Bru (Chao), Song Vo (Tawing), Umpi Kong Kula Chou Oj (Chu Oong), Kui (Suay), Nyah Kur (Chao Bon), Nyaw, Yoy, Khmer Thai, Vietnam (Yuan), Nye Mee Sor (Bizu), Chong, Krachong, Malay, Kaleang, and Lao Song (Tai Dam).

3) Ethnic groups that settled on coastline or "Chao Lay" consist of three groups, including Moken, Moklen, and Urak Lawoi.

4) Ethnic groups that live in the forest consist of two groups: Mlabri (Tong Luang) and Sakai (Mani).

Ethnic groups are people who share a similar way of life, beliefs, culture, customs, and language, as well as a shared history. In addition, each ethnic group organizes its way of life differently. The manner in which each group interacts with each other and their relationships is distinctive [5], [6]. The separation of an ethnic group is essential in a society based on diverse ancestral teaching practices, a group of people with different biological characteristics, histories, and roles in society. Therefore, behavior and beliefs, occurring in human society and referred to as "culture," are different as well. A study of relational ethnography emphasizing ethnic groups as cultural groups that share ancestors or a long history is a study of the organization of social and governance, beliefs, customs and rituals, spoken language, clothes, and so on of each ethnic group. Currently, new generations of ethnic groups are taking a greater role in studying their own ethnic groups, providing them with more opportunities to learn about ethnic cultures [7]. Research information on ethnic groups is abundant and diverse, such as language, culture, literature, history, archeology, pottery, anthropology, folklore, habitation, and way of life,

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which are mostly separated into specific areas. For example, the study of language attitudes of Tai ethnic group toward their own language in the lower northern region and the study of the use of various Tai dialects in the lower northern region. It is a comparison of tendencies and situations in language usage and language attitudes toward their own dialects of Thai people who speak Tai dialect in the lower northern region and a study of the way of life of the Hmong ethnic group in Mae Rim District, Chiang Mai Province [8], [9]. Therefore, searching for relational and related information is limited.

Ontology is a concept applied in knowledge management. It is widely used and studied, and it is able to organize and present knowledge in the form of conceptual groups and interrelationships within the scope of interest [10]. It creates a hierarchical relationship by using the concept of grouping and segmentation [11], [12]. Applying ontology concept to ethnic groups, namely Ethnicity Ontology (EO), was developed as an extension of the Basic Formal Ontology two standard for general reference to ethnographic concepts. It combines semantic datasets from different knowledge sources to compile definitions for interpretation [13]. Gathering data and building relationships in a hierarchical form is often used in the fields of artificial intelligence, semantic web, software engineering, and biomedical informatics [14]. To design and develop ontology for information retrieval of ethnic groups in Chiang Mai, the researcher gathered knowledge of different ethnic groups by having the information integrated according to the concept of ontology, which is a type of knowledge management system that plays an important role in semantic explanations. This is to create a common understanding of a particular field of knowledge using a single concept. This study defined or created a vocabulary system that can be used to illustrate knowledge that represents a comprehensive scope of knowledge. It can be used as a base for semantic searches for the development of knowledge-based systems, as well as a semantic search system for specific information systems related to ethnic knowledge in Chiang Mai province.

II. CONCEPTUAL FRAMEWORK AND METHODOLOGY

A. Objectives

1) Design and develop ontology for information retrieval about ethnic groups in Chiang Mai.

2) Evaluate ontology for information retrieval about ethnic groups in Chiang Mai.

B. Conceptual Framework

The objectives of this study is to design, develop, and evaluate ontology for information retrieval about ethnic groups in Chiang Mai. The researcher conducted the study according to the conceptual framework as shown in Fig. 1.

C. Methodology

1) *Concept and theory*: The development of ontology was based on the basic ontological of knowledge sharing approach [15], which the researcher employed primarily to develop Domain Ontology as the main framework. There are three stages of development as follows.

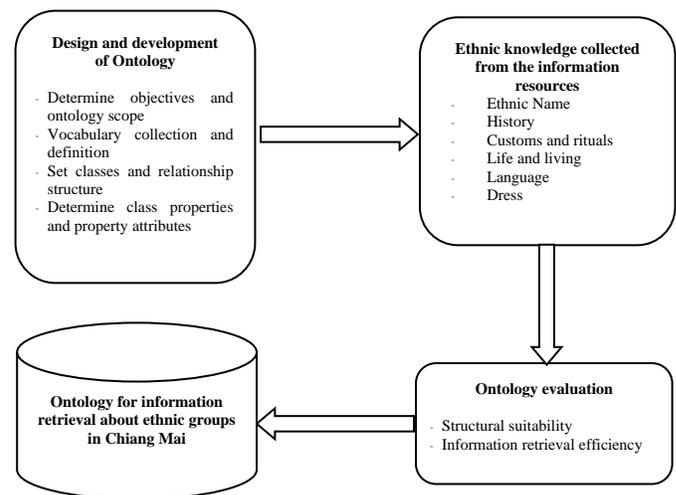


Fig. 1. Conceptual Framework.

a) Determine ontology objectives by studying the ontology requirements from online data to analyze the data of the keyword from the research database of Chiang Mai University Library's Online Information Resource Database (OPAC) and Ratchamangkhaphisek National Library, Chiang Mai for grouping the words.

b) Protégé program was utilized to establish word correlations related to ethnic groups.

c) Ontology evaluation is divided into two parts: the evaluation of the suitability of the ontology structure using the Inter-Class Relational Accuracy Assessment Scale by five experts (two ontology specialists) and an examination of ethnic grouping data (three ontology specialists).

The development process of ontology has applied knowledge engineering theory for developing the ontology to make domain assumptions explicit as a framework [16]. The development process consists of seven stages: 1) determining domain and scope of ontology; 2) lexical clarification; 3) class and class hierarchy establishment; 4) defining relationships; 5) defining properties; 6) defining views on class properties; and 7) creating sample data within that class.

2) Research development process

a) *The development of ontology has three phases*: Phase 1: Determine the objectives and scope and ontology's scope to present a set of terms and concepts related to ethnic groups in Chiang Mai from the online data to analyze the keyword data from the research database from the Online Information Resource Database (OPAC), research database (e-Research), thesis database (e-Thesis), and journal database (e-Journal) of Chiang Mai University Library for 330 items, as well as the National Library of Thailand's Online Information Resource Database (OPAC) for 453 items, for a total of 783. This is to study the term group and apply it suitably for the design and development of ontology, along with the group of obtained words used in interviewing three experts in ethnology to collect information from them. Furthermore, it is to evaluate the correctness of the data obtained from the conceptual and vocabulary analysis processes to classify knowledge

(Knowledge classification approach) of Broughton [12] from the document and systematically prepare it before taking it to the next phase.

Phase 2: From the collection of word groups in phase 1 for developing ontology that consists of vocabulary grouping, setting main classes and subclasses, determining properties and attributes of classes, and creating representative data within classes for defining the vocabulary value and data attributes, the Protégé program was applied to design and develop the ontology, class design, main class and subclass setting, hierarchy, properties, and relationships between classes in a technical connection form.

Phase 3 Ontology evaluation. It is to confirm the academic authenticity of information about ethnic groups in Chiang Mai from experts and use the evaluation results to improve the ontology appropriately. The ontology evaluation is separated into two parts, which are the evaluation of the vocabularies of ethnic groups in Chiang Mai. Then, three ethnic experts would evaluate the structured vocabulary's coherence in the correlation grouping. Additionally, the evaluation of class relationships and class properties would be tested by two experts in ontology, using the accuracy, consistency, and suitability assessment scale of the structure and word relationships by finding the consistency value. To be more accurate and complete, the researcher utilized expert advice to gather, organize, and summarize the results.

b) *Research tool*: Protégé program is a free, open-source knowledge management system program developed by Mark Musen in 1987 and a team at Stanford University [17]. It has established an ontology evaluation approach using the evaluation of Obrst and team [18]. It consists of the evaluation of 1) a process of identifying definitions, scope, and objectives of development; 2) a method of defining a concept or class; 3) a process for defining a class's properties; 4) a process for creating a model or representative data; and 5) applications and development guidelines in the future.

c) *Data analysis*: The researcher analyzed the data by evaluating the Index of Conformity or IOC (Index of item objective congruence) based on advice and suggestions from three experts in ontology and semantic web and two experts in ethnic groups in Chiang Mai, a total of five people. Upon seeking the experts for this study, the researcher required experts who are qualified as academics or researchers in a relevant field with research papers, academic papers, or other works that have been published continuously to date, or who are recognized nationally or internationally, or qualified people with experience doing research or teaching in a related field. The criteria that are acceptable and considered to be consistent or appropriate are a score of 0.5 or higher, whereas a score of less than 0.5 must be improved [19].

III. RESULT AND CONCLUSIONS

The development of ontology for information retrieval about ethnic groups in Chiang Mai aims to design, develop, and evaluate the ontology for information retrieval about ethnic groups in Chiang Mai. The summary of the findings is divided into three parts as follows:

A. Development of a Semantic Ontology of Knowledge about Ethnic Groups in Chiang Mai

The results of the study on ethnic groups in Chiang Mai revealed that the scope of knowledge of ethnic groups in Chiang Mai can be divided into nine groups: 1) ethnic Name; 2) history; 3) customs and rituals; 4) life and living; 5) language; 6) religion and faith; 7) dress; 8) entertainment; and 9) economy and society. The knowledge structure of ethnic groups in Chiang Mai can be divided into nine main classes, 29 subclasses, and 37 subgroups. An example of knowledge structures is shown in Table I.

According to Table I, it shows the main classes and their descriptions of the nine main classes, each with subclasses, subgroups, and properties to describe their relationship to the main class in more detail by dividing 29 subclasses, 37 subgroups, and 37 class properties. An example of the design of ontology can be seen in Table II.

Table II demonstrates the main classes and subclasses, as well as the description of subgroups and their properties, to show the relationship after the design of the ontology and then to establish the relationship with the Protégé program, which illustrates an example of ontology design and shows the relationship between main classes and subclasses as shown in Fig. 2.

TABLE I. CLASS STRUCTURE AND THE DESCRIPTION OF THE MAIN CLASS OF THE ONTOLOGY

| Ethnic groups (Ethnic Group: thing) in Chiang Mai who have their own names, customs, religion, dress, etc. can be shown according to the ontology's main classes and subclasses divided by relationships. | | |
|--|---------------------|---|
| <i>Class no.</i> | <i>Class name</i> | <i>Class description</i> |
| 1. | Ethnic Name | A group of people who are officially named according to documents and research. |
| 2. | History | History, origins, migrations, and settlements of ethnic groups. |
| 3. | Customs and Rituals | The expressions, behaviors, worship, role models, or patterns that most people hold in their ethnic groups serve as a pattern for future generations to follow. |
| 4. | Life and Living | The way of life of people in ethnic groups, such as food, medication, way of life, occupation, animal husbandry, wisdom, utensils, accessories, and social values. |
| 5. | Language | Phonetic characters, words, speech, and symbols are used in place of speech to express one's ethnicity. |
| 6. | Religion and Faith | Forms of belief, faith, religiosity, or cult of belief in regard to many matters in ethnic groups. |
| 7. | Dress | Elements or dress styles of people in ethnic groups. |
| 8. | Entertainment | Grouping together to communicate certain things, emotional expressions, and stories for entertainment and pleasure. |
| 9. | Economy and Society | Earning money, exchange system, economic system of people in ethnic groups that generate income for each other, social organization of people in ethnic groups from the household level to the community level. |

TABLE II. AN EXAMPLE OF THE DESIGN OF ONTOLOGY FOR INFORMATION RETRIEVAL ABOUT ETHNIC GROUPS

| No. | Main classes | Subclasses | Subgroups | Properties | |
|---------------------------|---------------------------|-------------------------|---------------------|-----------------------------------|-------|
| 1. | Ethnic name | Self-name | Name Meaning | Creating a group name | |
| | | Official name | Official name | Difference | |
| | | Other name | Other name | | |
| 2. | History | Origin | Origin | Route of immigration | |
| | | Original settlement | Original settlement | | |
| | | Immigration to Thailand | Route | | |
| | | Story/myth | myth | Name | Story |
| | | | | Landmark | Name |
| Background | | | | | |
| 3. | Customs and rituals | Name | Name of ritual | | Name |
| | | Time of event | Duration | Duration | |
| | | Purpose | Purpose | Purpose | |
| | | Background/story | Background | Cause | |
| | | Ritual tools | Offerings | Relevance | |
| | | | Other tools | | |
| | | Method | Method | Procedure | |
| | | Clothing | Clothing | Dress | |
| Prohibitions /obligations | Prohibitions /obligations | Success | | | |
| 4. | Life and living | Food | Name | Name | |
| | | | Type of food | Type of food | |
| | | | Ingredient | Ingredient | |
| | | | Seasoning | Seasoning | |
| | | | Way of eating | Way of eating | |
| 5. | Language | Spoken language | Speech pattern | Speech pattern | |
| | | Written language | Language family | Language family | |
| | | Letters | Letters origin | Letters origin | |
| 6. | Religion and Faith | Religion | Name | Name | |
| | | | Name of sect | Sect | |
| | | | Name of cult | cult Beliefs | |
| 7. | Dress | Shirt | Cloth pattern | Background story of cloth pattern | |
| | | Pants | | | |
| | | Accessories | | | |

| | | | | |
|----|---------------------|-----------------------|------------------|-------------------------|
| | | Foot | | |
| | | | Color tone | Synthetic/natural color |
| | | | Material | Material |
| 8. | Entertainment | Place | Gathering center | Appropriateness |
| | | Festival | Festival | Duration |
| 9. | Economy and Society | Economic system | Income | Income |
| | | Financial integration | Income sources | Income sources |
| | | Social dependence | Dependent income | Dependent income |

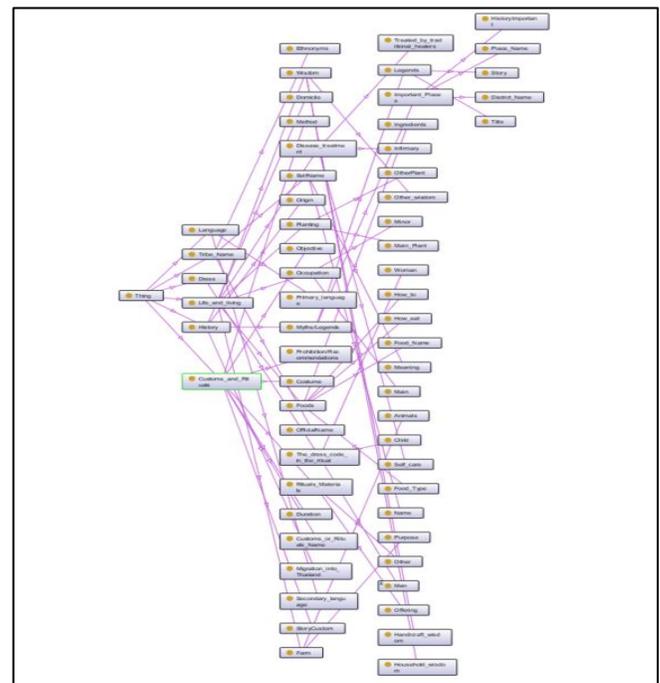


Fig. 2. Relationships between Ontology's Main Classes and Subclasses for Information Retrieval about Ethnic Groups in Chiang Mai.

B. Results of Ontology Evaluation for Information Retrieval about Ethnic Groups in Chiang Mai

Ontology evaluation is divided into two parts, which are the evaluation of the ontology structure by experts and an examination of the data analysis by evaluating the consistency index. The details are as follows:

1) The results of the evaluation of the suitability of the ontology structure for information retrieval about ethnic groups in Chiang Mai by experts found that the suitability of the ontology scored at 0.93. Class grouping, class ordering, class name, property name, the relationship between classes, the name of the relationship between classes, the accuracy and appropriateness of ontology content, and ontology overview were appropriate at 1.00. Followed by ontology class and its properties or attributes, the appropriateness was 0.66, respectively. These results are as shown in Table III.

TABLE III. RESULTS OF ONTOLOGY EVALUATION OF ETHNIC GROUPS

| Items | IOC | Results |
|---|-------------|--------------------|
| 1. Class grouping within the ontology | 1.00 | Appropriate |
| 2. Class ordering within the ontology | 1.00 | Appropriate |
| 3. Ontology classes | 0.66 | Appropriate |
| 4. Name of classes within the ontology | 1.00 | Appropriate |
| 5. Properties or attributes of classes | 0.66 | Appropriate |
| 6. Name of properties | 1.00 | Appropriate |
| 7. Relationships between classes | 1.00 | Appropriate |
| 8. Name of the relationships between classes | 1.00 | Appropriate |
| 9. Accuracy and appropriateness of ontology content | 1.00 | Appropriate |
| 10. Ontology overview | 1.00 | Appropriate |
| Total | 0.93 | Appropriate |

2) The evaluation of data analysis was conducted by determining the Index of Conformity, or IOC (Index of item objective congruence), with an acceptable average score of IOC. If a value is 0.50 or higher, the content is consistent and applicable [20]. The evaluation by two ethnic and cultural experts assessed the analysis of the data by determining the conformity index used to connect and group information of ethnic groups. The overall evaluation results revealed that the ontology structure was consistent and had definition value, scope, and objectives of development. The results were also found to be consistent (score value = 0.89) in three areas: defining relation name and class properties (score value = 0.88), grouping, and ranking of classes within the ontology (score value = 0.90), and the accuracy and appropriateness of the overall ontology content (score value = 0.90), as demonstrated in Table IV.

TABLE IV. RESULTS OF THE ONTOLOGY CONSISTENCY EVALUATION FOR INFORMATION RETRIEVAL ABOUT ETHNIC GROUPS

| Items | IOC | Results | |
|--|---|-------------------|------------|
| Specifying, definition, scope, and objectives of development are appropriate | 1. Name of classes within the ontology | 0.95 | Consistent |
| | 2. Properties or attributes of classes | 0.98 | Consistent |
| | 3. Name of properties | 0.98 | Consistent |
| | 4. Relationships between classes | 0.96 | Consistent |
| | 5. Name of the relationships between classes | 0.98 | Consistent |
| Consistency average | 0.97 | Consistent | |
| Class grouping and ordering within the ontology | 1. Class grouping within the ontology | 0.98 | Consistent |
| | 2. Class ordering within the ontology | 0.97 | Consistent |
| | 3. Ontology classes | 0.98 | Consistent |
| Consistency average | 0.98 | Consistent | |
| Accuracy and appropriateness of the overall ontology content | 1. Accuracy and appropriateness of ontology content | 0.97 | Consistent |
| | 2. Ontology overview | 0.95 | Consistent |
| Consistency average | 0.96 | Consistent | |
| Total | 0.97 | Consistent | |

The results of the evaluation can be used in class design, relationships between classes, and properties of classes within the ontology for information retrieval about ethnic groups in Chiang Mai, making the developed ontology more suitable and consistent with the query requirements.

C. Conclusions

The structural classification resulting from this research is based on the principle of main classes and subclasses and by stratification based on the knowledge found in the source material. Ontology of ethnic groups covers many dimensions and reflects the content of ethnic groups in Chiang Mai Province of Thailand. The classification of ethnic groups in Thailand is detailed in many aspects which grouped the population according to the cultural and ethnic group. This is classified by using the criteria of the original topographic location and other similar factors, such as social characteristics, customs, history, etc. The structure is concluded three groups: (1) cultural and ethnic similarities according to the classification criteria; (2) identification of ethnic groups or groups; the culture is more detailed than the first two levels and (3) livelihoods of knowledge classification and knowledge structure of ethnic groups in Thailand focuses on data extraction. Named ethnic groups of Thailand as the main constituent groups with similar and related topics. This research apart from others is the effort to categorize details under each main class and subclasses. For example, in Class 7, subsistence, the class of dress care has four subclasses, i.e., Shirt, Pants, Accessories, Foot. This research organizes classes and subclasses of knowledge margins and creates a knowledge structure that delves into the content of various researches. Details are given hierarchically from subclasses to different properties and it will be useful in the future, although this ethnic knowledge structure is for an ontology developed to support semantic web for searching capabilities and recommendation system [21], [22]. Also can be applied to data extraction in other ways, such as for a large number of ethnic sources, for example, semantic web construction. Therefore, ethnic classifications in Thailand can be combined with and used to expand the assigned classification notation. To categorize ethnic group outcomes appropriate to an automated retrieval system that provides access to the content of information resources rather than lists, the researchers also saw that the methods used in the study could be applied to improve knowledge classification.

IV. DISCUSSIONS

The ontology design for information retrieval about ethnic groups in Chiang Mai is developed to define the classification structure of knowledge subjects arising from the classification structure based on the source of knowledge and ethnic and cultural experts. This is in accordance with the principle of grouping as well as sub-components of ethnic knowledge, which is comprehensive and reflects the content of ethnic groups of Chiang Mai. It is also in line, where there is a detailed grouping of the ethnic structure of Thailand with a hierarchical structure analysis that includes the original geographic location and other similar factors, such as social characteristics, customs, history, etc. [23] These include structures that can be divided into three levels: (1) geography; (2) cultural and ethnic similarity according to classification criteria; and (3) ethnic

identification, group, or culture with details. When cultural grouping is conducted in accordance with the process for grouping and retrieval of the body of knowledge, which consists of a body of knowledge derived from wisdom and culture, such as religion, art, and culture, as well as important historical sites, it can also be applied to the body of knowledge derived from other fields [24].

Eventually, the researcher has synthesized a guideline derived from the conceptual process of studying knowledge about ethnic groups in Chiang Mai Province, which contains the semantic ontology of knowledge about ethnic groups in Chiang Mai as a model that can be applied as a source of information. Furthermore, the researcher has applied SPARQL language to retrieve information rather than the relational database system and using SQL language in the original pattern, which will assist in obtaining more information in ethnic areas according to the ideas [25], [26].

V. RECOMMENDATIONS

1) Increasing the class's attributes to support ethnic group data collection in other Northern provinces can expand the scope of learning and data storage even more.

2) An ontology may be used to develop a semantic search program by providing search methods or alternatives that allow users to make better use of information resources.

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