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Development of an Ontology-Based Recommendation System for Agricultural Product E-Commerce on the WooCommerce Platform: A case study of Wang Somza Local Enterprise Group in Phitsanulok Province

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Abstract

This study examines the use of an ontology-based recommendation system for agricultural product sales on the WooCommerce platform, specifically designed for the Wang Somza Local Enterprise Group in Phitsanulok Province. The objective is to improve the online shopping experience by providing personalized product recommendations, efficient order management, and better customer service.

The ontology model is structured to organize and connect critical e-commerce data elements such as orders, customers, products, and reviews. It consists of three layers: the first layer covers basic e-commerce concepts; the second focuses on online sales-specific details; and the third categorizes agricultural products like oilseeds, herbs, and vegetables. This structure aids in data analysis, more accurate recommendations, and effective product management. Semantic Web Rule Language (SWRL) is used to create rules that infer valuable information from the ontology, enabling the system to offer personalized recommendations based on customer behavior, preferences, and past interactions. The algorithm combines database management (DBMS) with SPARQL queries to extract relevant data, search the database, and enhance recommendations using the ontology.

Performance evaluation results indicate that the system is effective in retrieving relevant information, with high precision (0.90) and recall (0.85). Despite this, certain areas, such as customer support and order management, received lower satisfaction scores,

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indicating room for improvement in these aspects. Overall, the system's average satisfaction score ($\bar{X}$ = 4.24, SD = 0.60) reflects high satisfaction, with the system showing clear benefits in product discovery, personalized recommendations, and customer experience, while also identifying areas for further enhancement.

Keywords: Agricultural product, Ontology-based recommendation system, WooCommerce platform, Wang Somza Local Enterprise Group

Introduction

E-commerce has become a crucial element of business activities across numerous industries. Advances in information and communication technology have not only transformed consumer behavior but also emerged as a key enabler for market access to agricultural products. This shift is especially evident in the digital age, where the popularity of online shopping continues to rise (Li & Zhang, 2024). Utilizing online platforms to develop web applications for product sales is a strategic approach to enhancing business performance by increasing sales and expanding customer reach. Digital platforms also streamline transactions and reduce operational costs (Ballerini, Herhausen & Ferraris, 2023) enabling small and medium-sized enterprises to compete more effectively in highly competitive markets.

The agricultural product industry in the lower northern region of Thailand plays an increasingly important role in driving economic growth. However, most local enterprise groups that provide agricultural products still rely on traditional direct-sale methods, which are insufficient to meet the demands of modern consumers and businesses. These groups require efficient online systems that offer real-time order processing, immediate feedback, and seamless delivery updates through digital channels (Kaul & Khurana, 2022). However, some e-commerce platforms, while providing easy-to-use services for downloading and setup, lack a recommendation engine to link product catalogs with related items. This limitation results in inefficient promotion of products, hindering consumer decision-making.

The Wang Somgza Community in Phitsanulok Province is key to agriculture and community development, producing unique agricultural products like fruits, vegetables, and processed goods. It promotes these products through modern technology, including online sales and participation in trade events. The community also developed OTOP tourism programs to showcase its local culture, lifestyle, religion, and natural resources, offering a diverse tourism experience by selling local products and connecting with nearby villages (Chomphoopanya & Rojanatrakul, 2023). However, despite these efforts, the community faces several challenges. A major problem is the reliance on traditional sales methods, which hinders the full potential of its e-commerce platform. Additionally, the platform lacks key digital features such as a recommendation engine, which limits its ability to effectively link related products and personalize the shopping experience. Other challenges include limited digital marketing expertise, insufficient data analytics for consumer behavior insights, and inconsistent product presentation online. These issues reduce customer engagement, limit sales growth, and make it difficult to meet the expectations of modern, tech-savvy consumers. Implementing a recommendation system and strengthening digital capabilities

would significantly improve user experience, increase sales, and support the community's long-term development goals.

An ontology-based recommendation system can benefit agricultural product businesses by boosting sales, personalizing the customer experience, enhancing customer loyalty, and enabling more precise marketing (Guia et al., 2019). It helps streamline inventory management, improve conversion rates, and provides a competitive edge. By analyzing customer data, businesses can make informed decisions that drive growth and enhance customer satisfaction. The system offers personalized, context-driven product suggestions, improves recommendation accuracy, and adapts to new products as the business expands. When integrated into e-commerce platforms like WooCommerce—a popular extension of WordPress—this system helps farmers manage various aspects of their business efficiently. It assists in creating professional websites and enables fast, secure transactions, making it easier for customers to complete payments. Additionally, using social media tools like Facebook and Instagram for marketing can further boost customer engagement.

Ontology-based recommendation systems improve the accuracy of product recommendations by creating models that link data and user behaviors effectively. By suggesting new products or services that match user preferences, the system enhances the overall user experience and supports business growth (Gharibi et al., 2024; Flachs et al., 2024). This combination leads to increased sales and more relevant, personalized interactions with customers.

This paper introduces an enhanced Ontology-Based Recommendation System for the WooCommerce platform, tailored for the Wang Somza Local Enterprise Group in Phitsanulok Province. The system is designed to improve the traditional WooCommerce platform by offering semantic recommendations to consumers, enabling local businesses to provide more personalized and relevant product suggestions. Consequently, this recommendation system is anticipated to boost the profitability of local enterprises by driving higher sales and improving customer satisfaction. By utilizing ontology-based models, the system can deliver context-aware product suggestions, creating a more personalized shopping experience for consumers while enhancing the overall effectiveness of the platform.

Materials and Methods

1. Analysis of Abilities and Extensions for E-Commerce in WordPress

The ideal e-commerce extension for WordPress depends on the size, goals, and specific needs of businesses. Businesses should select the best platform for their operations. The criteria for selecting a suitable platform for use in business organizations can be assessed comparatively based on factors such as Target Audience, Payment Gateway

Integration, Supported Product Types, Customization, User-Friendliness, Pricing, and Best Suited. To show the best e-commerce store platform extensions in WordPress, alternative extensions are compared, and the results are shown in Table 1.

Table 1: Comparison of E-Commerce Platform Extensions for WordPress (WooCommerce, n.d.; Shopify, n.d.; Easy Digital Downloads, n.d.; WP Easy Cart, n.d.)

Feature	WooCommerce	Shopify	Easy Digital Downloads	WP Easy Cart
Target Audience	General e-commerce businesses	Full e-commerce platform	Digital product sellers	General e-commerce businesses
Payment Gateway Integration	Wide range of options	Built-in integration	Limited options	Moderate options
Supported Product Types	Physical, Digital	Physical, Digital	Digital only	Physical, Digital
Customization Level	Highly customizable	Limited customization	Limited customization	Moderate customization
User-Friendliness	Easy to use	Easy to use	Easy to use	Easy to use
Pricing Structure	Free, with paid add-ons	Subscription-based	Free, with paid add-ons	Free, with paid add-ons
Best Suited For	Highly customizable stores	Large-scale businesses	Sellers of digital goods	Small to medium-sized stores

From Table 1, the comparison of WooCommerce, Shopify, Easy Digital Downloads, and WP Easy Cart reveals the unique strengths of each platform based on the specific needs of businesses. WooCommerce stands out for its high level of customization, support for both physical and digital products, and a wide range of payment gateway options. This makes it ideal for businesses like the Wang Somgza Community, which requires flexibility and customization, and can benefit from the addition of a recommendation engine to enhance the shopping experience and drive sales. Shopify, while easy to use with built-in features, is better suited for large businesses that prioritize convenience over extensive customization, which may not meet the Wang Somgza Community's requirements. Easy Digital

Downloads and WP Easy Cart are more limited in terms of product types and customization options, making them less appropriate for the community's needs. Overall, WooCommerce is the best choice for the Wang Somgza Community, offering flexibility, payment gateway options, and features that can improve the shopping experience and increase sales.

2. Knowledge based-Ontology creation for Agricultural Product Electronic Commerce

The WooCommerce database is created using the MySQL database management system and utilizes SQL commands for retrieving data from tables. WooCommerce adds approximately 20 custom tables to the core WordPress database structure to support the full functionality of the eCommerce system, including product management, order processing, shipping, and payments (WebAppick, 2022).

The WooCommerce database can be transformed into a semantic knowledge base through the use of ontology. The process starts by identifying key data tables, such as product details, product types, customer data, promotions, delivery statuses, and customer reviews, which will be converted into classes (uses simple class names) within the ontology. Each class will represent a distinct group of related information.

Additionally, database fields that are linked to other tables will be turned into attributes in the ontology, enriching the details of each class and establishing deeper connections between data points.

Moreover, primary and foreign keys from the database will be utilized to define the types of relationships between the classes in the ontology.

- Data Tables⟶Classes in Ontology (1)
- Database Fields ⟶Attributes in Ontology (2)
- Primary Key+Foreign Key⟶Relationships in Ontology (3)

By applying equations 1–3 to the data tables, such as product details, product types, customer data, promotions, delivery statuses, and customer reviews, the transformation process can be explained in three main steps. The created Knowledge-based Ontology for Agricultural Product Electronic Commerce using Protégé software is shown in Figure 1.

1.Tables ⟶ Classes:

ProductDetails ⟶ Product

ProductTypes ⟶ ProductType

CustomerData ⟶ Customer

OrderDetail ⟶ Order

Promotions ⟶ Promotion

DeliveryStatus ⟶ DeliveryStatus

CustomerReviews ⟶ Review

2.Fields ⟶ Attributes:

ProductName ⟶ P_name (Product)

ProductPrice ⟶ P_price (Product)

CustomerEmail ⟶ C_email (Customer)

ReviewRating ⟶ R_rating (Review)

PromotionDiscount ⟶ PD_discount (Promotion)

3. Primary Key/Foreign Key ⟶ Relationships:

PK(Customer) + FK(Order) ⟶ CustomerOrder

PK(Product) + FK(Order) ⟶ ProductOrder

PK(Customer) + FK(Review) ⟶ CustomerReview

PK(Promotion) + FK(Product) ⟶ PromotionProduct

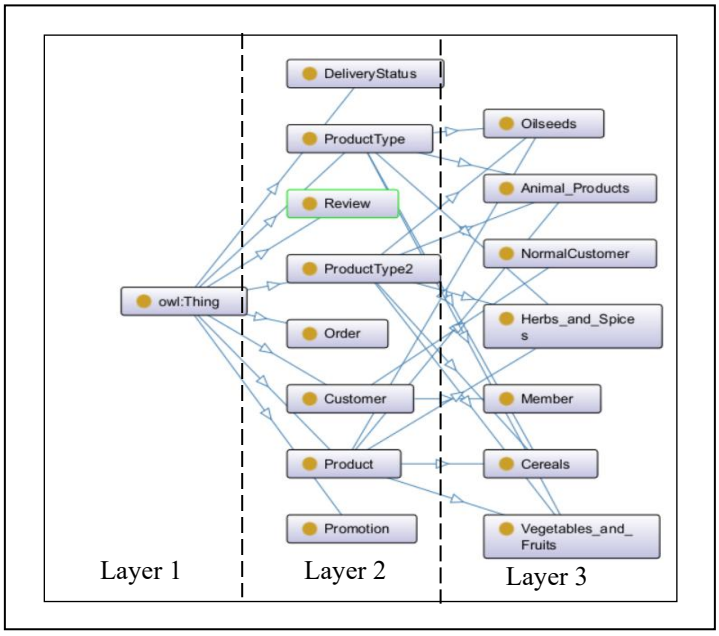

Figure 1 : created Knowledge-based Ontology for Agricultural Product Electronic Commerce

From Figure 1, the ontology for online agricultural product sales is a system for organizing and linking various data in an e-commerce environment, illustrating the relationships between key components related to agricultural product sales on an online platform. This model provides an overview of the different processes involved, such as order placement, product delivery, and reviews, by consolidating these pieces of information in an organized manner. It can be used for analysis, product recommendations, and efficient order management.

The model is divided into three layers, comprising a total of 16 classes. The first layer introduces fundamental concepts or classes. These serve as the basic structure for e-commerce operations.

The second layer delves into details specific to online product sales, such as Order, Customer, Product, and Promotion. This layer helps categorize and connect various data elements appropriately. This allows the system to track the status of products or orders and process data to enhance the customer experience.

The final layer defines specific categories of agricultural products, such as Oilseeds, Animal Products, Herbs and Spices, Cereals, and Vegetables and Fruits, which are sold on the platform. It also distinguishes between customer types, such as Normal Customer and Member, to differentiate the benefits each group receives.

3. Semantic Rule Creation and Data Retrieval Using SWRL and SPARQL in Agricultural Product Ontology

The five SWRL rules were created based on the opinions of 2 5 customers with member status and 5 entrepreneurs/employees from the Wang Somza Local Enterprise Group in Phitsanulok Province. The participants were selected using purposive sampling based on specific criteria, which included:

Customer Member Status: Participants had to be members of the Wang Somza Local Enterprise Group to ensure they had experience with the services and products offered by the group.

Entrepreneur/Employee Status: Entrepreneurs or employees actively involved in the group were selected to provide insights into business operations and product feedback.

This selection process ensured that the participants provided meaningful and relevant insights for the development of SWRL rules in the agricultural product system.

The questions were set to create five SWRL rules, as shown in Table 2.

Table 2 : Creation of Semantic Rules for Inference in the Agricultural Product Ontology Based on the Sample's Questions

Sample's Questions	SWRL Rule	SPARQL Query

1. What products are customers interested in based on their gender and age?	Customer(?c) ∧ hasGender(?c, ?g) ∧ hasAge(?c, ?a) ∧ Product(?p) ∧ interestedIn(?c, ?p) ⟶ ProductInterest(?c, ?p)	SELECT ?customer ?gender ?age ?product
		WHERE {
		?customer a ex:Customer ;
		ex:hasGender ?gender ;
		ex:hasAge ?age ;
		ex:interestedIn ?product .
		?product a ex:Product .
		}

Table 2 (cont.)

Sample's Questions	SWRL Rule	SPARQL Query

2. What is the list of items that are of the same type as those the customer is interested in?	Customer(?c) ∧ interestedIn(?c, ?p1) ∧ hasType(?p1, ?type) ∧ Product(?p2) ∧ hasType(?p2, ?type) ∧ differentFrom(?p1, ?p2) ⟶ SimilarProduct(?c, ?p2)	SELECT DISTINCT ?customer ?baseProduct ?similarProduct
		WHERE {
		?customer a ex:Customer ;
		ex:interestedIn ?baseProduct .
		?baseProduct a ex:Product ;
		ex:hasType ?type .
		?similarProduct a ex:Product ;
		ex:hasType ?type .
		FILTER(?similarProduct != ?baseProduct)
		}

3. What is the list of products that have received the highest star ratings or the most popular views?	Product(?p) ∧ hasRating(?p, ?r) ∧ isHighestRating(?r) ⟶ HighRatedProduct(?p)
	Product(?p) ∧ hasViews(?p, ?v) ∧ isMostPopularView(?v) ⟶ PopularProduct(?p)
		SELECT DISTINCT ?product
		WHERE {
		?product ex:hasRating ?rating .
		?rating ex:isHighestRating true .
		UNION {
		?product ex:hasViews ?views .
		?views ex:isMostPopularView true .
		}
		}

4. What is the list of herbal product and its therapeutic properties?	HerbalProduct(?p1) ∧ hasProperty(?p1, ?prop) ∧ hasIngredient(?p1, ?ing) ∧ HerbalProduct(?p2) ∧ hasProperty(?p2, ?prop) ∧ hasIngredient(?p2, ?ing) ∧ differentFrom(?p1, ?p2) ⟶ SimilarHerbalProduct(?p1, ?p2)	SELECT DISTINCT ?product1 ?product2
		WHERE {
		?product1 a ex:HerbalProduct ;
		ex:hasProperty ?property ;
		ex:hasIngredient ?ingredient .
		?product2 a ex:HerbalProduct ;
		ex:hasProperty ?property ;
		ex:hasIngredient ?ingredient .
		FILTER(?product1 != ?product2)
		}

5. What types of products price promotions and have the highest total sales?	Product(?p) ∧ hasPromotion(?p, ?promo) ∧ isReducedPricePromotion(?promo) ∧ totalSales(?p, ?sales) ∧ isHighestSales(?sales) ⟶ HighSalesReducedPriceProduct(?p)	SELECT DISTINCT ?product
		WHERE {
		?product ex:hasPromotion ?promo .
		?promo ex:isReducedPricePromotion true .
		?product ex:totalSales ?sales .
		?sales ex:isHighestSales true .
		}

From Table 2, the development of Semantic Rules using SWRL (Semantic Web Rule Language) is illustrated. SWRL is designed to create rules in the context of the web and linked data, specifically for inferring information from the agricultural product ontology. Each question in the table is associated with customer behavior, product ordering, and product characteristics. By applying these semantic rules, relevant information can be extracted from

a linked data ontology. Each row in the table contains a SWRL rule that defines the relationships between various data elements within the ontology, along with a SPARQL query used to retrieve that information from the database. This process helps provide semantic recommendations embedded in WooCommerce.

4. Development of an Algorithm and Ontology-Based Recommendation System for E-Commerce Using the WooCommerce Platform

4.1 Development of an Ontology-Based Recommendation System algorithm

Table 3 : Pseudo Code of Recommendation System Algorithm

Algorithm : Recommendation System Embedded in the WooCommerce Platform	
1	Keywords[] = Extract keywords based on the user's clicks on WooCommerce
2	Function SearchInDBMS(Keywords):
3	{
4	SQLQuery = "SELECT * FROM TableName WHERE field_name = Keywords"
5	TableNames.append(TableName)
6	Return TableNames, Keywords
7	}
8	TableNames, Keywords = SearchInDBMS(Keywords)
9	For i in SPARQLCommands :
10	If TableNames == ?ClassNames :
11	Result = Query_Ontology (i, Keywords)
12	Results.append(Result)
13	Print(Results)

From Table 3, This algorithm is designed to process user data from WooCommerce and generate personalized recommendations by combining information from a database (DBMS) and reasoning through SPARQL (a query language for ontologies):

1. Extract Relevant Keywords : The algorithm begins by analyzing the user's click behavior on WooCommerce to extract keywords that indicate their interest in products.

2. Search Data in the Database (DBMS) :

2.1 It uses the Search In DBMS function to create an SQL query that searches for data in the database tables matching the extracted keywords.

2.2 The list of tables that match the keywords is stored in Table Names.

3. Process Data with SPARQL Commands :

3.1 It loops through the SPARQL commands (used for ontology queries).

3.2 It compares the retrieved database tables with the classes in the ontology (?ClassNames).

3.3 If a match is found, it queries additional information using SPARQL and stores the results in Results.

4. Display Recommendation Results :

4.1 It prints out the list of recommendation results, displaying information or keywords that match the user's interests.

4.2 Development of the WooCommerce Platform with an Ontology-Based Recommendation System

Figure 2 : E-commerce home page

Figure 3 : Semantic Recommendation Based on Customer Profiles and Similar Products

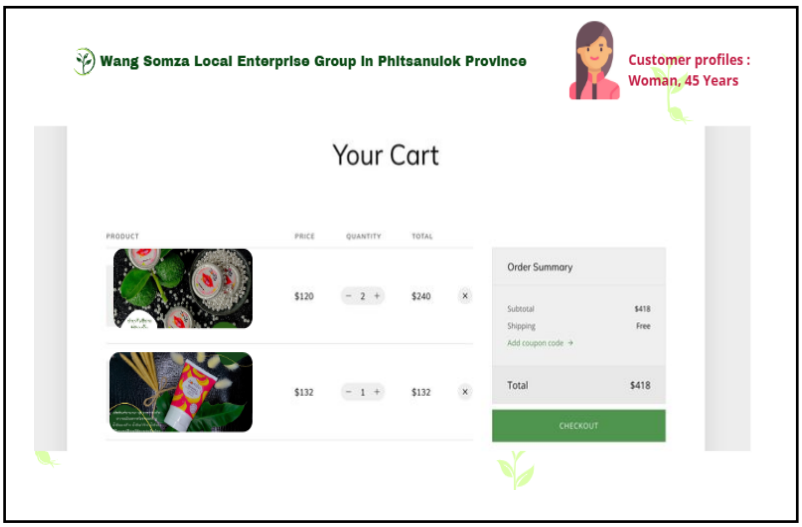

Figure 4 : Shopping Cart Process

Figures 2 to 4 illustrate the integration of an Ontology-Based Recommendation System in the WooCommerce platform. Figure 2 shows the home page of the e-commerce website, while Figure 3 includes semantic recommendation functions, such as recommendations based on Customer Profiles and Similar Products. These developed semantic recommendation functions will help customers make better decisions when purchasing product items. When customers click on the shopping cart to buy product items, they will be taken to the shopping cart process shown in Figure 4.

5. Performance Assessment of the Ontology-Based Recommendation System and E-commerce Web Application

The three specialists in information technology and local product commerce were selected through purposive sampling, based on their expertise in the development and implementation of e-commerce systems, as well as their knowledge of local product markets. They defined the expected keywords covered by the five questions in Table 2. These defined keywords were then used to assess the performance of the knowledge base recovery, measuring the effectiveness of the ontology and the rules created, as shown in Table 4.

Table 4 : Expected Keywords for Measuring the Effectiveness of the Ontology and the Rules

Question	Expected Keywords
1. What products are customers interested in based on their gender and age?	Customer Name, Gender, Age, Agricultural Product Name (e.g., Mango, Rice), Product Interest, Product Category (e.g., Fruit, Grains)
2. What is the list of items that are of the same type as those the customer is interested in?	Customer Name, Agricultural Product Name, Product Type (e.g., Organic, Processed), Similar Products, Product Category (e.g., Vegetable, Herb)
3. What is the list of products that have received the highest star ratings or the most popular views?	Agricultural Product Name, Rating (e.g., 5 Stars), Popularity (e.g., Views, Likes), Customer Reviews, Product Category (e.g., Fresh Produce, Packaged Goods)
4. What is the list of herbal product and its therapeutic properties?	Herbal Product Name, Ingredients (e.g., Turmeric, Ginseng), Properties (e.g., Anti-inflammatory), Symptoms Treated (e.g., Pain Relief, Digestion), Product Category (e.g., Medicinal Herbs)
5. What types of products price promotions and have the highest total sales?	Agricultural Product Name, Promotion Type (e.g., Discount, BOGO), Price (e.g., Sale Price, Original Price), Total Sales (e.g., Units Sold), Product Category (e.g., Grains, Vegetables)

The formulas for precision, recall, and F-measure are calculated to metric the relevance and accuracy of the results returned by the ontology. Precision measures the percentage of relevant results, recall measures the percentage of relevant results retrieved, and F-measure balances both metrics, as shown in Equations (4)–(6).

$$Precision = \frac{True\ Positives}{True\ Positives+False\ Positives} \quad (4)$$

$$Recall = \frac{True\ Positives}{True\ Positives+False\ Negatives} \quad (5)$$

$$F1 = 2\ x\ \frac{Precision\ x\ Recall}{Precision+\ Recall} \quad (6)$$

The E-commerce Web Application is assessed by 25 customers with member status and 5 entrepreneurs/employees from the Wang Somza Local Enterprise Group in Phitsanulok Province. The average ($\bar{X}$) and standard deviation (SD.) are used for data analysis and interpretation.

Results and Discussion

1. The result of the performance of knowledge base recovery, which measures the effectiveness of the ontology and the rules created, is shown in the bar chart in Figure 5.

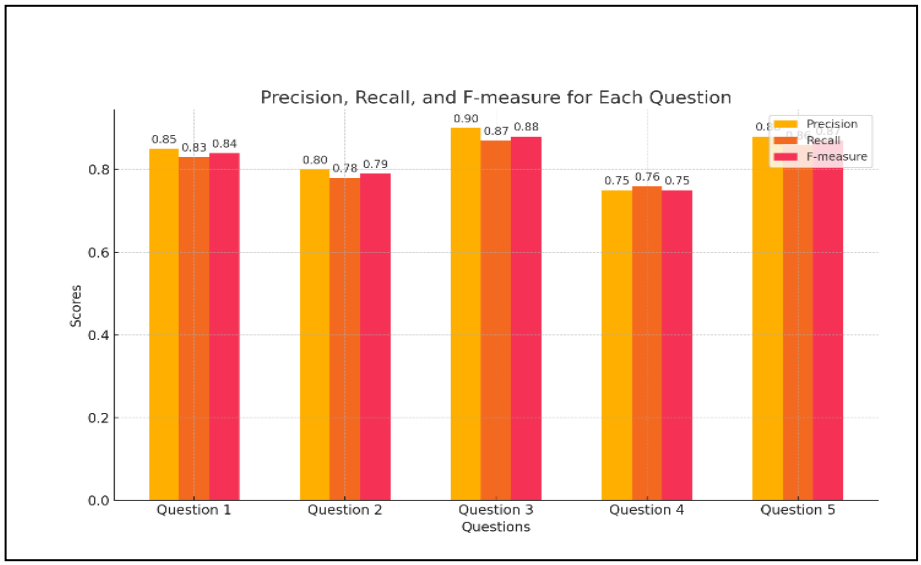

Figure 5 : result of the performance of knowledge base recovery

From Figure 5, the results in this table show the values of Precision, Recall, and F-measure for each question. The high values of Precision and Recall indicate that the model is accurate and able to retrieve relevant results effectively. For the first question, Precision is 0.90 and Recall is 0.85, demonstrating a high ability to predict correct answers and retrieve relevant results. The F-measure is 0.87, representing a good balance between both Precision and Recall when compared to other questions. The results still show good performance in predicting the most important data. Precision and Recall values may decrease in Question 4, where Precision and Recall are the lowest at 0.75 and 0.76, respectively. This indicates a drop in performance compared to other questions. Although the F-measure still reflects overall performance, the decrease in these values suggests areas that can be improved to enhance performance in these areas.

2. The result of the E-commerce Web Application's performance assessment from 30 users is shown in Table 5.

Table 5: User Satisfaction with the E-commerce Web Application's Performance

Assessment Topic	$\bar{x}$	SD	Satisfaction Level	Ranking
1.Security and Payment Systems	4.21	0.42	High	6
2.Product Information Accuracy	4.55	0.35	High	1
3.Performance and Load Time	4.45	0.56	High	2
4.Visual Appeal of the Website	4.41	0.45	High	3
5.Mobile Responsiveness and Compatibility	4.28	0.64	High	5
6.User Experience (UX) and Interface Design	4.30	0.69	High	4
7.Ease of Navigation and Site Structure	4.30	0.57	High	4
8.Product Discovery and Search Functionality	4.18	0.72	High	7
9.Checkout Process and Efficiency	3.91	0.77	High	8
10.Customer Support and Order Management	3.76	0.81	High	9
Sum Average	**4.24**	**0.60**	**High**	

Table 5 shows that the overall average score ($\bar{x}$ = 4.24, SD = 0.60) reflects high satisfaction, but there are areas that could be improved to further enhance the user experience. The results of the user satisfaction assessment for the performance of the E-commerce application across 10 key topics indicate that the application received high ratings in areas such as Product Information Accuracy ($\bar{x}$= 4.55, SD = 0.35) and Performance and Load Time ($\bar{x}$= 4.45, SD = 0.56), suggesting positive feedback regarding the accuracy of product details and the application's speed. However, Customer Support and Order Management ($\bar{x}$ = 3.76, SD = 0.81) received the lowest score, indicating dissatisfaction in this area, with variations in user opinions.

Using ontology in a recommendation system not only enhances data management efficiency but also allows integration with a semantic rule engine to retrieve information at a deeper level, down to the data record level, which may have varying conditions within the system. This integration offers greater flexibility compared to using DBMS and SQL directly, which may limit the retrieval of complex or condition-specific data. By utilizing a semantic rule engine alongside ontology, the system can better understand the meaning of data and the relationships between different pieces of information, allowing for more accurate identification of relevant data that meets user needs. In contrast, using DBMS and SQL may

require complex queries and may be limited in flexibility when retrieving data with special conditions or when dealing with non-static, unstructured data.

Ontology-based recommendations can support personalized searches for related knowledge within the scope of the knowledge base, thereby recommending inferential results. This approach is supported by several studies. For instance, a study on personalized activity eCoaching proposes a semantic ontology model to annotate AI predictions, forecast outcomes, and account for personal preferences, thereby conceptualizing a personalized coaching experience (Chatterjee et al., 2023). Similarly, research on healthy food recommender systems for obesity utilizes ontology and Semantic Web Rule Language (SWRL) to represent and process knowledge, enabling the development of rules for generating physical activity recommendations based on user preferences (Aditya et al., 2023).

Therefore, the combination of ontology and semantic rule engines enables the recommendation system to access data at a deeper level and adapt to various conditions and situations with maximum efficiency.

Conclusions

In conclusion, integrating ontology-based recommendation systems with semantic rule engines in the context of agricultural product e-commerce on the WooCommerce platform for the Wang Somza Local Enterprise Group in Phitsanulok Province offers a promising approach to enhancing online sales and customer experience. The ontology system effectively organizes and links key data elements, such as orders, products, and reviews, into a structured framework. This structure improves the system's ability to analyze, recommend, and manage orders efficiently. The model's three-layer design—covering fundamental e-commerce concepts, product sales details, and agricultural product categories—provides a more comprehensive understanding of the relationships between different components of the system. By utilizing Semantic Web Rule Language (SWRL) and SPARQL, the system can create rules and retrieve data that reflect the customer's preferences and purchase history, resulting in more accurate and personalized recommendations. Combining ontology with a semantic rule engine not only improves data management but also provides deeper, context-aware analysis. This combination offers greater flexibility and adaptability compared to traditional DBMS and SQL-based systems, especially when handling complex or condition-specific data and unstructured information that conventional methods struggle to process efficiently.

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