ASI
Asia Social Issues

E-ISSN: 2774-0315

https://doi.org/10.48048/asi.2025.264392

A Knowledge Base System of Processing Local Cash Crops into Products for Community Enterprises

Patcharaporn Chaipattanamatee

Department of Digital Business Technology, Faculty of Business Administration, Rajamangala University of Technology Rattanakosin,Wangkraikangwon Campus, Prachuapkhirikhan 77110, Thailand

Corresponding author's e-mail: patcharaporn.cha@rmutr.ac.th

Abstract Plant economy is used for consumption and is the main occupation that generates income. However, in some seasons, production exceeds market demand. Processing can bring more benefits and value. Community enterprises often transform local plant economies into products. However, knowledge about processing needs to be improved for creating new products. If knowledge management for processing is organized into a system, community enterprises can access and utilize it effectively. This research aims to study the efficiency of an ontology knowledge-based system. The goal is to design and develop a semantic retrieval system that transforms local plant economies into efficient community enterprise products, technology development was conducted using protégé programming, applying technology linking relationships between technology structures in protégé format, and developing a semantic web retrieval system. Experts evaluated the technology structure. The overall assessment was highly accurate and appropriate, with an average score of 4.60 and a standard deviation of 0.51. The efficiency of the retrieval system was evaluated at a good level with an average precision 0.95, indicating a very high level of accuracy in retrieving information from relevant collections, recall of 0.90, indicating a high level of completeness of the retrieved data from collections, and F-measure of 0.92, indicating a very high level of retrieval performance. The well-structured technology design contributed to the efficient development of the semantic retrieval system. This supported knowledge about local plant economy processing for community enterprises and was a guideline for creating new products.

Keywords Knowledge base; Semantic search; Ontology;
Processing cash crops; Community-based products

Received: *May 9, 2023*
Revised: *June 7, 2024*
Accepted: *July 8, 2024*

Introduction

Thailand is located in a geographical area conducive to agriculture and is predominantly an agrarian nation where most of the population is engaged in agricultural activities (Thongmeethip, 2021). Plants are both a source of food and money for households, as well as to continue generating revenue for the government until it becomes a viable crop plant farming. Thailand is diverse and distinct in each location. Many different sorts of essential cash crops are distributed over the world. Data from the Economic Analysis Center of ttb (2022) projects that in 2022, farmers' revenue from cash crops will reach its highest level in five years, owing to factors such as the growth of agricultural land owned by a farmer. The global demand for goods and services has improved, and so forth. The government has consistently backed agricultural development. Fresh and processed cash crops (Bala, 2020) are sold for produce processing and preservation to add value to the commodity. If we control it correctly, it will help us generate agricultural goods in bulk without overstocking. It also leads to the creation of new jobs in the neighborhood and lowers manufacturing costs.

From the guidelines to support the enhancement of efficiency in the agricultural sector operations of the Office of Agricultural Economics (2022), it is necessary to appropriately incorporate technology into agricultural management for community enterprises as agricultural institutions. Therefore, we should utilize technology to manage knowledge related to agricultural product processing. This will help add value to agricultural products through various processing methods (Department of Agricultural Extension, 2020) to efficiently manage production with agricultural economic crops, resulting in diverse products that better meet consumer demand. The agricultural sector of Thailand has been continuously growing over the past several decades. It plays a crucial role in the country's economy, as evidenced by Thailand being the top exporter of agricultural products in ASEAN and one of the top exporters globally. According, to the Department of Trade Negotiations (2022), in their overview report on agricultural exports in 2021, the value of Thailand's agricultural exports showed a growth rate of 28.8%. Key agricultural exports include cassava, rice, tobacco leaves, and rubber. Processed agricultural products exported to global markets accounted for 62.66% of total exports, with a 9.04% increase compared to the previous year. According to the report of the Office of Agricultural Economics (2022), the proportion of Gross Domestic Product (GDP) in the agriculture sector averaged from 2018 to 2021 is 8%, and the agricultural workforce accounts for 31% of the total workforce in the country. Experts expect the agricultural economy to expand by 2.0% to 3.0% in 2022, with the highest growth anticipated in the crop sector at 2.7% to 3.7%. In the National Strategy (2018 - 2037), the government has urgently implemented policies to assist farmers and promote innovation, with the Ministry of Agriculture and Cooperatives responsible for supporting the main objectives: 1) increasing domestic Gross Domestic Product (GDP) in the agricultural sector, 2) increasing the productivity of the agricultural sector, 3) increasing farmers' incomes in a sustainable and equitable manner, and 4) enhancing the country's agricultural resilience through various strategies, such as improving production efficiency, raising the value of agricultural products, promoting the use of technology and innovation to enhance competitiveness, and so on. Therefore, to develop the potential of Thailand's agricultural sector truly and sustainably, it is necessary to enhance competitiveness in agricultural products by generating income and ensuring long-term stability for farmers, aligning with the sustainable development approach outlined in the Economic Development Plan towards Sustainable Development or BCG (Bio-Circular-Green Economy) of the government, which aims to increase the productivity and quality of the country's agricultural economy.

Prachuap Khiri khan Province is a medium-sized province located in western Thailand. The climate is humid, and the tropical monsoon region has a high average humidity due to its proximity to the sea. According to the basic data report of the Office of the Permanent Secretary for the Ministry of Agriculture and Cooperatives (2022), Prachuap Khiri Khan Province, the agricultural area accounts for 39.83% of the total area, and the agricultural sector employs 27% of the total workforce. The

province's economy has a Gross Provincial Product (GPP) value of 102,844 million baht (74%) in 2022. The agricultural sector contributes 26% to this value. The economic structure in key production sectors includes agriculture (22.9%), industry (22.3%), and accommodation and food services (14.1%), respectively. The economic crops of the province are important agricultural export products of Thailand, including several types such as rubber, oil palm, cassava, pineapple, and coconut, among others. Pineapple stands out as the most prominent economic crop. According to data from the Ministry of Agriculture and Cooperatives summarizing the situation of pineapple cultivation and production in the year 2022, the total production quantity was 1.772 million tons. Key production areas include Prachuap Khiri Khan, Ratchaburi, Phetchaburi, Phitsanulok, and Rayong provinces. Compared to the past three years, there has been an increase of 0.39%, 2.68%, and 2.27%, respectively, indicating Thailand's potential as the world's leading exporter and producer of canned pineapple products, with a value of 20 billion baht and a 32% market share globally. Prachuap Khiri Khan Province is thus akin to the pineapple capital of Thailand and the world. However, agriculture is the main occupation of rural people. However, in the past, farmers faced problems with oversupply and low agricultural prices for a long time. Although the relevant agencies used various solutions, but only for a short period of time. There is no long-term answer or response to this problem. Many causes, including fast climate change, have contributed to the drop in agricultural prices. For example, when a huge volume of product is produced quickly, it surpasses market demand (Food and Agriculture Organization of the United Nations, 2014). Fresh agricultural products cannot be preserved for lengthy periods and are perishable. Farmers are rushing to sell, leading the price to drop even lower. As a result, company operators or community businesses frequently process agricultural goods into products. It is one technique to avoid an overabundance of crops. Moreover, it contributes to the increase in the price of agricultural products (Pornpraipetch, 2019).

The One Tambon One Product (OTOP) initiative, which aims to solve cash and poverty issues by promoting the low-level economy, will encourage community enterprise products to participate. The emphasis is on promoting local enterprises to use the funding available in the community. To encourage the application of local wisdom and to enhance the community, we must create jobs and generate income for community members. This will help build a strong financial foundation that can eventually grow into small and medium businesses (SMEs), where most community enterprises will choose local agricultural products as the main raw material Because it is easy to find, plentiful and cheap-However, the privatization of the same old community enterprises, there is no new product and lack of interest. This is partly due to the lack of knowledge of other cash crops due to community enterprises. According to cash crops theory, knowledge is essential for societies to learn and evolve in order to live (Khatsombun, 2017). As a result, if we don't promote knowledge management for the community, it could weaken their ability to compete with commercial rivals in the same industry, and community companies may eventually go out of business. Ontology applies specialized knowledge in computer programs and serves as a specialized form of knowledge. Developing and applying knowledge bases has several benefits, such as reducing the human burden and increasing accuracy. The ontology technology is applied to standardize the structured modeling language of a language that defines the rules of the data model and the conceptual model of the database structure.

Ontology is a specialized form of knowledge that applies specific knowledge to computer programs. There are various benefits to developing and applying knowledge-based systems, such as reducing human workload, increasing accuracy, and minimizing errors in processes (Effingham, 2013). Developers apply information technology to standardize data structure models, define data formats, and conceptualizing database structures.Experts categorize it as a modern semantic language development technology, enabling computers can interpret and execute commands. By defining models within the scope of knowledge, it aims to describe the objects of interest or domains accurately and effectively. It typically involves a hierarchical structure for categorizing objects, aiding knowledge

management. It applied in various fields such as database systems, e-commerce, and the semantic web development for knowledge storage and retrieval.

Based on the details of the problem mentioned above, researchers propose managing the knowledge of community enterprises engaged in agricultural product processing by developing semantic web technology. This aims to assist in knowledge storage and retrieval related to local agricultural product processing and utilize it to support knowledge management for community enterprises. The goal is to equip community enterprises with knowledge that can be applied to produce a diverse range of interesting products that meet customer demands, thereby enhancing their competitiveness. Additionally, it aims to increase income for community enterprises in line with the government's policy to promote a grassroots economy. Furthermore, this approach helps address the issue of oversupply in agricultural production, elevate product prices, and add value to agricultural products.

Research objectives

To study design efficiency and develop a semantic retrieval system for transforming local plant economies into community enterprise products.

Literature review

Ontology

The core of knowledge representation is ontology. The section describes the term used to represent knowledge and applies it to the work of systems that employ conceptual meanings of words to function more effectively. Gomez-Perez & Richard-Benjamins (1999) describe ontology as "A hierarchically structured set of terminology for characterizing a domain that may be utilized as a skeleton basis for a knowledge base" by Swartout, et al. (1997). To summarize the concept of ontology: 1) Concepts provide a detailed scope of knowledge about a subject. 2) Properties, which are used to characterize concepts in a hierarchical relationship (Subclass of or is-a hierarchy), a relationship that is part (Part of), a semantic relationship (Syn-of), and a relationship are the three sorts of relationships, image (Instance-of) 4) Axioms and connection requirements and 5) Information from a representative sample (Instance) Prakancharoen (2005) divided ontologies into three categories based on their scope of application: Generic ontology, Domain oriented ontology, and Task-oriented ontology are the three types of ontologies available. Seven phases are involved in developing an ontology using the Noy & McGuinness (2001) concept: 1) Determine scope 2) Consider reuse 3) Enumerate terms 4) Define classes. There are three methods for creating classes: top-down, bottom-up, and combination 5) Define properties, 6) Define constraints, and 7) Create Instance. As seen in Figure 1.

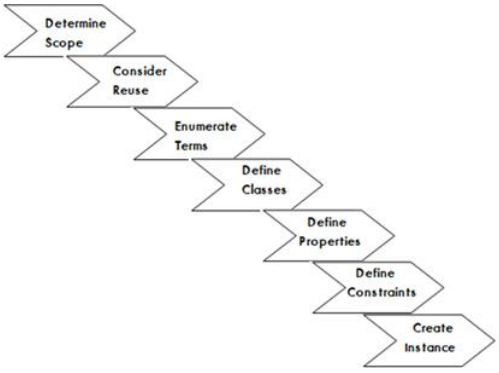

Figure 1 Process of developing ontology
Source: Noy and McGuinness (2001)

Researchers widely use ontology editors like Protégé, Hozo, and others. Protégé is a Java programming language. It may be run on a stand-alone computer or run on the network. There is a Graphical User Interface (GUI) for constructing ontologies and knowledge bases that enable multi-user activities and a tool for constructing an ontology domain and storing ontology in data files and relational databases. A handy data format that allows users to work on the class simultaneously as an example (Instance).

Semantic web

Semantic web- is a capability that allows computers to understand information in the same way that humans do. Automatic data interchange and processing is possible. This enables the computer to recognize the meaning of a word and the concepts about that word as defined by the developer. It is the manipulation of data to link data relationships at the level of the description of the data set (Metadata). There are two approaches to semantic web development: 1) the method of linking the information contained in the document and the data markup, and 2) how to add datasets to the web and share interpreted datasets. This is the most popular strategy today (Coyle, 2012). A semantic web contains the following components: 1) Uniform Resource Identifier 2) Extensive Markup Language (XML) 3) Record Description Framework (RDF) 4) RDF Schema (RDFS) 5) Web Ontology Language (OWL) 6) SPARQL 7) Rule Interchange Format (RIF) 8) Logic 9) Proof and 10) Trust. A semantic web allows users to build a network of information that is easy to find. It is also a networked document, and differentiation approaches are used to group people together meaningfully. The system includes a search that returns relevant information tailored to the user's demands. It also allows users to exchange information and knowledge because the ontology is described using the OWL language. OWL LITE, OWL DL, and OWL FULL are three different forms of OWL languages, with each type is suited to specific tasks.

Cash crops

Sabry (2023) defines the plant economy as plants to sell in the market or exported to other countries for profit. This contributes to the improvement of the country's economy. High demand for agricultural products can drive prices up, impacting the economy of both producing and exporting countries. Cultivating plants in large quantities allows other countries to consume them, boosting the economy. Money is crucial in elevating a country's standards, especially for developing nations. Britannica (2009) categorizes cash crops into six types: food plants, fodder plants, fiber plants, oil plants, ornamental plants, and industrial plants. Most globally cultivated crops are economically significant plants grown for sale in national and international markets. Babu & Gajanan (2021) summarize aspects of the cash crop, noting its role in fostering biodiversity, enhancing income-generating potential, and directly increasing household expenditure capacity. This is due to the increasing demand for labor, thus helping alleviate some household income constraint.

Processing of agricultural products

Srichayet (2019) defines food processing as "a method and technique used to convert raw resources into food for consumers." This process results in safe-to-eat food products and adds value to raw resources while developing new products. There are numerous ways of food processing ranging from chopping, blending, heat processing, cold processing, drying, fermentation, and so on". Processing agricultural products extends the shelf life of items like plants, vegetables, fruits, and meat, preventing deterioration before they reach the client and ensuring preservation. Alternatively, it may have changed from its original state, but the consumer accepts it and the food remains nutritious (Muninnoppamas, 2018). Agricultural goods storage and processing is the process of putting agricultural products through a series of steps in order to preserve them before they reach the market

and purchasers. Product condition, cleanliness, humidity, temperature, and other elements play a role in agricultural product preservation. We can observe that processing agricultural products offers numerous advantages, such as prolonging shelf life, helping develop new products to increase income, and advancing careers. It raises the value of agricultural products and alleviates issues such as overproduction. As a result, the usage of processed agricultural good, It will assist to avoid an overabundance of fresh fruit as well as increasing the price of produce to prevent it from falling. Agricultural products must meet certain standards to boost their value by being processed into food for consumer safety and approval, allowing the trade sector to flourish domestically and globally. This will also help farmers and entrepreneurs earn more money.

Community enterprises

Community enterprise is an economic activity related to the livelihoods and existence of people in the community. Therefore, Community enterprises are a group of activities with various formats, linking and supporting production and service activities. The Department of Agricultural Extension (2014) classifies methods of processing agricultural products into products of community enterprises, including production from resources and local wisdom, substitute production for external purchases, and processing agricultural products into goods. Community enterprises consider processing methods a core activity because they add value to agricultural products, which are the main livelihoods of farmers, and create employment within the community. In this regard, community enterprises vary according to different factors such as environmental conditions, resources, social structure, and local wisdom. We can categorize community enterprises based on their objectives and target markets. Basic community enterprises aim at local markets with production techniques that are simple enough, aiming to reduce expenses or increase income. Advanced community enterprises, on the other hand, develop from the grassroots with knowledge, experience, and technology. They operate systematically with modern and clearly defined goals for domestic and international markets, which are significant factors in supporting community enterprises to successfully achieve the government's policy objectives (Mettathamron et al., 2022). Key factors influencing the potential of driving community enterprises forward include capable leadership for efficient organizational management and members possessing knowledge, capabilities, skills, innovation, and technology at a proficient level.

Materials and methods

A semantic search system for processing local cash crops into community enterprise products is one of the research instruments. They are developing ontology using the Noy & McGuinness model. Its strengths lie in the clear sequential process, making management easier, and each step yielding visible results. However, we must exercise caution, as any errors in a step may force us to go back and rectify from the beginning, potentially consuming more time and budget. The initial step is crucial as subsequent steps will utilize the data. Therefore, it is essential to define clear boundaries and domains to cover the data used sufficiently. We do this by generating questions to find answers from the stored data, such as how many cash crops there are. What components do each plant species utilize? After confirming that all questions have been adequately answered, the data storage is summarized and ensured to be complete according to the requirements.

1) Preliminary study results of the products of community enterprises in Prachuap Khiri Khan Province are mostly processed agricultural products. This is because the main occupation is agriculture. After harvesting, if the quantity of produce is large or does not meet quality standards for sale, community enterprises will use their knowledge, expertise, tools, and simple production methods to process them into various products such as dried pineapple paste, dried mango paste, dried coconut, and so on. These community enterprises engage in agricultural product processing and distribution to diversify their product offerings and provide alternatives to customers. Additionally, they aim to

enhance competitiveness in the domestic market and elevate product quality to become a One Tambon One Product (OTOP) in the future. Regarding the scope of data conversion into the province's crops, all relevant data related to agricultural product processing. The defined boundaries for plant economic transformation methods include: 1) Drying methods 2) Sugar utilization methods 3) Cold utilization methods 4) Heat utilization methods 5) Use of additives and 6) Radiation usage as processes to extend the shelf life and increase the agricultural product value, resulting in a variety of products according to the transformation methods.

Cash crop information of Prachuap Khiri Khan Province for the year 2021-2022. The province of Prachuap Khiri Khan cultivates various types of plants, divided into garden crops, field crops, and forests. Economically important plants are categorized as food crops, animal feed crops, fiber crops, oil crops, ornamental plants, and industrial crops. Information on vegetable and fruit processing to increase the value of the Department of Agricultural Extension (2020) and information on processed products from economic plants of community enterprises in Prachuap Khiri Khan Province for the year 2021. This information will be used for analysis and further design.

2) Technology creation utilizes Protégé software. The language used to describe data with RDF (Resource Description Framework) schema is used to describe classes, instances, and relationships. Owl Lite is used to manage ordering and categorization using simple classification features. Answers are found through path traversal in taxonomy.

3) Evaluation of technology structure accuracy by experts involves collecting data through an evaluation form for technology structure. The questionnaire adopts a closed-ended format using a 5-level Rating Scale (Srisaat, 2002). The questionnaire employs a Rating Scale consisting of the highest level (5 points), high level (4 points), moderate level (3 points), low level (2 points), and the lowest level (1 point) (Thaweerat, 2006).

4) We evaluate search efficiency using standard measurement methods, such as Precision, Recall, and F-measure, to assess accuracy. The retrieved data are classified into four groups: True Positive (TP) - relevant data retrieved, False Positive (FP) - irrelevant data retrieved, False Negative (FN) - relevant data not retrieved, and True Negative (TN) - irrelevant data not retrieved (Miao, Duan, Zhang, & Jiao, 2009). Criteria for assessing quality range values. As shown in table 2. The retrieval ontology efficiency study used the accuracy, recall and f-measure values (Sornlertlamvanich, 2017).

4.1) The accuracy of a measurement represents how near it is to the actual or acceptable value. The percentage of correctly classified data instances overall data instances is known as accuracy. The following is the formula.

$$\text{Accuracy} = \frac{A}{A+B+C+D} \quad (1)$$

Given:
A = TruePositive (relevant and retrieved) or TP
B = FalsePositive (non-Relevant and retrieved) or FP
C = FalseNegative (non-Relevant and not retrieved) or FN
D = True Negative (Relevant and not retrieved) or TN

4.2) Precision is the percentage ratio of the number of relevant information retrieved to the total number of information retrieved in each retrieval. The formula is as follows:

$$\text{Precision} = \frac{\text{A}}{\text{A}+\text{B}} \quad (2)$$

Given:
A = TruePositive (relevant and retrieved) or TP
B = FalsePositive (non-Relevant and retrieved) or PF

4.3) Recall is the percentage ratio of the number of correct information items the system finds to the total number of relevant information items available. It measures the system's retrieval capability, indicating how much relevant information it retrieved out of the total relevant information available. The formula is as follows:

$$\text{Recall} = \frac{A}{A+C} \quad (3)$$

Given:
A = TruePositive (relevant and retrieved) or TP
C= FalseNegative (non-Relevant and not retrieved) or FN

4.4) F-Measure (F-Score) or F-measure is a metric that averages precision and recall by computing from the precision and recall values. It gives equal importance to both precision and recall. The formula is as follows:

$$F_1 = \frac{2pr}{p+r} \quad (4)$$

Given:
r is the calculated recall value.
p is the calculated precision value.

A questionnaire for evaluating the suitability of the ontology structure was created according to Likert rating scales with 5 levels (1 lowest, 2 low, 3 moderate, 4 high, and 5 highest scores). For the interpretation criteria to classify the meaning into score levels, calculate the width of each interval using the equation: (maximum score - minimum score) / number of intervals, or $(5-1)/5 = 0.8$ (Rueangpraphan, 2015). Summarize the score range criteria as shown in Table 1.

Table 1 The criteria for the range of suitability scores for ontology structures

Rating scale	Descriptive rating
4.21 – 5.00	Most suitable.
3.41 – 4.20	Very suitable.
2.61 – 3.40	Moderate suitable.
1.81 – 2.60	Low suitable.
1.00 – 1.80	Lowest suitable.

Table 2 Assessing the rating levels' values for quality of ontology

Values	Test quality
0.9 – 1.0	Very good
0.8 – 0.9	Good
0.7 – 0.8	Fair
0.6 – 0.7	Poor
0.5 – 0.6	Fail

Sources: Ekelund (2011)

Results

Ontology assessment evaluation results

1) Ontology design results. The process of designing and developing an ontology of processing local cash crops into community enterprise products is based on the concept of Noy and McGuinness.

Table 3 Description of classes

Class	Description
Processing products	The class represents economic agricultural processed goods that are transformed into commodities using a variety of processing techniques. Alternatively, goods that cater to consumer demands
Crop type	The class represents each type of cash crop, such as field crops, horticulture, and forestry, which can be further broken down; for instance, field crops can be further broken down into grains, sugar crops, oil crops, fiber crops, fodder crops, root crops, and other crops that stimulate the nervous system.
Crop use	The class represents both economic and consumer uses of economic crops. which has subcategories such as consumer goods large, medium, and small industries, etc.
Methods	The class represents processing methods used for cash crops, including drying, stirring sugar, applying compounds, etc.
Species	The class represents economic plant species various types of rice, cassava, oil palm, pineapple, coconut, rubber, and mango. By species categorization or according to specific species
Main taste	The class represents cash crop taste which can be tasted as sweet, sour, bitter, etc.
Benefit	The class represents economic crops with benefits such as being green, having chlorophyll having positive effects on health, etc.
Crops component	The class represents some parts of plants; for example, roots, flowers, fruits, and seeds~~,~~ are utilized.
Community enterprise	The class represents community enterprise. It is organized by the product production and service categories of community groups.
Economic crops	The class represents crops that support local economies, consisting of cassava, rubber, sugar cane, mango, pineapple, coconut, and pineapple.

Table 4 Class relationships in an ontology for processing cash crops

Class Relationship	Subject Class	Object Class
has	Economic crops	Crops Type
has	Economic crops)	Benefit
has	Economic crops	Crop use
has	Economic crops	Methods
has	Economic crops	Species
has	Species	Main Taste
has	Species	Crops Component
is	Methods	Processing products
is	Crops component	Processing products
is	Species	Processing products
has	Processing products	Community enterprise
is	Crops Type	Economic crops
is	Benefit	Economic crops
is	Crop use	Economic crops
is	Methods	Economic crops
is	Species	Economic crops
is	Main Taste	Species
is	Crops component	Species
is	Processing products	Methods
is	Processing products	Crops component
is	Processing products	Species
is	Community enterprise	Processing products

2) Ontology of processing local cash crops into community enterprise products created by program Protégé v. 4.3

3) Semantic searching application for transforming processing of local cash crops into products community enterprise.

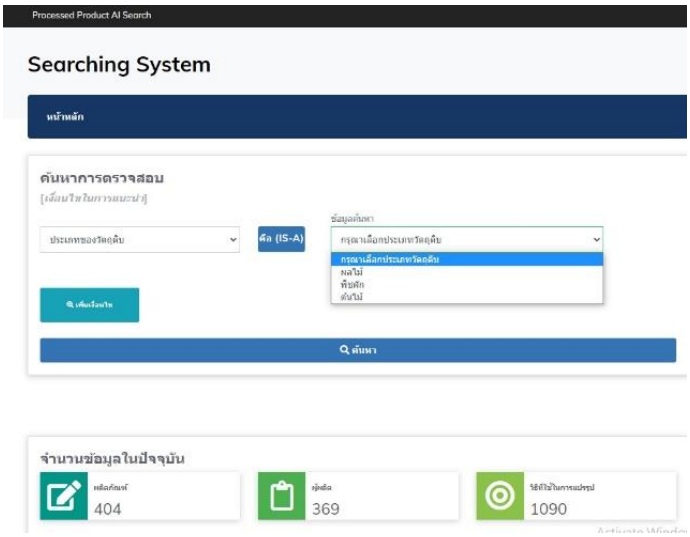

Figure 2 shows the conditions of the search system as seen on a screen

Figure 2 displays the interface used as a web application. The search area is one of the screen's two primary parts. Users may quickly and simply specify the necessary criteria thanks to the user interface's thoughtful design. In order for the system to analyze the conditions, show the search results, and show the total quantity of information that is currently stored.

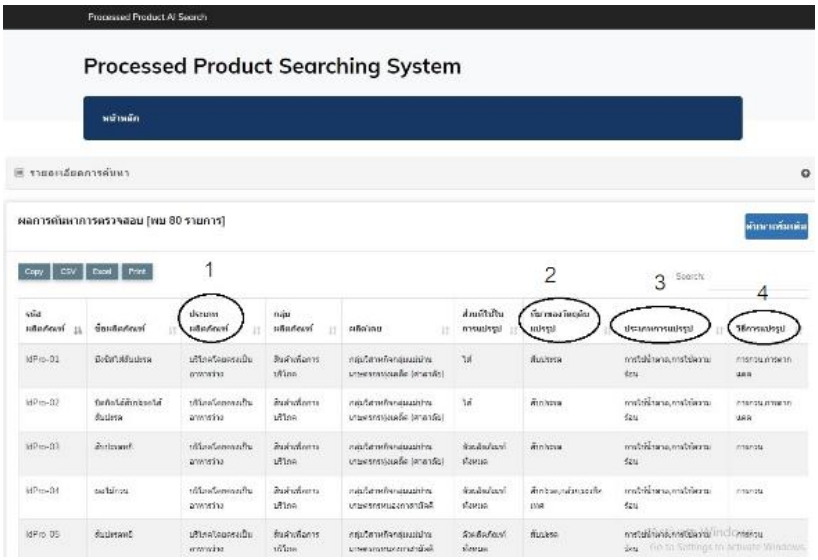

Figure 3 Shows results from searching on a screen.

Figure 3 is a sample of a search with four conditions, the first of which is Product type. "Direct consumption as a snack," "processed raw material," "pineapple," "type of processing," "using sugar, using heat," and "stirring" are the remaining conditions. The processing algorithm then discovered 80 entries containing comprehensive product information. The user may copy, export to CSV or Excel, and print these search results in whichever format they select.

4) Ontology assessment evaluation results

4.1) Assessment of an ontology structure by experts. The evaluation results found that the structural suitability of the ontology was at the highest level, As shown in Table 5.

Table 5 The results of the expert's evaluation of the ontologies' structure

No.	Assessment Items	Mean	Std.	meaning
1	The ontology classification of classes is suitable.	4.33	0.58	most suitable
2	The ontology's classes are thorough enough to offer knowledge about cash crop processing.	4.67	0.58	most suitable
3	The ontology's classes have appropriate names.	5.00	0.00	most suitable
4	Ontology term names are descriptive and simple for understanding.	5.00	0.00	most suitable
5	The ontology's classes are placed in a proper order.	4.33	0.58	most suitable
6	Class attributes or properties being able to describe class properties	4.00	0.00	very suitable
7	In the ontology, relationships between the classes are proper.	4.67	0.58	most suitable

No.	Assessment Items	Mean	Std.	meaning
8	Class relationships in an ontology with a proper name that can describe its understood meaning.	5.00	0.00	most suitable
9	The name of data type properties matches the description.	4.67	0.58	most suitable
10	For the purposes of its implementation, the ontology has appropriate content.	4.67	0.58	most suitable
	Average overall	**4.60**	**0.51**	**most suitable**

Table 5 shows that the assessment results of the suitability of the technology structure by three experts found that the average score was 4.60 with a standard deviation (S.D.) of 0.51. Considering the evaluation criteria from Table 2, it can be concluded that the technology structure is highly suitable. Out of the total of 10 assessment items, the top three most suitable assessments, as perceived by the experts, are as follows: 1) Appropriately named classes within the technology structure. 2) Clearly understandable class naming within the technology. and 3) Appropriately named relationships between classes within the technology and understandable meanings conveyed. This indicates that the technology structure is highly suitable and effectively meets the criteria set forth by the experts.

4.2) Results of the study on the effectiveness of ontology retrieval. A total of 1,863 items were measured using performance measures to show the outcomes of the overall amount of data in the database (Baeza & Ribeiro, 2011). The results showed that the accuracy was 0.89 (89%), the precision was 0.95 (95%), the recall was 0.90 (90%) and the F_1 was 0.92 (92%). The evaluation's findings were of excellent value. Using the database for processing local cash crops, Ontology users can access information about plants by linking to ontology knowledge bases using OWL (Web Ontology Language) to communicate between computer languages using OAM (Ontology Application Management) and search results satisfy the needs of users.

$$\text{Accuracy} = \frac{TP+TN}{TP+TN+FP+FN} = \frac{1500+160}{1500+160+85+118} = 0.89$$

The accuracy value comprises the number of data points relevant and correctly retrieved (TruePositive: TP), which is 1500 items; the number of relevant data points not retrieved (TrueNegative : TN), which is 160 items, the number of irrelevant data points retrieved (FalsePositive : FP) which is 85 items, and the number of relevant data points not retrieved (FalseNegative : FN) which is 118 items. The calculated result, according to the formula, is 0.89 or 89%.

$$\text{Precision} = \frac{TP}{TP+FP} = \frac{1500}{1500+85} = 0.95$$

The precision value comprises the number of data points relevant and correctly retrieved (TruePositive: TP), which is 1500 items, and the number of irrelevant data points retrieved (FalsePositive : FP), which is 85 items. The calculated result, according to the formula, is 0.95 or 95%.

$$\text{Recall} = \frac{TP}{TP+TN} = \frac{1500}{1500+160} = 0.90$$

The recall value comprises the number of data points relevant and correctly retrieved (TruePositive: TP), which is 1500 items, and the number of relevant data points not retrieved (TrueNegative : TN), which is 160 items. The calculated result, according to the formula, is 0.90 or 90%.

$$F_1 = \frac{2\,x\,(P\,x\,R)}{(P+R)} = \frac{2\,x\,(0.95\,x\,0.90)}{(0.95+0.90)} = 0.92$$

The F1 score combines the precision value (P), which measures the accuracy of the data, and the recall value (R), which is the ratio of correctly retrieved data to all relevant data. The calculated result according, to the formula, is 0.92 or 92%

Experts evaluated the ontology design and found that the structure is most suitable. The top three assessment items out of a total of 10 are÷ appropriate naming of classes, relationships between classes, and clear understanding. Developing a meaning-oriented search system using the concepts of Noy and McGuinness, creating an ontology with Protégé v. 4.3 software, and developing a user-friendly web application for quick and convenient usage. The performance evaluation results of the data retrieval technology are as follows: Accuracy 0.89 (89%), Precision÷0.95 (95%), Recall 0.90 (90%), and F1 0.92 (92%).

Discussion

The development of a semantic search system for local economic plant processing into community enterprise products has resulted in the highest level of suitability for the technology structure. When applied to develop a semantic search system for local economic plant processing into community enterprise products, the evaluation performance of the developed technology yields a precision (P) value of 95%, a recall (R) value of 90%, and an overall F-measure efficiency of 92%. The researchers believe that the appropriate design of technology classes and class relationships, along with clear and understandable nomenclature, aids user comprehension. Designing classes that encompass accurate knowledge of economic plant processing for practical use responds well to user needs and contributes to overall retrieval efficiency at a good to excellent level. Additionally, this study demonstrates the organization of abstract knowledge related to local economic plant processing into a specific and clear domain structure. The classification and description of entities contribute to the creation of a coherent vocabulary system. Furthermore, the dynamic presentation of contextual knowledge facilitates the adaptation of information scope according to objectives and the evolution of knowledge boundaries. To use the local agricultural plant processing knowledge system, you can conveniently go through the website. The system administrator is responsible for maintaining and ensuring the accuracy of the knowledge base. Users can search for desired information by typing keywords into the search box or searching based on conditions such as economic crops (e.g., rice, pineapple, coconut), processing methods (e.g., drying, sugar syrup), and so on. The search results will display a list of data that matches the condition specified by the user, providing accurate and reliable information. This supports community enterprises in utilizing knowledge to efficiently process agricultural products into a diverse range of products. The study results and development of an agricultural product processing knowledge base system are utilized as a strategy to promote the use of technology and innovation for agricultural product processing into community enterprise products. This helps to enhance competitiveness by increasing the value and elevating the value of agricultural products, which is in line with the government's policy goals for agricultural sustainability in Prachuap Khiri Khan Province. This province is an agricultural area with significant production of various important economic crops in the country

Designing an ontology with suitable class names, relationships, and meanings assists in understanding. The necessary cash agriculture processing knowledge to put it into operation is handled by collecting knowledge. Assist in meeting user demands while also preserving overall good retrieval performance in accordance with Kanawarong & Chamnongsri's (2016) study, established and constructed an ontology of cultural tourism sites with a very excellent ontology structure. Furthermore, the total data retrieval performance was excellent (96%).

Angkurnak (2014) established and constructed an ontology for herbal medicines in primary health care that can be used and has successful retrieval. Thai food ontology was conceived and developed by Saengsuphawat (2014) to enable raw material compensation. Overall retrieval efficiency was high (90%), which can be utilized to compensate for raw material shortages. Pinthongpan (2014) used ontology to create a knowledge base structure for ecotourism that has a high overall retrieval efficiency (100%). It's possible to use it as a keyword. Chansiriwat and Polsawat (2018) designed and created a structured health tourism ontology in Thailand to locate and encourage the usage of semantic web apps that improve browsing efficiency. The technology's suitability is excellent.

Sitthisarn et al. (2018) designed and developed an ontology for the arts, culture, and local wisdom of Phatthalung Province. The ontology's appropriateness is at a high level, following the ideas and principles of knowledge engineering (Noy & McGuinness, 2004), and the overall efficiency of data retrieval is excellent (95%). Bangkhomnet and Payakgaek (2019) created an ontology for the semantic discovery of longan illness management that has a high overall data retrieval efficiency (93.57%). It may also be utilized as a model for a long-term disease specialist system. Chariyamakarn et al. (2016) investigated an ontology support system for integrated farming aimed at achieving a sufficiency economy idea with high overall data retrieval efficiency (94.75%). Individual farmers utilize technology as a knowledge source. Farming should be planned in accordance with the environment and needs in order to attain resource self-sufficiency and sustainability. Chamnongsri (2020) created an ontology for herbal medicine based on ancient writings. The appropriateness of the ontology structure is good, and the overall efficiency of data retrieval was excellent (98%).

Conclusion and recommendations

The results of an ontology design for a semantic search for cash crop processing were derived from the study and development of an ontology based on the concept of Noy and McGuinness. Experts evaluated the structure's appropriateness and that the ontology was at a good level (mean = 4.60, S.D. = 0.51). Web Ontology Language was used to link the economic crop transformation database to the ontology knowledge base. The Ontology Application Management application facilitates communication between computer languages. The precision (P) mean was 0.95, the recall (R) mean was 0.90, and the F-measure (F1) mean was 0.92 or accounted for 92% in the evaluation of the retrieval efficiency of ontology for semantic search for cash crop alterations. The ontology is excellent, capable of searching for useful information while also meeting the needs of users. According to the results of this study, knowledge management on semantic cash crop processing intends to bring the body of information in a certain field (Domain Knowledge) to use in an ontology. It can provide community enterprises with information on the processing of cash crops in a format that is automatically processed through the website. If community businesses are successful, apply the findings to the creation of new community enterprise products, hence increasing product variety.

Limitations and recommendations for future research

Processed agricultural product information will focus only on the types of crops of economic significance to align with the scope of the study. This results in less processed product data collected than the total processed products available from community enterprise agricultural produce. For future research, it's advisable to expand the scope of data to include all types of agricultural produce grown in the province area to ensure a more diverse range of processed agricultural products.

There are several important suggestions for future research, including: 1) Expanding the domain scope to cover other types of plants that can be processed into products. 2) Presenting interesting data in formats beyond just text. And 3) Designing a knowledge base that can link documents and markup data and enable targeted searches beyond just using keywords.

Acknowledgement

Funding was also received from the Thailand Science Research and Innovation (TSRI) and Fundamental Fund of Rajamangala University of Technology Rattanakosin with funding under project code 1510491/ Research Project "The Development of Ontologies for Semantic Search about the Processing of Economic Crops of Prachuapkhirikhan Province" (2021).

References

Angkurnak, T. (2014). *Development of ontology for finding herbal therapies in primary health care* (pp. 376-383). In Proceedings of the 1st national academic conference about rattanakosin art and culture fair to develop local: 1 decade faculty of fine and applied arts 4 decades art-music-dancing. Bangkok, Thailand: Suan Sunandha Rajabhat University.

Baeza, Y. R., & Ribeiro, N. B. (2011). *Modern information retrieval* (2nd eds.). New York, US: Addison-Wesley.

Babu, S., & Gajanan, S. (2021). *Food security, poverty and nutrition policy analysis: Statistical methods and applications*. Cambridge, Massachusetts, United States: Academic Press.

Bala, B. K. (2020). *Agro-product processing technology.principles and practice*. New York, US: CRC Press.

Bangkhomned, W., & Payakpate, J. (2019). The development of ontologies of semantic search technology for disease management in longan. *Phranakhon Rajabhat Research Journal. Science and Technology*, 14, 93-108.

Britannica, T. (2009, February 20). *Crop | definition, types, & facts*. Encyclopedia Britannica. Retrieved from https://www.britannica.com/topic/crop-agriculture

Chamnongsri, N. (2020). *Ontology development for Thai herbal medicine recorded in ancient documents*. (Research reports). Retrieved from http://sutir.sut.ac.th

Chansiriwat, T., & Polsawat, A. (2018). The development of ontology for health tourism in Thailand. *FEU Academic Review*, 12, 113-129.

Chariyamakarn, W., Boonbrahm, P., Supnithi, T., & Ruangrajitpakorn, T. (2016). An ontology-based supporting system for integrated farming towards a concept of the sufficiency economy. *KKU Science Journal*, 44, 691-704.

Coyle, K. (2012). Understanding the semantic web: Bibliographic data and metadata. *Library Technology Reports, 48*, 10-14.

Department of Agricultural Extension, Ministry of Agriculture and Cooperatives. (2014). *Academic document No. 4/2014 business operations community enterprises to support entry into AEC*. Bangkok, Thailand: Agricultural Cooperatives Association of Thailand.

Department of Agricultural Extension, Ministry of Agriculture and Cooperatives. (2020). *Processing vegetables and fruits to increase their value*. Bangkok, Thailand: Printing House Group, Bureau of Technology Transfer Development.

Department of Trade Negotiations, Ministry of Commerce. (2022). *The report summarizes the situation of agricultural, agro-processing, and industrial product exports under Free Trade Agreements (FTAs) in the year 2021*.Bangkok, Thailand: Department of Trade Negotiations, Ministry of Commerce.

Economic Analysis Center (ttb). (2022). *Estimated farm income from 5 economic crops in 2022, the highest growth in 5 years*. Retrieved from http://www.moneyandbanking.co.th/article/news/ttb-analytics-farmer-24032022

Effingham, N. (2013). *An introduction to ontology*. London, UK: Polity Press.

Ekelund, S. (2011, January). *ROC curves – what are they and how are they used?* Scientific publications and daily practice surrounding acute care testing | acutecaretesting.org. Retrieved from https://acutecaretesting.org/en/articles/roc-curves-what-are-they-and-how-are-they-used

Gomez-Perez, A., & Richard-Benjamins, V. (1999). Applications of ontologies and problem-solving methods. *AI-Magazine, 20*, 119-122.

Mettathamrong, J., Promket, C., & Vichasilp, K. (2022). How community enterprises of Thailand managed to become Thailand 4.0*. *International Journal of Operations and Quantitative Management, 28*(1), 121-133.

Kanawarong, W. & Chamnongsri, N. (2016). Ontology design of a cultural tourism attraction. *Proceeding of national conference held in School of Science University of Phayao*, 21-27.

Khatsombun, H. (2017). knowledge of community self management based on the guidelines of the sufficiency economy, a case study "NOEN KLANG Community, Moo 2, KROK PHRA District, Nakhon Sawan Province". *Journal of MCU Social Science Review, 6*, 26-37.

Miao, D., Duan, Q., Zhang, H., & Jiao, N. (2009). Rough set based hybrid algorithm for text classification. *Expert Systems with Applications, 36*, 9168-9174.

Muninnoppamas, W. (2018). *Principles of food preservation and processing*. Yala, Thailand: Center for academic promotion of rajabhat university.

Noy, N. F., & McGuinness, D. L. (2001). *Ontology development 101: A guide to creating your first ontology*. Stanford Knowledge Systems Laboratory Technical Report KSL-01-05. CA, USA: Stanforn University.

Noy, N. F., & McGuinness, D. L. (2004). Ontology evolution: Not the same as schema evolution. *Knowledge and Information Systems, 6*(4), 428-440.

Office of Agricultural Economics, Ministry of Agriculture and Cooperatives. (2022). Agricultural. *statistics of Thailand 2021*. Bangkok, Thailand: Office of Agricultural Economics, Ministry of Agriculture and Cooperatives.

Office of the Permanent Secretary for Ministry of Agriculture and Cooperatives. (2022). *Basic data report of Prachuap Khiri Khan province for the year 2022*. Bangkok, Thailand: Office of the Permanent Secretary for Ministry of Agriculture and Cooperatives.

Pinthongpan, T. (2014). *The application of ontology for ecotiurism information searching system in Lower-Southern Thailand*. (Master thesis). Songkhla, Thailand: Prince of Songkla University.

Pornpraipetch, C. (2019). Development of banana processing products to create added value and creditability for the banana processing community enterprise, Nikhom Songkhro Sub-district, Mueang Udon Thani District. *Journal of Humanities and Social Sciences Nakhon Phanom University*, 9, 1-9.

Prakancharoen, S. (2014). *An alternative ontology of developing a knowledge base Ontologies: Alternatives to Developing Content-Oriented Knowledge Bases*. Bangkok, Thailand: Faculty of Applied Science. King Mongkut's University of Technology North Bangkok.

Rueangpraphan, C. (2015). *Basic statistics*. (2nd eds.). Khon Kaen: Thailand: Khon Kaen University.

Sabry, F. (2023). *Cash crop: Cultivating a world of stories, unveiling the secrets of cash crops*. Retrieved from https://www.perlego.com/book/4314203

Saengsuphawat, P. (2014). *The development of a Thai Food recipe ontology for supporting ingredient substitution*. (Master thesis). Nakhon Ratchasima, Thailand: Suranaree University of Technology.

Sitthisarn, S., Pukkhem, N., & Naco, A. (2018). Development of ontology in arts and culture and local wisdom of Phatthalung Province. *Thaksin University Journal, 21*, 259-266.

Sornlertlamvanich, V. (2017). *Information retrieval*. Bangkok, Thailand: Thammasat university press.

Srichayet, P. (2019). Principles of food processing to extend product's shelf life. *Food Journal Journal of the Institute of Food Research and Product Development Kasetsart University*, 49, 12-19.

Srisaat, B. (2002). *Preliminary research* (7th eds.). Bangkok, Thailand: Suwiriyasan.

Swartout, B., Patil, R., Knight, K., Russ, T. (1997). Toward distributed use of large-scale ontologies. *Ontological Engineering. AAAI-97, Spring Symposium Series*, 138-148.

Thaweerat, P. (2006). R*esearch methods in behavioral sciences and social sciences* (10th eds.). Bangkok, Thailand: Education and psychological test Bureau of srinakharinwirot university.
Thongmeethip, K. (2021). Agricultural development in Thailand in terms of community development and quality of life. *PSDS Journal of Development Studies, 4*, 132-162.