

Ontology Based Thai Chatbot on Social Media Marketing for Community Enterprise



Sumitra Nuanmeesri, Lap Poomhiran

Abstract: *Communicating with customers is the key to maintaining relationships so that customers are loyal to the business. But employees in the organization are unable to support or keep contact with the customer all day, especially for community enterprise with limited budgets. The chatbot is one of the tools that can increase the efficiency of automated communication with customers at all times. This paper presents Thai chatbot on social media marketing for community enterprise using the ontology technique. To develop a semi-automatic approach to create query terms and answers in different styles of response which is related to describe the features of online community product purchases for online buyers with community enterprise. The Longest matching approach was used to increase the capability of the Thai word segmentation, thus providing detailed and accurate information. The results show effectiveness and evaluation in terms of the accuracy of the classification and relationship of ontology and black box testing at the high-level while being used has high consensus both experts and users.*

Keywords: *ontology, word segmentation, semi-automatic, social media, Q&A, chatbot.*

I. INTRODUCTION

In 2019, Google and Temasek [1] conducted digital economy research in Southeast Asia. The research shows that the internet economy in this region is worth over US\$100 billion for the first time. Over the past four years, the number of internet users in Southeast Asia has 360 million users and has increased by 100 million. Thailand has 47 million internet users, an increase from 36 million users. Most users use the internet for communication, shopping, entertainment, order food online, travel, learn and train their new skills. Hootsuite (2019) shows that Thailand is ranked number one in the world where Thai people spent five hours and 13 minutes per day on the mobile internet, while the world average is three hours and 13 minutes per day [2]. As a result, there is an opportunity to buy the product at any time.

Besides, the government has stimulated public spending to buy community products and can be tax-deductible. However, there is a limitation that community product merchants do not have much knowledge of internet technology to support their marketing and selling their products.

Nowadays, the rapid advancement in internet technology combined with the technology of smartphones, this has led to the change of community trading methods from traditional methods to more online trading methods. Affecting the seller to prepare and have tools to support the increasing number of customers, including finding ways to support communication with customers who have queries or request to order products on the internet at all times.

Chatbot is a computer program that has the ability to hold a conversation with human beings using Natural Language Speech [3] that interacts with human users through automated chat. The work here is concentrated on the conversation between a chatbot system and human users for specific situations and therefore requires some natural language processing. There are many approaches to solving any natural languages processing problem [4] but when working on a conversational interface there are primarily two approaches: natural language parsing and conversation prediction. Natural language parsing follows a traditional parsing approach where the text is analyzed using a parser similar to a computer language parser but modified with more lookaheads and feature enriched grammars (e.g., in tense resolution), and utilizing statistical methods based on relevant word corpora to resolve ambiguities. World knowledge is usually supplied in the form of predefined ontologies which are used to determine the proper responses according to a domain knowledge pool [5]. Ontology is the blueprint of a conception to represent knowledge by identifying a set of representational terms; the vocabulary and the relationships, to capture the relevant domain knowledge, and propose a common understanding of the field to identify the common vocabulary, give a clear formal definition and requires efforts to uncover and organize relevant domain knowledge in a suitable structure according to the purpose of the ontology's usage. This can be done manually or by using automatic or semi-automatic methods, in which learning methods and knowledge engineering are applied to extract concepts and conceptual relations from domain documents. Ontology-based conversating is indeed a way of domain-driven conversation work for two purposes: to store the knowledge and to navigate through the domain. The knowledge base component takes part in many dialogue systems with turns queries into a logical form to interrogate the knowledge base for the answer generation.

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However, the creation of the ontology is a very complicated process and it takes time consuming. To minimize an error and a tedious work of building ontology, semi-automatic approach was proposed to deploy with this project and also Thai word segmentation based on longest matching method was chosen to augment the efficiency of the research to use for the concrete manual ontology building, mapping technique to transform ontologies and knowledge into relational database and then use that knowledge to drive its chats. This research presents as structural knowledge to model Thai words for purchase process knowledge with an ontology-based approach so as to search the information about what exactly the meaning of words presents from Thai words in Q&A in purchase process, including the type of answer such as text, picture, clip video, sticker and link to website and social network. Section II will be examined some related research, section III is described the research methodology, experiments and to the evaluation phase in section IV, and conclusion and future works are in section V.

II. RELATED WORKS

The exploration of the literature reviews which are related to this research shows that ontology based chatbot is very popular in the commerce ranges. The chatbot can interact with customers and helps the companies to create several value-propositions in business-to-consumer (B2C) [6][7]. In online shopping, the chatbot helps customers to gain user experiences [8]. It is available all day and increases customer satisfaction [9]. Chatbots help reduces costs, for example, Toshiba uses chatbot instead of employee cause reduce the number of support calls by 30-50% and decreasing service workload for employees [10]. In most countries, small and medium-sized enterprises (SMEs) play an important role in shaping the economy [11]. For this reason, SMEs are aware of the value of IT in order to efficiently build relationships with customers and Effectiveness [11][12]. In contrast, SMEs have limited investment [13] and lack of digital support [13][14]. The chatbot can be applied to support business for SMEs. Moreover, there is also a development of chatbots that can be integrated with the messaging for social media platforms or speech recognition [15][16] such as Facebook, LINE, etc. In addition, the service is also available for the free use of the chatbot service free of charge. It also gives the opportunity to be able to add more knowledge words of question and answer in many languages. In which Thai is one of the languages that can be operated.

In 2019, the number of Facebook clients in Thailand was anticipated to reach 26.9 million, up from 26.3 million in 2018. At the end of the second quarter of 2019, nearly two billion people had monthly access to the social network. In 2018, more than half of them used Facebook as Thailand had 40.7 million internet users [17]. The favorite application on Facebook is Facebook Messenger which is a chat module for users interact to ask their queries to other users or systems. The developers who have developed software which integrates with Facebook Messenger need to request the permissions related to messaging services from Facebook before deploying it [18].

Some studies that specify how to manage requirements for designing and using ontology technology as information

acquiring and advising systems in the chatbot. An ontology based chatbot is proposed to address the concerns of customers on the internet with the main objective of finding the right message and then responding back to the user. This chatbot allows the user to map connections between different entities that are needed by the users, providing detailed and accurate information in order to address conventional chatbots' disadvantages. The ontology template is generated by using Protégé [18] platform which stores the knowledge acquired from data source on the internet and integrated the dialog manager. The corresponding request response is stored on the dialog manager and returned to the client [18]. For example, the ontology-based dialogue manager (OntoDM) is a German dialogue manager which stores the conversations, provides a basic solution, and proceed the conversation via domain ontologies in the field of banking and finance [19].

III. RESEARCH METHODOLOGY

The research methods adopted in the development process for the Thai chatbot on social media marketing for the purpose of ontology semi-automatic technique for community enterprise, include the following steps:

A. Requirement analyzing

This process, we used rapid application development (RAD) to develop Thai chatbot on Facebook and to collect and analyze user requirement due to the rapid development approach focuses on the reduction of cost and development time and RAD always applies to use in a small development team that has the knowledge and ability to the project in order to quickly develop the work system. RAD consists of four distinct phases; requirement planning; system design; development and cutover phase [20] as shown in Figure 1.

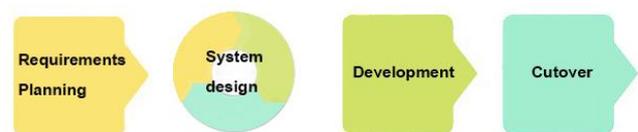


Fig. 1. Rapid application development process.

This work, RAD was employed to develop ontology based Thai chatbot for online community enterprise and to collect and analyze user requirements, the first step is to plan the requirement survey and assign duties and tasks within the system. The design of the contents displaying in user interface has been designed by participated users for more styles, suitable, meaningful and make it easy to understand. The results from the requirement and planning process will be used to design and develop the system by analyzing the necessary components of the system [21].

In this research is designed to increase productivity and improves the precision of results by dividing the important three components: the user interface, the word segmentation, and the ontology and database.

The user interface consists of two main functions: providing information to users and displaying answers (such as text, image, sticker, clip video and link to website or social media) that related user questions. User says the queries and the system response the related answers to the relevant matching ontology information. The longest matching technique was used in the word segmentation phase to cut sentences. In the ontology and database phase perform to store and manage matching information and knowledge of questions and answers for trading.

B. Design and building the ontology structure

In this research used data and information related with Thai conversations of customers and merchants in Facebook Pages and Facebook Messenger were used to gather 3,700 sentences. These data were collected by a data collector engine which is developed in this research as a service in a web platform using PHP that connected to Facebook Graph API with messaging permissions. Also, Figure 2 shows the system architecture diagram of this process. All messages were grouped to noun, pronoun, verb, preposition, conjunction, adjective, number, currency, and multimedia objects such as images or stickers which are defined as text.

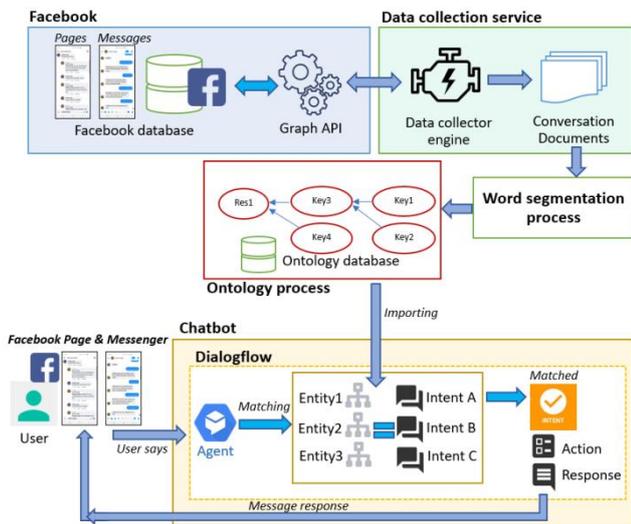


Fig. 2. The architecture diagrams.

In process of design and create ontology, natural language processing language (NLP) was adapted to use in this work. However, with the limitation on natural language processing language, Thai language differs from English language because Thai writing system does not have markers for word boundaries or delimiters between the multiple words and between sentences. In order to accumulate data, classification theory used to be additionally used as the foundation for grouping and dividing information into primary classes, also each group of data was divided into sub-classes for analyzing the content, the extent of domain knowledge and the theory of cognitive systems. Reinberger’s method suggests that a parsed medical corpus pattern matching and clustering algorithms to the classes of dependencies to build sets of semantically related words and establish semantic links between them [22].

The feature extraction process is the necessity to extract relevant information from the conversations. There are five steps as the following:

1. Data collection and preprocess: the documents of the Thai conversations were gathered by using a service that is developed in the web platform for gathering, cleansing, transforming, and improving data to be appropriate for analysis.
2. Word segmentation process: each word or number in this step was separated by the longest matching method.
3. Keyword extraction process: both keywords of user queries and merchant’s response messages were extracted from the documents.
4. Keyword grouping process: all keywords were categorized in kind of word.
5. Named entity recognition process: entity extraction classified named entities that are present in a keyword into categories which has meaningful units for matching question and answers in different style such as text, image, hyperlink, multimedia, etc.

Term Frequency-Inverse Document Frequency (TF-IDF) was exploited to specify the weight of a word in a set of documents by calculating term frequency from documents. The TF-IDF value by using the formula as presented in (1) and (2) [23]:

$$W_{i,j} = TF_{i,j} \times IDF_i \tag{1}$$

$$IDF_i = \log \frac{|N|}{DF_i} \tag{2}$$

Where:

$TF_{i,j}$ is frequency of i in j .

DF_i is number of documents containing i .

N is total number of documents.

The results of the calculation are determined the features of keyword sets in each category and converted the feature to document-terms matrix shown in Figure 3.

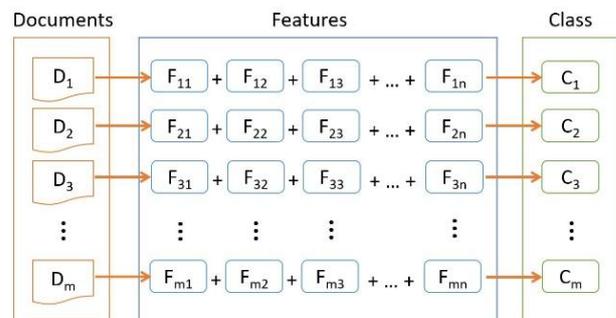


Fig. 3. The document-term matrix.

The data collected and gathered in ontology approach. We were approved by ten experts in information technology and business and forty users who are experiences buyers or merchants. The Protégé [18] was utilized to linguistic and business management and the ontology of this work. It is a free framework for generating the ontology and OWL (Web Ontology Language) was applied to describe ontologies and defines the relationship between the data and knowledge. In addition, this ontology implemented for use in this system has been evaluated by experts and users to assess the validity of the ontology in the concept and relationship.

The results of the ontology process are stored in the ontology database which is designed in this work. After that it will be imported as an input for the dialogue manager. In this research, the Dialogflow [24] is used as a dialogue manager which has abilities to manage intents, entities, message responses in several styles, and integrate to Facebook Messenger.

Figure 4 display user queries and answers in different styles of response which is related to describe the features of online community product purchase by buyers and Thai chatbot for community enterprise.

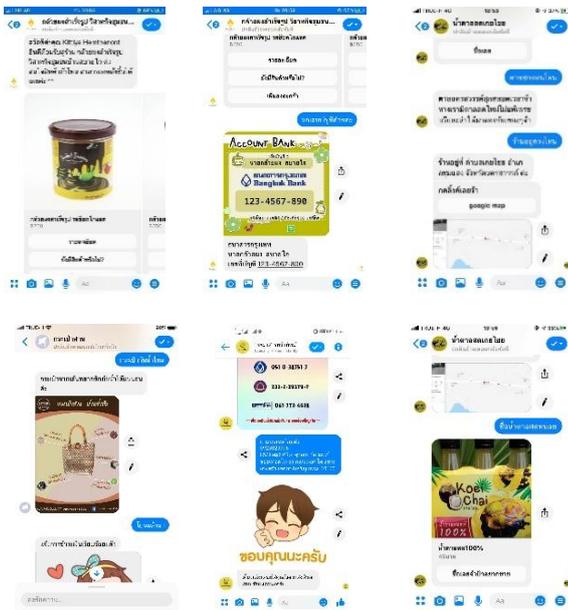


Fig. 4. Contents show in the chatbot.

C. Evaluation the ontology and chatbot

In this section, accuracy, recall, precision and F-measure were used to evaluate the performance of text classification before building ontology. In this research, feature extraction is the first step of pre-processing to recognize and classify key words. TF-IDF is used to determine the relative frequency of words in a set of specified documents through an inverse proportion of the word over the entire document corpus. According to discover the information from a set of documents, information extraction is the significant process that handles with the extraction of specified entities, events, and relationships from sources. Accuracy, recall, precision, and F-measure show in (3), (4), (5), and (6) [25][26] respectively.

$$Precision = \frac{TP}{TP+FP} \tag{3}$$

$$Recall = \frac{TP}{TP+FN} \tag{4}$$

$$Accuracy = \frac{TP+TN}{TP+FP+FN+TN} \tag{5}$$

$$F\text{-measure} = \frac{2 \times Precision \times Recall}{Precision+Recall} \tag{6}$$

Where:

- TP: the response is appropriate to the query, with the response matches the query.
- TN: the response is not appropriate to the query, with the response that does not match the query.
- FP: the response is appropriate to the query, with the response that does not match the query.
- FN: the response is not appropriate to the query, with the response matches the query.

To test the accuracy of the classification and relationship of ontology, ten experts in information technology and business evaluated with the system and questionnaires with consistent with the scope, the accuracy of the classification, consistent of terminology, the accuracy of the information relationships, the consistent of question and answer and the completeness of marketing. Black box testing evaluated with the system and questionnaires with function requirement test, function test, usability test, performance test and security test by ten experts in the field of information technology and business and forty users.

The data was analyzed to find the mean value and the standard deviation value [27] according to the scoring criteria of the Likert Scale [28] to rate, as shown in Table I.

Table- I: Scoring criteria for evaluation

Scale	Range of Weighted Mean	Level of Effective
5	4.51 – 5.00	The highest
4	3.51 – 4.50	The high
3	2.51 – 3.50	The medium
2	1.51 – 2.50	The little
1	1.00 - 1.50	The least

IV. EXPERIMENTAL RESULTS

In this section, we provide the results of accuracy of the classification and relationship of ontology and effectiveness evaluation of the chatbot from block box testing.

A. Accuracy of the classification and relationship of ontology

The accuracy results of classification and relationship of ontology, precision was 94.70%, recall was 93.86%, accuracy was 96.10%, and F-measure was 94.97%. Table II shows the result of the accuracy of the classification and relationship, display the results of the terms of connection and information categories at the highest level, mean was 4.56 and the standard deviation was 0.50.

Table- II: The results of the accuracy of the classification and relationship

Assessment Indicators	Experts	
	Mean	SD
1. The consistent with the scope	4.70	0.48
2. The accuracy of the classification	4.60	0.52
4. The accuracy of the information relationship	4.60	0.52



3. The consistent of question and answer	4.50	0.53
5. The completeness of marketing	4.40	0.50
Total	4.56	0.50

The result of accuracy for acceptance of the ontology that could be detected by experts while being used has high consensus. All of values the interquartile range no more than 1 and the quartile deviation no more than 0.5 in five assessment indicators shows as Table III.

Table- III: The results of evaluation for acceptance of chatbot by experts

Assessment Indicators	Mean	SD	Quartiles			Interquartile Rang	Quartile Deviation
			Q1	Median	Q3		
Experts							
1. The consistent with the scope	4.70	0.48	4.25	5.00	5.00	0.75	0.375
2. The accuracy of the classification	4.60	0.52	4.00	5.00	5.00	1.00	0.500
3. The accuracy of the information relationship	4.60	0.52	4.00	5.00	5.00	1.00	0.500
4. The consistent of question and answer	4.50	0.53	4.00	5.00	5.00	1.00	0.500
5. The completeness of marketing	4.40	0.50	4.00	5.00	5.00	1.00	0.500
Total	4.56	0.50	4.00	5.00	5.00	1.00	0.500

B. Effectiveness evaluation of the chatbot from black box testing

In this section, black box testing was used to test to evaluation the effectiveness of chatbot. Black box testing is a software testing technique that ignores the internal mechanisms of a system or component [29] such as the internal code structure, implementation details and knowledge of internal paths of the software. This testing focus on inputs and output of the software system without bothering about internal knowledge of the software program.

The effectiveness evaluation results of the chatbot, focusing on the black box testing, showed that, among the five indicators, “Usability Test” criteria had the highest mean value at 4.70 together with the standard deviation value at 0.48 by experts and users have mean value at 4.70 together with the standard deviation value at 0.46, The other indicators had almost the same mean value which was higher than 4.19. The overall mean for experts was 4.52 and the overall standard deviation was 0.50 and the overall mean for users was 4.66 and the overall standard deviation was 0.48, showing that the developed chatbot was the highest effective, as shown in Table IV.

Table- IV: The results of black box testing for chatbot efficiency

Assessment Indicators	Experts		Users	
	Mean	SD	Mean	SD
1. Function Requirement Test	4.60	0.52	4.63	0.49
2. Function Test	4.60	0.52	4.65	0.48
3. Usability Test	4.70	0.48	4.70	0.46
4. Performance Test	4.50	0.53	4.68	0.47
5. Security Test	4.20	0.42	4.63	0.49

Total	4.52	0.50	4.66	0.48
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The result of evaluation for acceptance of the chatbot based black box that could be detected by experts and users while being used has high consensus. All of values the interquartile range no more than 1 and the quartile deviation no more than 0.5 in five assessment indicators shows as Table V.

Table- V: The results of black box testing for acceptance of chatbot while being used

Assessment Indicators	Mean	SD	Quartiles			Interquartile Rang	Quartile Deviation
			Q1	Median	Q3		
Experts							
1. Function Requirement Test	4.60	0.52	4.00	5.00	5.00	1.00	0.500
2. Function Test	4.60	0.52	4.00	5.00	5.00	1.00	0.500
3. Usability Test	4.70	0.48	4.25	5.00	5.00	0.75	0.375
4. Performance Test	4.50	0.53	4.00	5.00	5.00	1.00	0.500
5. Security Test	4.20	0.42	4.00	5.00	5.00	1.00	0.500
Total	4.52	0.50	4.00	5.00	5.00	1.00	0.500
Users							
1. Function Requirement Test	4.63	0.49	4.00	5.00	5.00	1.00	0.500
2. Function Test	4.65	0.48	4.00	5.00	5.00	1.00	0.500
3. Usability Test	4.70	0.46	4	5.00	5.00	1.00	0.500
4. Performance Test	4.68	0.47	4	5.00	5.00	1.00	0.500
5. Security Test	4.63	0.49	4	5.00	5.00	1.00	0.500
Total	4.66	0.48	4	5.00	5.00	1.00	0.500
Grand total	4.63	0.48	4	5.00	5.00	1.00	0.500

V. CONCLUSION

This research presents the Thai chatbot on social media marketing based on Facebook by using the ontology technique. The chatbot can efficiently answer the questions in the purchase of community products. The ontology technique is created to handle terms and relationships to describe the features of questions and answers in online community product purchases. The longest matching approach was used to increase the capability of the system to Thai word segmentation. The TF-IDF is applied to determine the relative frequency of words in a set of specified documents. Accuracy is evaluated the correctly classified and F-measure is evaluated the related terms by precision and recall. The black box testing technique and questionnaires were applied to evaluate the system. The results of the evaluation by experts and users were found this chatbot with the highest performance. It can be said that ontology based Thai chatbot on social media marketing could be effectively used as a tool to support community enterprises in buying their products. Future research, we will present the word detection and correction techniques of conversation inputs for Thai chatbot.

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