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Using Ontology to Represent Cultural Aspects of Local Products for Supporting Local Community Enterprise in Thailand

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ABSTRACT

Community enterprise plays an important role for developing local business. Products from local communities apply local specialties such as high-quality materials and inherited wisdom. This work aims to support merchandises from local community enterprises by bringing out their specialties related to local wisdom and intangible cultural aspects. An ontology is applied to demonstrate the innate information regarding the implicit values of the products and is used as a core for a semantic search system. Details of the products are gathered from their respective community using an interview method and are extracted to align with the developed ontological schema. The semantic search system thus is implemented with a recommendation process for online accessibility for providing the organised information. From evaluation, the developed ontology and its instances are rated highly for their consistency, conciseness, and completeness. In usage, accuracy of the query and recommendation results are evaluated at 97.38% searching accuracy and 85.03% for recommending interesting products.

Keywords: community enterprise, intangible culture, local product, ontology, knowledge graph

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1. INTRODUCTION

Local businesses play a crucial role in a country since they provide jobs for neighbours and strengthen bonds in a community (Edmiston, 2007). Local small enterprises take root to a landscape where their community is and bring growth to local economies, for they normally use local materials and manpower (Robinson & LaMore, 2010). Although the benefit of such businesses is low, they are essential to a community for contributing meaningful drive in community growth. Furthermore, local businesses often apply inherited wisdom to increase the value of their product to become uniquely outstanding in terms of quality instead of quantity.

In Thailand, small local businesses formed in a community referred as Community Enterprise (CE) have been supported by the Community Enterprise Promotion Division under the Department of Agricultural Extension, Ministry of Agriculture and Cooperatives since 2005 (Community Enterprise Promotion Division, 2012). With the support from government agencies, many CEs have been legally registered and drive their community towards the world of business. In comparison, large business may have an advantage over CE in terms of funds for advertising and share in a market, but CE features local specialties which cannot be accomplished via mass production of large businesses. Thus, it is important to demonstrate local specialties of CE when it comes to supporting CE business. However, noticeable disadvantages of CE such as mass-advertising and accessibility still remain, and these issues should be managed for CE to become successful.

With the latest information and communication technology, information can be digitally accessed via the Internet. This technology can resolve the issues of accessibility challenges for CE. There are many Information Technology (IT) works to assist business such as electronic catalogues (e-catalogues) for browsing products online (Xu et al., 2009), product search engines, product recommendation systems (Thotharat, 2017), and platforms for online stores including Amazon, Lazada, and Shoppee. For Thai local products, supporting systems (Thotharat, 2017) have also been invented, especially searching systems towards OTOP, which stands for 'One Tumbon One Product,' referring to highlighted products selected from each Thai subdistrict (Tumbon) community. These online applications, however, focus on providing product information and basic details of a product such as price, size, and reviews from buyers as well as providing a channel to contact product providers and the transaction process. CE products thus may pale in comparison since they cannot fully display their specialties from inherited local wisdom. Moreover, the existing online platforms requires business owners to self-handle the product information, while many CE owners are technology-challenged and may not be able to adapt to such technologies.

In fact, CE products have their own outstanding values in terms of cultural representation features. Since the products are made using inherited local wisdom, they are rather unique as opposed to mass products. The wisdom for production includes how to select materials from local sources, properties of the material, manufacturing expertise, and refinement of the product. This wisdom is a local wisdom inherited from generations in a local lineage, since it is related to local materials and crafting methods that have special attributes and may not be found elsewhere. For example, some locals are renowned for their stone having extra sturdiness and use it as material for a product with some inherited techniques, resulting in a more durable houseware comparing to similar products in the market. Furthermore, the products can also be related to local folklore and represent spiritual supports such as charms for health and luck and talismans for protection. These cultural aspects are invaluable features that cannot be replicated in mass products. These attributes can be imprinted in a CE product in various ways of manifestation. Some products such as houseware may show higher quality in terms of durability from local knowledge of choosing proper materials known to be special and using secret inherited manufacturing techniques, or this may include drawing patterns bringing luck according to local folklore. Thus it is necessary to use these cultural aspects to advertise CE products.

This work hence aims to develop an ontology to represent the network of concepts regarding cultural aspects manifested in CE products to feature their specialties in terms of their relation with intangible culture, including tradition, belief, knowledge, and skill. The ontology and the product information collected from CE are thus used in an e-catalogue which has a function to search and recommend products based on the given cultural aspects following the ontology structures. We expect that this will help to bring out the tacit specialties of community products and improve their business opportunity to a larger scale of economy. The rest of the paper is organised as follows. Section 2 provides background knowledge related to the design of the proposed system and related work. Section 3 gives a design and development of the proposed system. Evaluation and results are described in Section 4.

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Section 5 gives a conclusion and remarks regarding this research.

2. BACKGROUNDS

2.1. Ontology Representation

Ontology is one of the knowledge representation structures representing the explicit formal specifications of terms in the domain and relations among them (Gruber, 1995; Mizoguchi, 2003). An ontology defines a common vocabulary for users who need to share information in a domain (Noy & McGuinness, 2001). For usage, an ontology provides machine-interpretable definitions of concepts in the domain and relations. Hence, ontology schemas become a good resource to represent a network of concepts as a knowledge base to enhance IT with real-world knowledge among things in relevant domains (Ruangrajitpakorn et al., 2018).

In ontology, a schema of concepts in a domain as a set of classes is constructed and related to each other by a relation. Types of relation are as follows:

- Is-a relation: This relation forms a hypernym-hyponym (supertype-subtype) relationship between concepts to define a taxonomic hierarchy. As a taxonomic hierarchical structure, all qualifications of a supertype must inherit into its subtype.
- Property relation: This relation forms a holonym-meronym (whole-part) relationship to define a possession or composition. For linking a concept with other concepts, Object property or Part-of (P/o) is called while Data property or Attribute-of (A/o) is used to mention a link between a concept and data.

With these relations, concepts are linked to each other with a specification and semantic constraint. Ontology is given in a computational logic-based language called OWL (web ontology language) designed by W3C (McGuinness & van Harmelen, 2004). OWL is built upon a W3C XML standard for objects called the Resource Description Framework (de Bruijn & Welty, 2013). It is designed to represent rich and complex knowledge as a base for a machine to interpret and understand knowledge of things and their relations.

2.2. Cultural Aspects

Culture is a term with several meanings, but in this work we summarily refer to the term as "the shared thought, behavior and schemes created by a group of people to explicitly and implicitly perceive, interpret, express, and respond to the people around them" (Banks & McGee, 1989; Damen, 1987; Kroeber & Kluckhohn, 1952; Lederach, 1995). Culture is manifested in beliefs, behaviors, and objects in both tangible and intangible forms and become the cultural heritage of the people. According to UNESCO, 'Tangible Cultural Heritage' refers to physical artefacts produced, maintained, and transmitted inter-generationally in a society, while 'Intangible Cultural Heritage' includes oral traditions, performing arts, social practices, rituals, festive events, knowledge, and practices concerning nature and the universe, or the knowledge and skills to produce traditional crafts (UNESCO, 2003). The essence of intangible cultural heritage is the wealth of knowledge and skills that pass down from one generation to the next.

As the community continues, its members gain more experience and knowledge combining to have sound judgement towards procedures as wisdom. Within the passing down of culture, a solid and sound judgement of situations as wisdom of the ancestors is hidden in cultural aspects. Within its tales, the wisdom of a community (local wisdom) may show in the form of a story of legends or folktales to exemplify the situation and hint on what is important. On the other hand, local wisdom can be inherited as secluded knowledge and skills to wisely handle local resources as a specific procedure to produce products. In this work, such products are a manifestation of intangible cultural heritage.

In terms of cultural manifestation, intangible cultural heritage can be crafted into community products showing the tradition, customs, and beliefs of the community in several ways. Since each community has its own culture core from different ethnic, geographical, historical, social connections, inherited knowledge and skill, and profession, these variables can make them uniquely outstanding, and these aspects are implicitly manifested into their way of living and oral expression, as well as in produced goods.

We can group the intangible cultural aspects that are manifested into produced goods into four types, as tradition/custom, belief, knowledge, and skill.

- Tradition/custom: referring to well-known social practices, rituals, tangible heritages, and festive events of the area where the community belongs to. The products may include the use of festive/ritual symbolic items or verbal phrases imprinted into the products such as imitated figurines, or drawings wholly or in part representing a community tradi-

tion. This also includes the characteristics of traditional patterns or designs which are famous in the locality as part of the goods.

- Belief: referring to the stories that the community accepts as virtuous and true, including legends, folklore, and local tales (Tuamsuk et al., 2018). The manifestation of this aspect can be in the form of materializing the characters as human or imaginary creatures (Chansanam et al., 2014), locations and objects appearing in the passed-down story into imitating objects, or as a drawing pattern imprinted on the goods.
- Knowledge: referring to a set of specific knowledge on things related to producing goods, such as knowledge of determining materials and procedures to prepare materials for production. Materials include plant-based and natural materials, living materials, and synthetic materials. The knowledge within the community also includes how to produce the material using local resources based on unique natural qualities as well as inherited herbal medicinal knowledge. The knowledge thus improves the overall quality of the products such as durability of furniture and decorations, artistic quality of accessories and decorations, and taste and preservative quality for consumable goods.
- Skill: referring to a set of specific abilities to perform an action with good execution for certain tasks. The skill is a technical skill involving specific processing and techniques such as craftsmanship and cooking. The skill thus improves the quality of the end products regarding applied techniques which may differentiate the products and others.

The manifested cultural aspects thus are shown as a part of community products. These cultural properties exist but are not focused on or advertised as one of the product's values in common online market platforms. Furthermore, such cultural aspects are implicit and require being explicitly shown since some are not generally known to the public, such as local tales or qualities regarding local materials. These properties, however, can be a selling point of goods from CEs.

2.3. Related Works

There are many works on using IT to support marketing and online markets. The focuses of these works are such as to support and enhance product searching, to personalise user interfaces to match user behavior, and to analyze users' trends to develop new products. For these works, digital data of products and users are crucial as the main input data for a system to decide and manage functions properly. Among many data representations, an ontology is favored to represent a schema of data for its ability to logically relate data as a semantic web (Noy & McGuinness, 2001). An ontology is developed to specify concepts within a domain to assist in explaining data relations based on facts in a real-world aspect. A semantic network model of an ontology and instance data enables logical reasoning and inferences (Pinto et al., 2009), which helps in advance searching and recommendations. Thus we review the recent work related to using an ontology to support marketing and online markets.

Thotharat (2017) proposed a design of an ontology to store information of local products in Thailand. The work focused on OTOP products (One Tambon One Product), which is a program to stimulate local entrepreneurship by the Thai government. The ontology was crafted to represent information of both product and local entrepreneurship for linking product and local area. For concepts related to products, properties are designed to store basic attributes of the products as well as additional defined attributes such as edibility, preservation usage, and packaging. With such properties, the ontology was developed towards the idea of decision-making for users to consider in-depth details in terms of purchasing. The online semantic search was also developed for the ontological information to be retrieved via user interface.

Ontology-Based Recommendation of Editorial Products (Thanapalasingam et al., 2018) is a work using an ontology as a taxonomy of research areas regarding scholarly publications in the field of computer science to recommend articles relevant to a topic of interest. The relevant information from about 16 million scholarly publications in terms of research topic is extracted to match an ontology schema. A similarity of publications based on the research topics is calculated to group similar publications. Since the content is involved in text description, natural language process techniques, including term-frequency and text-similarity, were chosen to handle word occurrence.

Lee et al. (2006) published their work on an ontology-based product recommender system for B2B marketplaces (a digital platform for conducting business with others). The ontology was developed to capture user preference and product information. By matching user preferences and product information, resulting in many possible matches, a Bayesian network was applied to calculate

for probabilistic score, and the score is used to rank the matched items.

Ontology-based recommendation involving consumer product reviews (Baizal et al., 2016) presents a recommender system developed based on the ontology consisting of concepts related to user preference, product feature, and product review. By extending product features with customer review, a review rating of each attached feature of the product is created. The feature with review rate then is calculated to match the user preference for recommendation.

Ontology-Based Sentiment Analysis Model of Customer Reviews for Electronic Products (Sam & Chatwin, 2013) is a research work to develop a method to analyse user sentiment based on review and to design an ontology to schematise information of electronic products and emotions. The sentiment analysis was developed using text-mining techniques to define emotional keywords that match to the concept in the ontology. The system then allows a user to make a query about a type of product with sentimental expressions such as "Which tablet PC is most excellent?" and the information in the ontology is filtered by the product information and assigned sentiment review.

From the review, an ontology representation shows potential as a formal data model for products since it can demonstrate relationships among concepts to represent how concepts are rationally related. Some works include additional concepts that involve objectives such as customer review and user preference. For the task of querying and recommendation, ontologies in these works are used as a core knowledge base to describe a group of product items regarding taxonomy trees or how products are similar based on the designed properties. Unfortunately, additional computational techniques are needed when text information requires handling.

Most of these works focus on applying an ontology schema to enhance search engines and recommendations. Some works use attributes within an ontology to assist in recommending similar products while some use an ontology to collect opinions and reviews for additional features in searching. These works are a showcase of how useful and capable ontology can help in marketing. Since these ontologies are developed specifically to a domain of focused products such as academic publications and electronic products, they are hardly reusable for another type of product with different properties. Thus, it is essential to develop a specific ontology for CE products while related techniques for recommending and querying can be applied to enhance the usage of the ontology for promoting local Thai products.

3. RESEARCH METHODOLOGY

This work is a mix between a study of cultural aspects in local products and innovation. Thus, the research includes gathering information of the local products for analysis and development of a system using the analysed information.

For exploring cultural aspects in local products, we interview the voluntary CEs that own local products to seek insights of the product and cultural/wisdom perspectives, since these details are not well-defined and are given in public as common product details. This data collection was conducted from March 7, 2020 to June 13, 2020 from 67 voluntary CEs in Nonthaburi province with a total of 82 products. The basis of the interview is to ask for details of the product regarding basic information of the products and their specialty related to cultural aspects to fill in a questionnaire. Since the target information is related to culture and beliefs, which is complicated and prone to confuse the informants, we chose the interview format to obtain precise answers to reduce communication error. The interview was conducted via online meetings due to the emerging of COVID-19. Particularly, the interviewer asked about the specialty of the products since the product owner (interviewee) may not know about its cultural aspects. To ascertain the accuracy of the interview, summarised answers are processed and then approved by the interviewee. The topics for asking are as follows.

- Basic information
  - Product name: to define the identity of the product including its brand and locally called name
  - Product type: to group the product based on type of the product
  - Price: to provide a price for the product per unit
  - Manufacturer: to define the identity of the product manufacturer and its contact
- Specialty
  - Cultural aspect: to define how the product relates to local culture and beliefs such as folklore, legend, and local lifestyle
  - Used materials: to define specialties related to used materials with renowned popularity, such as fruit, plants, and other natural materials
  - Manufacturing technique: to define methods to make a product to obtain better attributes than

others in the market

This interview is a task to get the information from CEs about their products that cannot be obtained from observing their products. According to the cultural aspect mentioned in Section 2.2, the collected data on the specialty part are analysed to assign the group of aspect. As there are four aspects, tradition/custom, belief, knowledge, and skill, we map the information to the aspect accordingly. In case of the tradition/custom aspect, the information in this aspect involves known event names of traditional items and traditional dances, such as the tradition name 'ประเพณีตักบาตรดอกไม้' (tradition of offering flowers to a Buddhist monk) and traditional cloth 'ผ้าขาวม้า' (chest-patterned fabric used as loincloths). Such products include a bag using chest-patterned fabrics as materials and a traditional cloth commonly worn in the customary event of offering flowers to a Buddhist monk. For the belief aspect, information related to cultural stories including legends and folklore is categorised in this group. For instance, there is the folklore of a person who freed the eels stuck in the dried canal to receive a blessing of extended life and prevention of accidents. The products involved in the tale such as eel figurines and decorating drawings of the tales are associated into the group. For the knowledge aspect, the specialty of products is related to inherited knowledge of product materials. This aspect involves products that require processing such as foods and processed objects including furniture and decoration. This also includes the use of local materials which are famous for higher quality and better taste. In terms of the skill aspect, the products are related to special techniques such as handicraft techniques and secluded food process methods. The products varied from consumable products to wood and clay sculpting products, knitted clothes, and dyed products. Depending on the information answered by the product owner, it is possible for a CE product to have more than one aspect while some products may not contain such a cultural aspect as they are not related to the inherited wisdom of the community but follow the demand of the market.

From the questions of the interview, we obtain the details of the CE products with their relationships towards cultural aspect concepts or their specialty regarding local materials and inherited manufacturing techniques. For instance, we found a vase product using a local clay as a material which results in more durability and has a drawn pattern representing the divine creature respected in the locality (according to local folklore) to bring luck towards the owner's household. This information then is analysed based on knowledge engineering to develop a knowledge schema to represent product properties in the form of an ontology. The details of the product are allocated in the database field matching the ontology schema. The development of the ontology and the system is explained in the following section.

4. DEVELOPMENT OF SUPPORTING SYSTEM FOR CE

This work focuses on bringing out specialties of products from CE in Thailand. These products are not the latest technological creations, but they are produced from cultural perspectives using passed-down wisdom and culture-related practises. Hence, their values rely on intangible-cultural concepts of creation and are attached with authentic feelings of local specialties. The CE products thus are commonly handmade and become a part of cultural products. In this work, we attempt to extract those implicit specialties and make them their explicit selling points. An ontology is chosen to represent the complex and tacit relations among them, while a semantic search is developed to apply the ontology for supporting an e-catalogue system for CE products. An overview of the system is illustrated in Fig. 1.

Based on Fig. 1, there are four layers: the input layer, storage layer, processing layer, and user-interface layer. The input layer transforms the relevant information including product details, product-related cultural concept, and manufacturing wisdom obtained from the interview into a knowledge base. The storage layer stores the knowledge base in the form of an ontology with the extracted information as ontological instances. With ontology representation, new information can be added, and existing information is allowed to be modified with newfound aspects. The processing layer processes user queries for retrieving the matching result and finding similar products for recommendation. Last, the user-interface layer gets input from users and display results from the processing layer.

4.1. Knowledge Base

4.1.1. Design of Community Enterprise Ontology

The aim of the ontology is to represent relationship between products and their specialties from local materials and local inherited wisdom in regard of CE. Thus, this CE ontology is designed to cover those relevant concepts.

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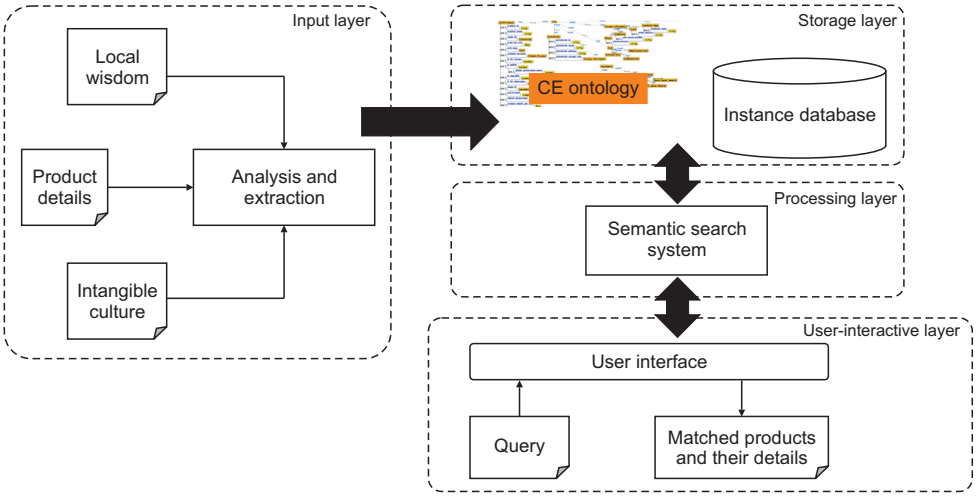

Fig. 1. An overview of supporting system for community enterprise (CE).

To design the ontology schema, we list the relevant concepts in the scope of CE products and their cultural aspect mentioned in Section 2.2. The found relevant concepts include the main concept of *Product*, *Community*, and *Cultural Aspect*. As these concepts are distinct in terms of meaning but are related as part of a relationship, we design the concepts into separated trees. Then, the relations to link the concepts are designed to link the concepts across the trees. As we realise that the *Product* concept is the main concept to represent the core product instance data, the *Product* concept is determined to be the main tree of this ontology, and other concepts are thus logically related to this main tree. At this state, the relations are designed to show the properties of the *Product* concept. Since the *Community* and *Cultural Aspect* concepts are the properties of CE products, as a product is made by a community and a product has a selling point for its cultural aspect, we related the *Product* concept as the domain of relation to the range concept of *Community* and *Cultural Aspect* with a *made_by* relationship and *related_to_cultural_aspect* relatively, respectively. Because the relations are to relate among concepts, the properties are defined as an object property (part-of) relation. As we design further, we found more related data to the *Product* concept (data are not the concept, as they have little to no meaning) including the product name and the price of a product. Such data thus are designed as additional relations for data properties to the *Product* concepts, with the assigned datatypes based on appropriate data for the slot as *string* datatype for name relation and integer *datatype* for price. For the *Community* concept, the concept has its own property since a community commonly has a name, an address, and contact information. Thus, we design the distinct property to represent the relations separately. As address, email address, and name do not give meaning or represent a conceptual entity, they are designed as data with the relationship of a data property (attribute-of) relation to attach to the *Community* concept. For the *Cultural Aspect* tree, we realise that there is another relevant concept as *Quality Aspect* of the product; thus, we design the two aspects together under the more generalised concept of *Selling Point* and link the *Quality Aspect* as another object property with the relation name of *related_to_qualit_aspect* to the main tree *Product*. After this state, related concepts are added to furnish the existing trees for more complete network of related concepts and datatype.

The ontology is the conceptual schema to explain how concepts and specified datatype relate to one another in a given domain of interest based on real-world facts. Thus, the schema does not include the data of the real-world entities which will be instantiated to the concepts with property values following the schema.

As the designed result, the ontology consists of three main concepts, *Product*, *Community*, and *Selling_Point*, while there are several minor concepts such as *Person* and *Manufacturing_Type* to compliment the properties of the main concept. Some of the concepts including *Selling_Point* and *Manufacturing_Type* are represented in a tree to inform taxonomic hierarchy, where a subclass has a type-of relationship to its superclass. Some major concepts of the ontology are illustrated in Fig. 2.

For ontology properties, they help to define the relationships of a concept to other concepts and of concept to data value. We design properties for concepts and exemplify the major properties in Table 1.

For explanation, the core concept of the ontology is the

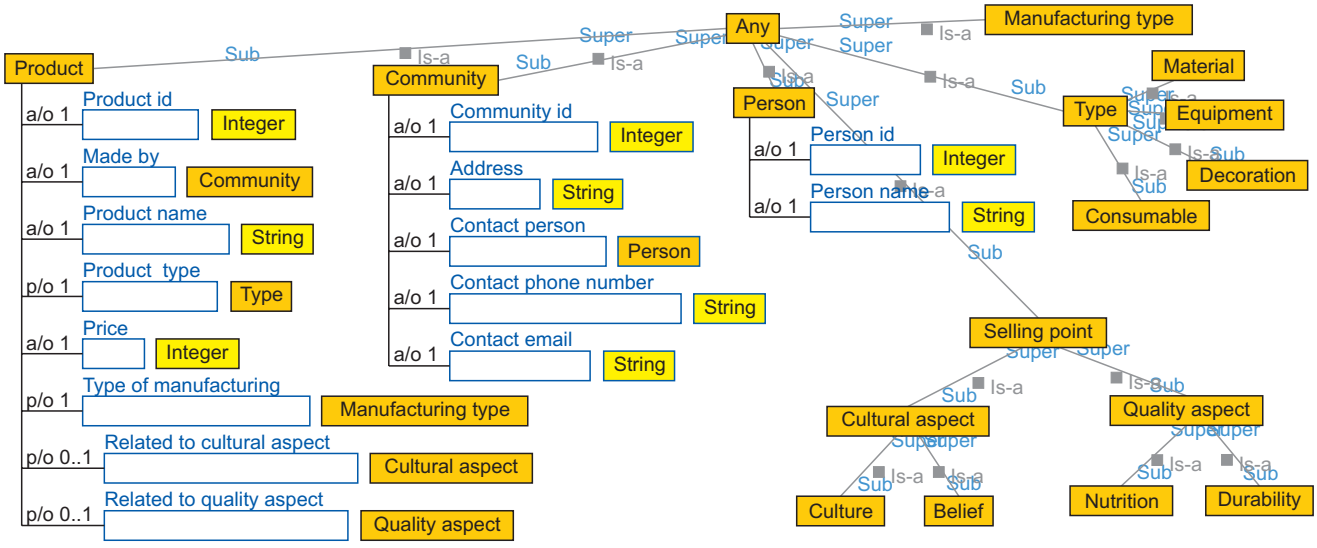

Fig. 2. Main trees of the community enterprise ontology.

Table 1. List of main properties and their specifications

Property	Definition	Specification
Product type	To inform a purposed type of a product	Type • Consumption (such as food, shampoo, and soap) • Equipment (such as cloth and jewellery) • Decoration (such as vase and houseware) • Material (such as clay and brick)
Type of manufacturing	To inform how they make a product	Manufacturing type • Hand-made • Machine
Related to cultural aspect	To inform implicit selling points involved to cultural heritages	Cultural aspect • Culture (specified with an instance of this class such as local tradition and usage) • Belief (specified with an instance of this class such as folklore, and tales)
Related to quality aspect	To inform implicit selling points relevant to how the product having higher quality	Quality aspect • Nutrition (specified with an instance of this class) • Taste (specified with an instance of this class) • Durability (specified with an instance of this class)

concept *Product*, which connects to concept *Community*, *Type*, *Manufacturing_Type*, *Cultural_Aspect*, and *Quality Aspect*. This *Product* concept represents CE product; hence, it directly relates to several kinds of related information as a part-of a product. The relationship between *Product* and *Community* informs which community made the product, while *Manufacturing_Type*, *Cultural_Aspect*, and *Quality Aspect* provide how unique the product is, based on the aspect of manufacturing-related concept, culture-based concept, and quality-based concept, respectively. Other properties of the concept *Product* are the data-property to link the concept to data, including *product id* (for system usage), product *name*, and product *price* per unit. For *Community* there are five properties, which are four data-properties and one object-property. The object-property of the concept *Community* links to a person who is a communicative representative of the community. The data properties are the basic information of a community including address, contact number, and contact email. The concept *Type* which is related to *Product* separates products based on type of product, such as consumable, equipment, and decoration. Last, *Cultural_*

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Aspect and *Quality Aspect*, which are the sub-concepts of *Selling Point*, respectively relate a product to relevant cultural information including specified beliefs, folklore, and lifestyle and link to qualities of local materials and manufacturing techniques.

With the relation of the ontology, information regarding the specified concept can be linked into a graph. This ontology thus can represent local products related to their community, culture, and applied inherited wisdom in a structural form with relations as a machine-readable graph. This assists to illustrate specialties of local products with abstract ideals relating to cultural beliefs which can rarely be found in a mass product.

4.1.2. Ontological Instantiation

Instances of this ontology are CE products with additional data regarding the designed properties following the ontology schema. Since the required data for the system are not usual information obtainable elsewhere, we need to contact product owners directly to access the necessary data for the system. As we obtained the data from the interview of product representatives mentioned in Section 3 to fill up the questionnaire, the products with basic information and categorised cultural aspects for specialty are instantiated to the ontology schema. The scope of the data is CE products within Nonthaburi province, Thailand.

The data collected from the interview now become the answers of the questionnaire. The obtained answers for each question in the questionnaire are then instantiated to the designed ontological properties. The English-translated questions are summarised in Table 2.

Details of the products thus are mapped into the designed ontology and are ready to use in the system. Furthermore, we can also learn how products contain cultural value and how they relate to each other with the help of a graph from the ontology. For example, a knowledge graph related to a product can be generated based on the relation of the ontology as shown in Fig. 3.

From an example given in Fig. 3, the focused CE product instance is *Hand-bag made by Thai Chest-patterned Fabric*. It directly relates to a material, *Cotton*, and to a cultural_related variable, *Thai Chest-patterned Fabric* according to the ontology schema, since the product concept has the properties of 'related to cultural aspect' and 'related

Table 2. Questions to obtain instances of community enterprise ontology

Question	Answer type	Linking to ontology
Product name	Free fill	Data property: product_name
Product type	Choose from the given list	Object property: product_type
Price	Number in Thai bath	Data property: price
Manufacturer	Free fill	Object property: Made by
Manufacturing type	Choose from the given list	Object property: manufacturing_type
Cultural selling point	Free fill	Object property: related to cultural aspect
Quality selling point	Free fill	Object property: related to quality aspect
Used materials	Free fill	For analysis to link to selling point instance
Main feature	Free fill	For analysis to link to selling point instance

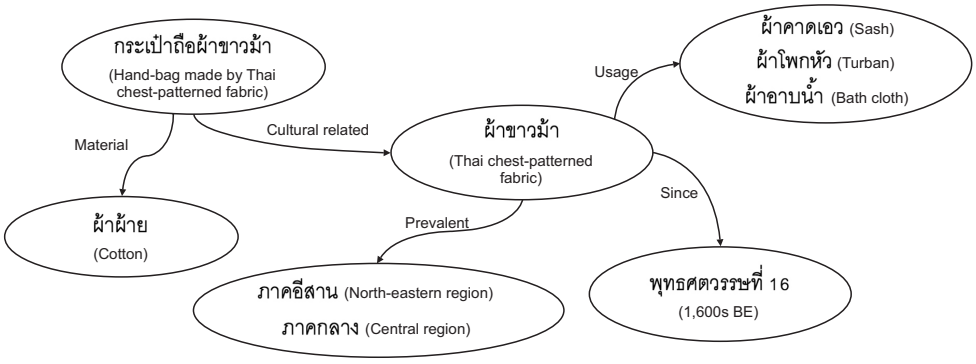

Fig. 3. A knowledge graph of a community enterprise product according to the given ontology schema.

to quality aspect.' The *Thai Chest-patterned Fabric* is an instance of the class 'Culture' that comes with the link to specific property details such as 'prevalent,' 'since,' and 'usage.' These three properties which are data properties then have a defined value; for example, the prevalent property informs that the culture concept is prevalent in an area of the North-eastern and Central Region of Thailand. This graph hence shows the relation to other concepts according to information of products, and these make the product itself different from another. In case two or more products share the same property value such as a cultural_ related *Thai Chest-patterned Fabric*, those products can also be considered as they are culturally related to one another and are linked in the graph via the shared property.

As data for this research, there are 67 voluntary CEs providing their product details for a total of 82 CE products. The products are in categories of equipment, accessory, household decorations, consumable goods, and processed material. For the cultural aspect, the products are mostly from Nonthaburi province; thus, only Central region cultural aspects are found in this set of data.

4.2. Semantic Search System for CE

With the ontology and its instances, the knowledgebase for the semantic search system is ready. Semantic search in this work refers to a function of retrieving knowledge from richly structured data sources given in the designed ontology, which enables the formal articulation of domain knowledge at a high level of expressiveness and allows users to specify their need with details as storage in structural ontological representation. To apply the ontology into a semantic search system, an ontology application management (OAM) framework (Buranarach et al., 2016) is chosen as a framework to connect ontology and semantic queries to allow the retrieval of both explicitly and implicitly derived information, based on ontological structural information through pattern matching and inference reasoning.

The search result thus comes with rich expressiveness of the ontology and its instances. We design the user interface to display the search output as an e-catalogue as details of product are given in a structural info box to clearly define information type, which can prevent ambiguity and confusion.

Aside from matched search results, it is possible that users may be interested in a similar item with a different name or keyword. Hence, we chose to develop a recommended system to display similar products to users' query results as advertising products. The selected approach for recommendation in this work is content-based filtering approach (Mooney & Roy, 2000). This approach exploits given characteristics of products to recommend additional products with similar properties. As applying to an ontology-based system, properties of the designed ontology are used for calculating for similar products.

Cosine similarity is applied to find similarity between queried products and the rest. Cosine similarity is a measure of similarity between two non-zero vectors using a given set of attributes (Sitikhu et al., 2019). The vector of attributes from an ontological instance is a representation of a product computational pattern in which the patterns can be matching to one another to find their similarity. For this work, two vectors of attributes for similarity comparison are ontological object properties while ignoring data properties, since data properties inform on naming and numerical data which contain less meaning. Thus, only object properties are used as attributes for calculating for similarity. The two vectors S and O for a product from a searching result and other products respectively are defined to compare for the cosine similarity using a dot product and magnitude as given in (1).

$$similarity = \cos\theta = \frac{S \cdot O}{\|S\|\|O\|} = \frac{\sum_{i=1}^{n} S_i O_i}{\sqrt{\sum_i^n S_i^2}\sqrt{\sum_i^n O_i^2}} \quad (1)$$

where S_i and O_i are components which refer to values from ontological properties of vector *S* and *O* respectively. The similarity score can range from –1 to 1 where 1 signifies exactly the same and –1 means exactly the opposite, with 0 indicating decorrelation, whereas in-between values refer to intermediate similarity or dissimilarity. Since components in an ontology can be related to another in the form of an ontological hierarchical tree, logical inference is applied to extend the object properties to include their immediate parent and child concepts, but the found data properties using hierarchical inference are weighted down for half of the given score.

In fact, the searching result is able to yield several products, and these products are used as vector *S*. Hence, each *S* produces a set of similar products. We then calculate for a summation of similarity scores. The 5-top ranked products based on similarity score then are listed for recommendation. An example of the search result and recommendation is illustrated in Fig. 4.

From the example of an ontology-based system, the matched result is given at the top of the page with its ontological properties. The underlying properties give

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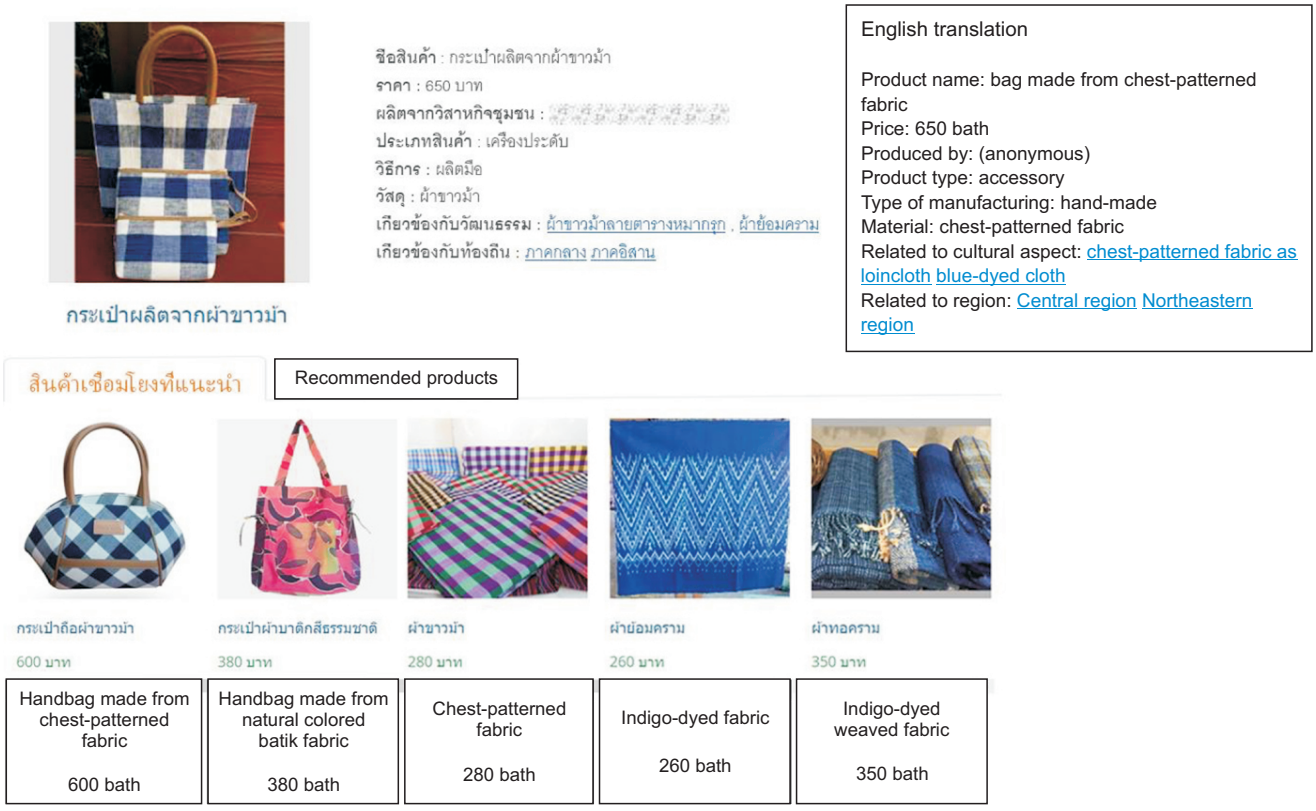

Fig. 4. An example of a semantic search result and recommendation from community enterprise ontology.

a link to a related page of knowledge. The bottom part shows the recommendation results similarly related to the focused products. The example searching result shows a bag made with Thai chest-patterned fabric (**ผ้าขาวม้า**) with properties such as type of 'manufacturing' property indicated as 'handmade' (shown as '**ผลิตมือ**'), and 'related to cultural aspect' with 'Thai chest-patterned fabric' (shown as '**ผ้าขาวม้าลายตารางหมากรุก**'). These properties are used for calculating a similarity score with other products given in the knowledge base. The other products that share the same property values will be ranked high from the high calculated similarity score, and those top-ranking products are recommended. In this example, the shared properties from the queried product and recommended products are mostly related by 'Thai chest-patterned fabric' and 'handmade,' because all the recommended products share the same properties and result in a high similarity score for recommendation.

This recommendation list is expected to help users to find similar products further than what they seek and to extend their searching with more options. With the pattern of similar properties, advertising similar products is beneficial to both users and CE owners for reducing transaction costs of finding and selecting items in an online shopping environment.

5. EVALUATIONS

We set up two experiments to test the capability of the proposed system. First, we evaluate the ontology to ascertain its quality. Second, users of the ontology-based application are asked to assess its usage.

5.1. Ontology Evaluation

Five ontology experts were asked to rate the ontology and its instances in a 5-point Likert scale with 1 for very poor, 2 for poor, 3 for average, 4 for good, and 5 for excellent. The aspects for evaluation include consistency, completeness, conciseness, expandability, and sensitiveness (Gómez-Pérez, 2004). The ontology evaluation results are given in Table 3.

The ontology evaluation results are good in all aspects, as the median of the considering aspects is 4. The experts mostly favour the consistency of the ontology with a mean of 4.4 since they found the class and property design to be consistent, while expandability got the least score as a

mean of 3.8 for many specific representative classes. Another remark from experts is that the instances for the ontology should be clarified into more details, as some can be useful in a schema level for inference.

5.2. Usage Evaluation

To evaluate how the system performs, we asked 100 users to test the system. Users were to search for their own criteria 3-10 times. In this experiment, 497 queries were made from 100 users, and 2,485 recommendation products were generated in total. For the system, two functions are evaluated as searching and recommending. We determine the search results with the criterion of matching user intention or not; thus, the result is either 'matched' or 'not matched' for determining accuracy. Percentage is calculated to present the search result of the 497 queries. For the recommendation function, since the recommendation is a list of related items considering similarity score and expecting to interest the user, we asked users to rate each recommendation in the generated list as 'interested,' 'similar but not-interested,' and 'not similar.' Then, a percentage of the rating is calculated to present the capability of the recommendation. The usage evaluation results of both search and recommendation are given in Table 4.

The results from Table 4 show that users found the results to be accurate for 97% while the recommendation made the user interested for 85% of the time. Upon analysing the inaccurate results and not-interested recommendation with the users, we found that the cause was not from incorrect retrieval or mistakes from data but users' misunderstanding of ontological concepts. For example, some users did not expect to find a plant pot (กระถางต้นไม้) as a decoration but as a gardening tool, as their purpose for the item is a ware to keep a plant in. Thus, they marked the results as not-matching. This, though, may come from the concrete design of product categories that are not flexible to users' perspectives. This result, however, is not a mistake of either the ontology design or users, since we cannot argue that the plant pot belongs to either class depending on the perspective of things in the world based on the roles of an object. Unfortunately, the ontology is not allowed multiple parent classes, and this becomes a limitation of the current approach.

Table 3. Evaluation results of the community enterprise ontology

	Mean	Median	Mode
Consistency	4.4	4	4
Completeness	4	4	4
Conciseness	4.2	4	4
Expandability	3.8	4	4
Sensitiveness	4.2	4	4, 5

6. CONCLUSIONS AND REMARKS

This work proposes a method to bring out specialties of local products by linking the products to their intangible values related to cultural and local aspects. Since local products may look inferior comparing to the latest global commercial goods in terms of advance technology and design, they have their own specialties and values within them from their representative culture and traditional design. An ontology is developed to represent hidden cultural relations and used as a core for matching products to users' interests and displaying their intangible values as a structural graph-based representation. The searching system and recommender are developed to demonstrate the usefulness of the ontology.

For ontological instantiation, since the focused aspects of the products including related culture and beliefs are rather new, existing product information cannot be directly applied to the system. Hence, we ask for details from communities who produce the items for their insight and knowledge. The information is manually processed into instances and property values. This process requires several branches of knowledge to realise the relation and to maintain precision of the ontology result. With the 67 voluntary CEs, there are 82 local community products registered as instances mapped to the developed ontology for use in the system.

The evaluation results of the ontology show that the

Table 4. Evaluation results of the proposed system

	Matching user criteria		Not matching user criteria
Search accuracy	97.38% (484)		2.62% (13)
	Interested	Similar but not interested	Not similar
Recommendation efficiency	85.03% (2,113)	10.34% (257)	4.63% (115)

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designed ontology is acceptable for consistency, completeness, conciseness, expandability, and sensitiveness aspects as they all obtained a good evaluation in median from the five evaluators. The system was evaluated for practical usage and received 97% accuracy and 85% recommendation efficiency. From analysis, the current ontology approach signifies a limitation of categorisation. Since an ontology allows only one parent concept, the current designed product categories become rigid, as a product can belong to one specified category. This leads to a rigid viewpoint of conceptualisation which varies between different users, and it may cause misunderstandings or mislead in defining searching criteria. To further develop this work, we aim to include more local products from CEs around Thailand. Furthermore, we will design a method to break through the limitation of multiple categorisations without losing the ontological ability to link implicit relations for semantic and knowledge inference.

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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