Dwipa Ontology III: Implementation of Ontology Method Enrichment on Tourism Domain

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Abstract— This article summarizes some research results related to ontology enrichment specific to tourism domains from 2014 to 2017. Currently, some ontology enrichment approaches can use learning machinery such as support vector machine (SVM), Conditional Random Field (CRF) and kNN. Several studies have also been successful in evaluating ontology enrichment results with several parameters such as precision, recall and F-Measure. In addition, our research can enrich Dwipa Ontology II which has been successfully done by population to object / sample. The method used in this research is ontology enrichment method. This technique or method is used to show background knowledge (ontology) by adding new concepts and relationships through the extraction process. The enrichment process is done on semi-automated web document (corpus). The process using statistics and linguistics, by applying evaluation techniques by using reviewers in the field of tourism. The end result of Dwipa Ontology III (enriched ontology) contains 4 main classes, 15 subclasses and 199 samples / objects. The expansion of general concept / subclass knowledge under the attraction classes are: cultural parks, artists and monuments.

Keywords: Ontology Enrichment, machine learning, statistics, linguistics, tourism domain, semi-automatic, Ontology Dwipa III.

I. INTRODUCTION

Tourism is the industry that contributes the fourth largest foreign exchange after oil, coal and palm oil amounting to US $ 10 billion [1]. On the other hand, the need for information technology in particular to encourage the tourism industry is closely aligned with the rate of development of information technology (ICT) in Indonesia over the past two decades. The field of tourism is a business activity that is highly dependent on information [2]. Therefore, the utilization of ICT is crucial in providing information infrastructure. The form of collaboration of ICT utilization with tourism is known as e-tourism. One of the concrete forms of its utilization is the website (webpages) used to rally or market tourism commodities to all corners of the world through the Internet infrastructure. The most important feature in a site that provides tourism information is a search feature. The downside of search engines on tourist sites is that the information provided is sometimes irrelevant to the keywords used and has accuracy which is low, thus providing results that are not in line with user expectations [3]. The information contained in the web pages was originally designed to be readily readable by humans. The increasing complexity and size of the web, prompted T. Barness Lee and his colleagues to develop Semantic Web in order to improve capabilities in processing and managing web content, so that the information has meaning that can be understood not only by humans but by computers [4]. Ontology is present as a standard mechanism of representation of knowledge to support semantic web implementation [4], [5]. Although the search results of tourism information provided by search engines ontology-based semantic web search show results that have a high degree of relevance, on the other hand, the performance of this search engine is still low because inference feature support is still very limited [6].

Efforts to organize and manage information about tourism in Indonesia have been pursued through various means. One way is to use ontology as a source of knowledge that describes tourism in several provinces in Indonesia. According to Tanaamah [8], organizing information using on- tology to support accommodation and travel agent services in the city of Medan (North Sumatra Province) is very important. One of the benefits is that a comprehensive ontology

structure can reduce missing information about accommodation, destinations, planes, and prices [9]. In line with the research conducted by Tanaamah above, in 2012 Kuntarto and Gunawan managed to organize information about Bali tourism into an ontology named DWIPA [10]. The resulting ontology consists of four main classes namely attraction, event, accomodation, and regency [6].

Along with the continuous increase of information about Indonesia tourism from year to year either presented in the form of web document (semi structure) or in other format, need to consider ways to be able to popularize and enrich the ontology that has been built. For example, Banowasari et al in 2012 has tried to enrich (population) on ontology in the tourism domain. However, the population process is only limited to adding 281 instances and 29 properties to the ontology of tourism that has been previously built manually and does not extend the concept of ontology [11].

In 2017, Kuntarto et all have been managed to populate 41 relevant instances to the initialy ontology Dwipa I consist of the following classs/ subclasses: Accommodation, Attraction, Event and Regency using semi-automatic ontology population. The final ontology named Dwipa II which consist of 193 instances. The method used on the research are Part-Of-Speech (POS) and statistical (TF-IDF). The result found that the terms of linguistic methods (POS) gives higher relevance than the statistical method (TF-IDF). As a part of ontology population, Dwipa ontology II also evaluated by using description logic (DL) query to check its consistency [22].

Zhang in 2013 managed to reassess on several researches of the construction of ontology based on WordNet in China. The paper stated that in order to successfully construct the ontology, three key issues which are computation of semantic similarity, construction of core ontology and development of auxiliary resources should be emphasized. This research also finds that some common features and inadequacies like semiautomatic construction, low utilization ratio of WordNet and the lack of standardized evaluation could also be summarized through this reassessment [23].

II. ONTOLOGY ENRICHMENT

A. Introduction to Ontology

Ontology is an "explicit specification of an abstraction" that is actualized through concepts, relationships, and objects. In principle, the ontology construction process can be classified into two ways: the development of ontology manually using the tools (editor) and ontology construction using machine learning (ML). In ML method, data extraction process from structured format (database) and unstructured (text) can be done automatically or semi-automatic (Figure 1). Ontology learning is a process of construction or ontology integration that applies the ML method. The process is divided into three main approaches: 1) integrating existing ontologies, 2) extending (enriching) existing ontologies, 3) generating ontology generics according to specific domains [3]. Petasis et al in 2011, proposed an ontology learning methodology. In general, the ontology learning process includes core ontology and multimedia corpus preparation (1) for the population through ontology population process (2). After passing through the population process, the successfully populated ontology will then be enriched through an ontology enrichment process (3). The result of this process is enriched ontology. The next stage proposed by Petasis et al is the process of examination and resolution of inconsistent ontology, this process is known as the inconsistency resolution process (4). The final stage of the ontology learning process is the evaluation process (5), the end result is evolved ontology [4].

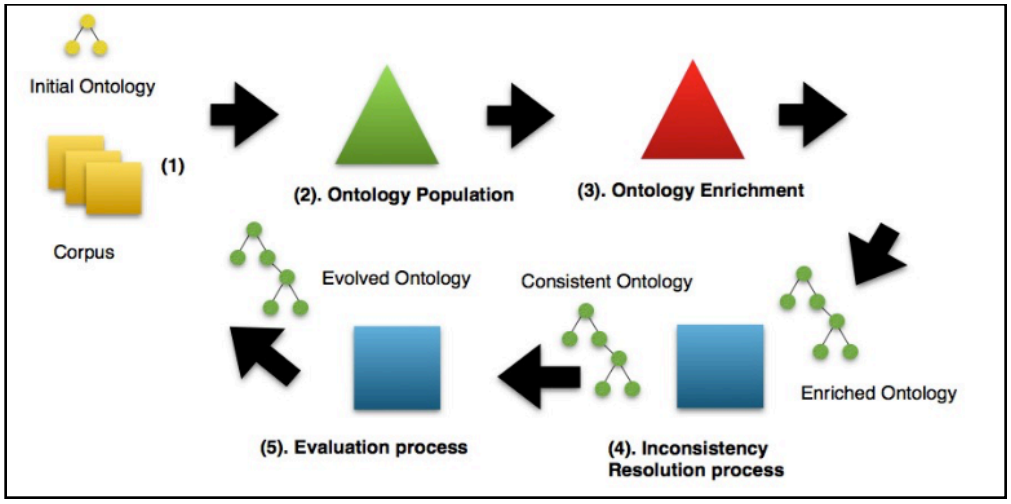

Figure. 1. The Ontology Construction from Text [3], [5].

The biggest challenge faced is the rapid ontology development with a high level of trust. The challenge is how information comes from a variety of sources (such as relevant text, web documents (eXtensible Markup Language (XML), Document type definition (DTD), and Resource Document Framework (RDF), database, dictionaries, semi-structured documents , email, wikis, and existing web ontologies) are extracted using several approaches such as natural language processing (NLP), machine learning, or statistical analysis to further study terms, synonyms, concepts, taxonomy, relations, rules and axioms so that ontology is generated rapidly have a high level of trust [8, 9] Ontology learning is the answer to the challenge [7].

In the early stages of ontology construction, ontology needs to be instantiated. This technique is known as the ontology population. However, there are limitations in terms of adding new concepts and relationships. This obstacle occurs because the initial ontology is unable to accommodate the population process [4, 9]. Thus, ontology enrichment is needed [9]. This activity aims to broaden background knowledge by adding new concepts and relationships through the process of information extraction. Unlike ontology population processes that can be done automatically, ontology enrichment process is usually done semi-automatically. In 2011, the BOEMIE project [9] proposed a semi-automatic ontology enrichment methodology approach. This method is known as isitilah Ontology Enrichment Methodology.

In general, the ontology enrichment process through three main stages is concept identification, taxonomic construction and extraction of semantic relations from data sources combined with initial ontology presented on figure 2. The final step of the ontology enrichment process is the evaluation stage. At this stage, evaluation is categorized into two stages: inconsistency resolution and evaluation process. Both methods are semi-automated, by applying one of the following methods: Golden Standard, application-based, data-drive and human or expert to ensure concepts, relationships and rules are appropriate. The "Golden standard" evaluation compares the ontology of ontology learning results with pre-define (usually manually built ontology). Application-based evaluation is used on integrated and implicitly integrated systems through an integrated system. Data-based evaluation is done by comparing the ontology of learning process results with data sources on the same domain. The last type of evaluation is through human-assisted evaluation. Evaluations are based on criteria, requirements or standards.

The evaluated variables include 1. Lexical, vocabulary and layer data 2. Relational layer and 3. ontology structure (for development) [14].

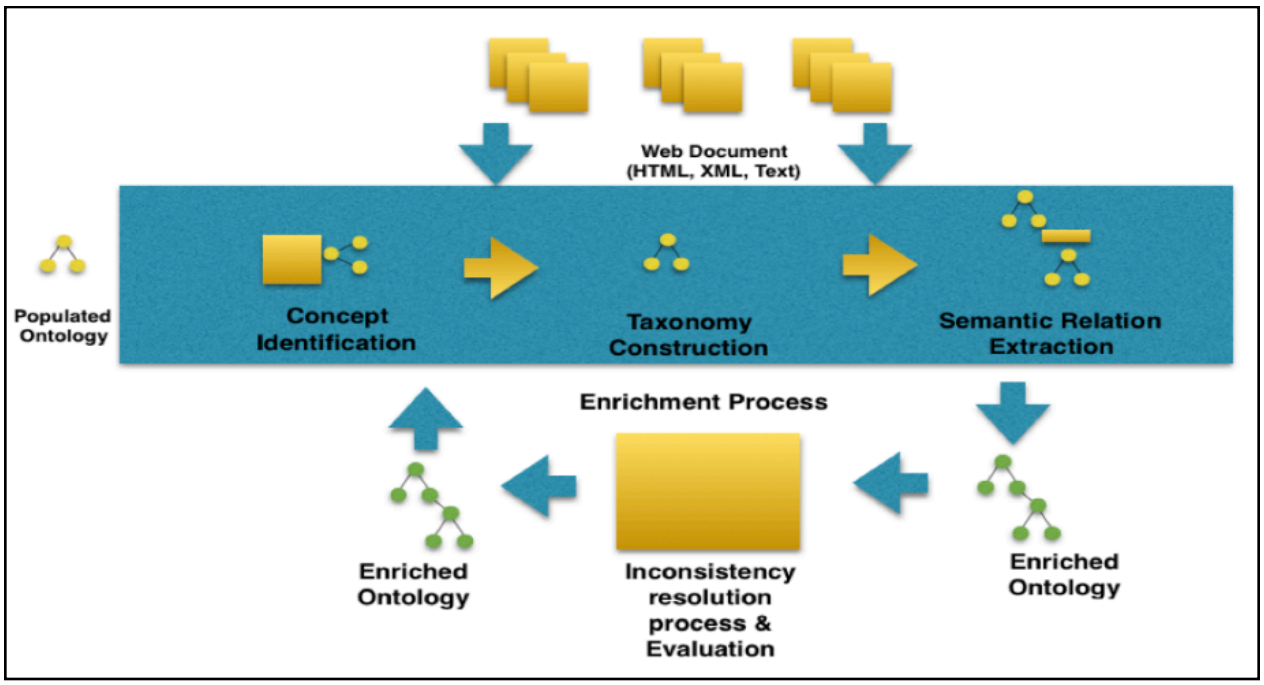

Figure 2. The Ontology Enrichment Process [3].

B. Review of Ontology Enrichment Methodology

Kularbphettong successfully developed an ontology for tourist information in Thailand. Methods of knowledge development related to cultural tourism by utilizing ontological theory to categorize tourist information and use data mining techniques to help categorize information and classify tourists' interest in cultural tourism. Source of data used in unstructured data (text / website). The results show that the reduction of Support Vector Machine (SVM) features and techniques present the highest accuracy. However, this study has not yet completely implemented a tool to expand the concept in experiments [8].

Imsombut, A. & Kajornrit, J. in 2017 has succeeded in producing ontology for tourism in Thailand. The data source used in this research is tourism website in Thailand. The methods used for ontology enrichment are statistical methods (Conditional Random Fields / CRF) and data mining methods (feature-weighted kNN classification). The results show that CRF techniques

provide greater precision and recall values than weighted features. The kNN method is more suitable for sequential data and unbalanced data [7].

In 2014 Bacciu et al, has succeeded in producing the Resources Description Framework (RDF). The data source used is The OpeNER Linked Dataset. This is a source of data for tourism in Tuscany. But the ontology / RDF construction is still done manually. The OpeNER Linked Dataset provides features: accommodation, luggage room or snack bar. [2].

Dennai, A. & Benslimane, S. M. in 2015 have succeeded in establishing Ontology. This study uses a data source HTML page or XML document. The data is further extracted into the tourism ontology domain. The extraction stage used is reverse engineering in web-based applications; In addition, this study also succeeded in indexing the ontologies built [6].

In 2014, Lisi et al successfully developed Ontology Web Language-Service (OWL-S) to support Integrated Tourism services in the Apulia region in the Puglia @ Service project. The data sources used are OnTourism and WIE-OnTour. The data available on OnTourism is data automatically generated from the Tri-pAdvisor and Google Maps websites. This research has not implemented machine learning: Foil-DL to improve the automatic composition of the OWL-S service. Foil-DL is used to remove compositions that do not reflect the preferences / expectations / needs of specific user profiles [11].

Soualah-Alila et al in 2016 managed to produce a tourism ontology called DataTourism. This ontology is built for the management of tourism data that solves many technical keys encountered while working with tourism data: heterogeneity, quality, interoperability, reusability and standardization. The study used a variety of sources, such as cellular or social networks, survey of tourist sites or satisfaction surveys, and in large numbers. In addition, a CDT17 and CDT touristic database is used. They are an important source for the tourism industry, but their heterogeneity makes it difficult to combine and analyze. This data used to map tourism, professional or political actors, is effectively managing and operating tourism information about their territory. The ontology enrichment technique used is semantic annotation and mining technique using machine learning. However, this study has not yet discussed the issue of ontology evaluation [16].

In 2015 Tachapetpaiboon, N. & Kularbphettong, K. succeeded in developing the knowledge (ontology) about cultural tourism information in the case of Dusiti Regency. Research starts from collecting all the problems and issues used in the system. Information is used on the basis of linguistic expert interviews and cultural management. From the results of publication, has not been found ontology enrichment and evaluation techniques. However, this research successfully developed a prototype of ontology-based cultural information tourism developed only for use in Dusit [17].

Tabel 1. Ontology enrichment technique on tourism domain

Peneliti	Tahun	Sumber Data	Teknik *Ontology Enrichment*	Teknik Evaluasi	Hasil Penelitian
Bacciu C., A, Duca, L. A., Marchetti, A. , & Tesconi, M.	2014	OpeNER Linked Dataset (OLD)	x	x	*Resources Description Framework* (RDF)
Lisi, F. A. & Esposito, F.	2014	OnTourism & WIE- OnTour	Machine Learning dan WSDL	x	*Ontology Web Language Services* (OWL-S)
Kularbphettong, K. & Tachapetpaiboon, N.	2015	Interview dari pakar linguistik dan management kultural	x	x	*Cultural Tourism Information Ontology-Based*
Dennai, A. & Benslimane, S. M.	2015	HTML dan XML	Indexing	x	*Domain-based Ontology* untuk *Tourism*
Soualah-Alila, Fayrouz and Coustaty, Mickael and Rempulski, Nicolas and Doucet, Antoine.	2016	Touristic Database CDT17 & CDT10	Annotation dan Mining	x	*DataTourism*
Imsombut, A. & Kajornrit, J.	2017	Thai tourism websites	Conditional Random Fields dan kNN	Precision, Recall dan f-Measure	*Ontology* untuk Thailand *Tourism.*
Kularbphettong, K.	2017	unstructured data (teks/ websites)	Machine Learning: Support Vector Machine (SVM)	Precision, Recall dan f-Measure	*Ontology* untuk *tourist information Thailand*

III. METHODS AND RESULTS

A. Methods

In general, the method applied in this study of the process involves a combination of two different approaches, namely automatic and manual processes (semi-automatic), as illustrated in Figure 4.

This research begins by preparing a collection of web documents (semi-structure data). The next process is to define the concept (class); this process aims to identify ontology concepts

including intension, extension and lexical realizations. After the concept definition process is completed, the next process is to execute the semantic relation extraction process consisting of: consist- of, purpose, causation, and attribute. The Corpus extraction that has been collected from these sources is done using the part-of-speech (POS) and statistical method (TF-IDF) method to generate a list of candidate terminology. This process is done automatically.

Evaluation on ontology enrichment is done semi-automatically, ie by involving experts to ensure concepts, relationships and rules are appropriate. Enriched ontology is evaluated using data-driven and human evaluation methods. The variables examined include: 1. Lexical, vocabulary and data layers; 2. Relational layer; and 3. ontology structure (for development). From here it will be calculated precision, recall and F-measure in order to obtain the best final terminology.

The evaluation of the extraction results of the methods tried in this research (linguistic, statistical and hybrid) will follow the evaluation procedure performed by [17] using Precision, Recall, and F-measure parameters. This evaluation will determine the relevance of the terminology generated according to the method employed.

Precision (P) is the ratio between the acceptable number of acceptable (A) terms to the total number of all relevant and irrelevant terms received (B):

$$P = \frac{A}{A+B} \times 100\% \qquad (1)$$

Recall (R) is the ratio between the amount of acceptable term (A) with the number of relevant terminology that should be accepted (C):

$$R = \frac{A}{A+C} \times 100\% \qquad (2)$$

While F-measure (F) is the balance between the two precision and recall indices as follows:

$$F = 2 \times \frac{P \cdot R}{P+R} \times 100\% \qquad (3)$$

One of the biggest challenges in calculating precision, recall, and F-measure metrics is the validation process to determine the relevance of terminology that can not be detached from the appraiser's appraisal factor [18]. When an assessor reads a corpus, the terminology it reads may be different from that read by another judge, or even by itself when the corpus is read at different times. That's why it takes more than an appraiser to avoid this factor of subjectivity.

B. Results: Ontology Enrichment on Dwipa Ontology II

This research uses initial ontology Dwipa Ontology II which has been developed by Kuntarto et al. in 2017 [22]. The ontology produced in the study still has limitations in the form of concepts, relationships and instances. The reason is that the ontology core is unable to accommodate instances derived from the semi-automated extraction process of the web document. Departure from the limitations on the ontology, in line with Petasis then open the opportunity to do ontology enrichment by extending the concepts, relationships and instances [14].

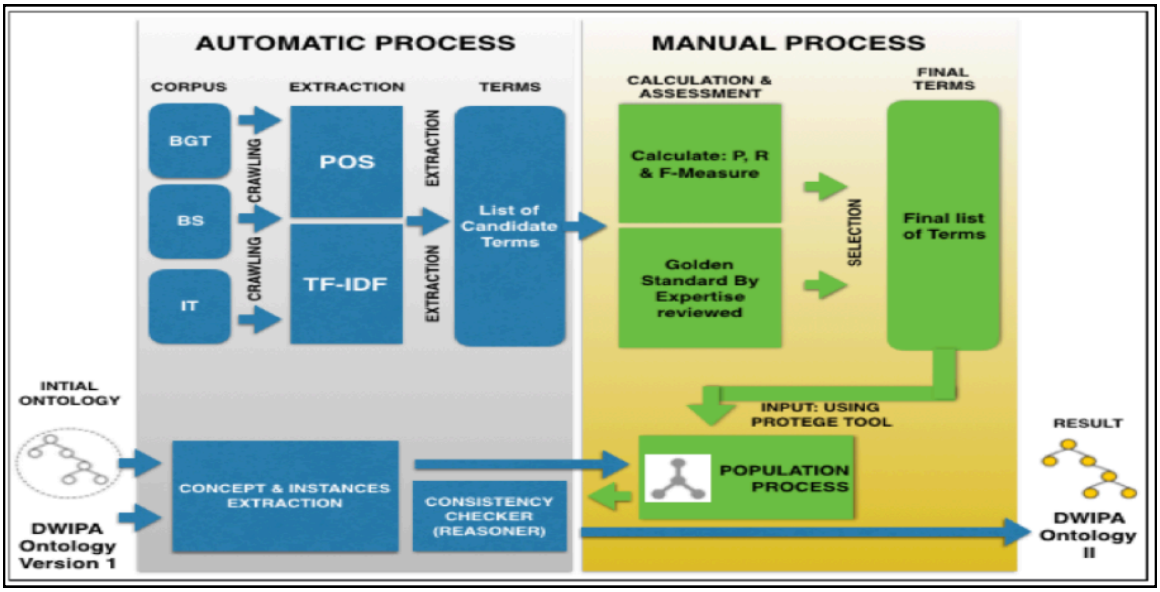

Figure 3. Semi-automatic ontology population process on Dwipa Ontology [22].

In contrast to the ontology enrichment technique as described in Table 1, this study uses data sources in the form of corpus from web documents related to the tourism domain. Referring to Petasis in 2014, the ontology enrichment process in this study is one of the integral processes of

ontology learning. In general, ontology learning consists of several processes: The process is divided into three main approaches: 1) integrating existing ontologies, 2) extending (enriching) existing ontologies, 3) generating ontology generics according to specific domains [3].

Ontology engineering (ontology enrichment) or ontology extension on the object or instances used is using statistics and linguistics used to select the best corpus candidate. Meanwhile, the enrichment process consists of the identification of the concept (class), taxonomic construction and extraction of semantic relations. The evaluation technique used to select features / instances derived from web documents is to use precision, recall and f-measure parameters.

Referring to the concept that has been developed by [3], this study followed up the existing deficiencies in [19] who have successfully populated ontology initials (Dwipa Ontology I) semi-automatically by adding 41 new instances generated through the selection process using statistical and linguistic techniques. However, there are still candidates for instances that have not yet been able to be popularized due to the limited concept of Dwipa Ontology I used [19]. The enrichment process consists of identification of concepts (classes), taxonomic constructs and extraction of semantic relations. The concept identification process found that there are seven instances that the population can not do, due to the limited concept of initial ontology. In general, the instances consist of an instance which is a concept or class of cultural parks, two instances are classified into monument buildings, and three instances are categorized into Balinese artist categories or concepts.

After the concept identification process is successfully done, the next process is the construction of taxonomy and extraction of semantic relations. The Corpus used in ontology enrichment is text; therefore, according to [3] the taxonomic construction process which can be done is semantic rather than syntax. The semantic process is chosen by considering that the corpus has been selected by using the linguistic approach (syntax) by using the Part-of-Speech (POS) technique with the separation of the corpus based on the noun word. Therefore, the semantic technique approach is chosen with consideration to elaborate the relation of the concept and the instances that have been selected.

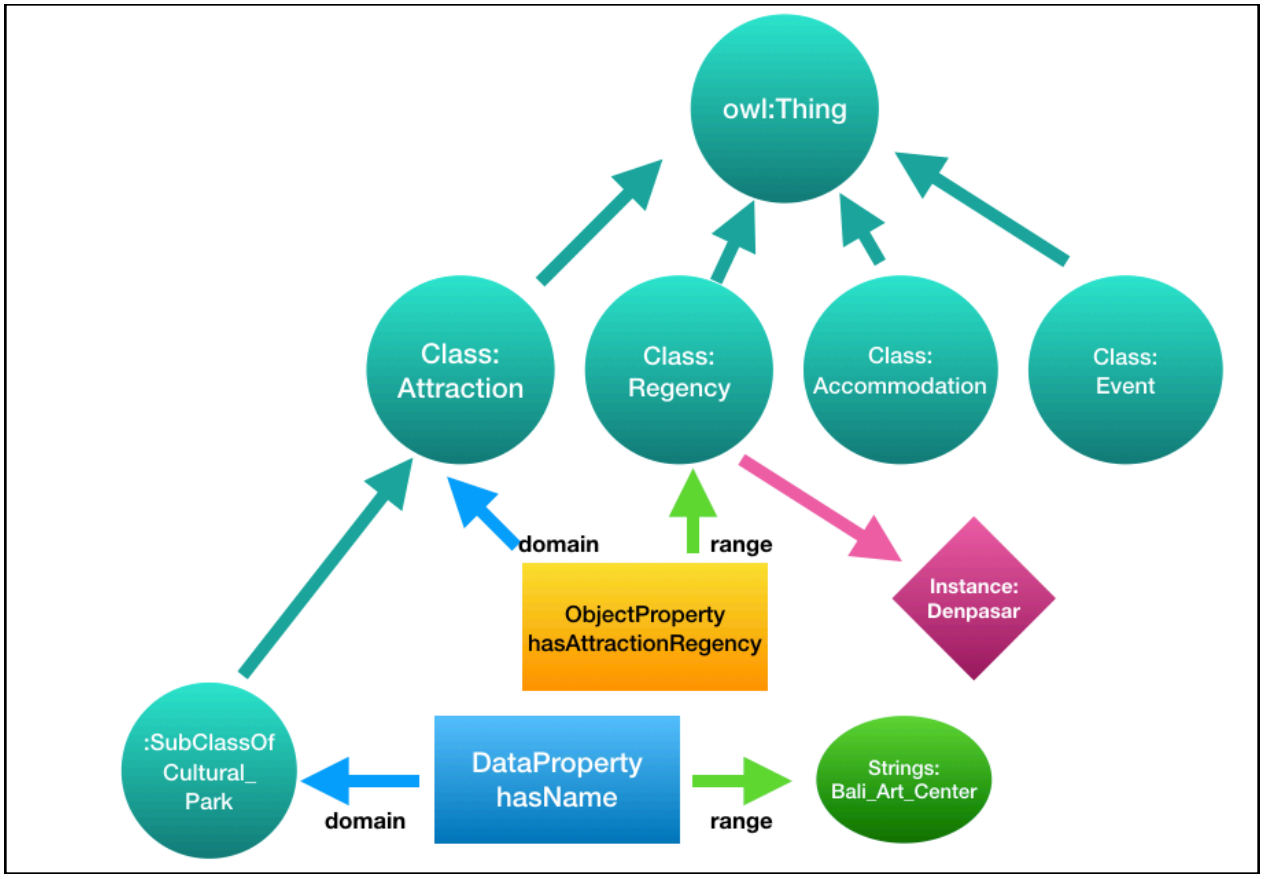

Figure 4. The process of elaborating a new concept of taxonomy: Cultural Park.

For example, the example: Bali Art Center is a cemetery of a cultural park. Cultural Park on the initial ontology has not been defined, so it is necessary to create a new concept that is: Cultural Park under the class: Attraction. Cultural Park is a tourist attraction so that the new concept is created under the class (subclassOf) Attraction. Figure 4 explains the taxonomic elaboration of a new concept: Cultural Park which is an extension of the (class) Atrraction concept that has an instance: Bali Art Center. Extraction of semantic relations generated from the ontology initialis is objectProperty with the name hasAttractionRegency and dataProperty with the name hasName. The semantic relationship hasAt- tractionRegency elaborates the relationship or relation between the class of Attraction with the Regency class. In other words, this model declares that Subclass: Cultural Park is a subclass of the class: Attraction has a relationship with class: Regency via objectProperty: hasAttractionRegency, where Regency has an instance:

Denpasar. While DataProperty: hasName declared that the renewal of the new concept has the domain dataP- roperty: hasName to subclass: Cultural Park and range to instance with string data type and value: Bali Art Center (Figure 5).

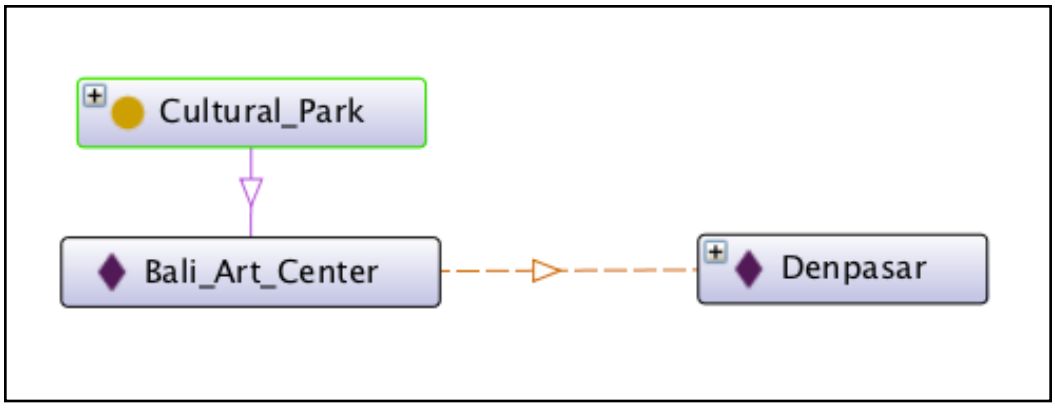

Figure 5. The process of elaborating a new concept of taxonomy: Cultural Park and semantic extraction of relationships with the name Bali Art Center located in Denpasar using OntoGraf visualization.

At this stage, semantic construction and semantic extraction of relationships have expanded the new concept of "Bali Art Center is an attraction of Cultural Park located in Denpasar". In addition, also successfully expanded the concept of monument and artist under the concept of attraction. With the addition of successive instances for the concept of monument: bhara badung, Bajra Sandhi monument; and for artist concepts: I Gusti Made Deblog, Anak Agung Gede Sobrat, and I Gusti Nyoman Lempad. For the two new concepts, the extraction of the semantic relation generated from the initial ontology is objectProperty with the name of hasAttractionRegency which gives the semantic meaning of the origin/ location of the intended attraction and the dataProperty with the name of theName that gives the semantic value of the extended concept. The data type used in dataProperty and ObjectProperty is String.

After the testing process using DL query done, then the next process is evaluation of enriched ontology. The ontology evaluation technique used in this study is a data-driven evaluation technique. This data-based evaluation technique is done by comparing the ontology of the learning process/ enrichment with the data source on the same domain [3]. By comparing the results of ontology enrichment to data sources from various online sources such as www.tripsketch.com, www.viator.com, and www.balisurfadvisor.com it can be concluded that the expansion of the new concept of Bali Art Center in accordance with the facts on the domain of tourism, especially in the Province Bali.

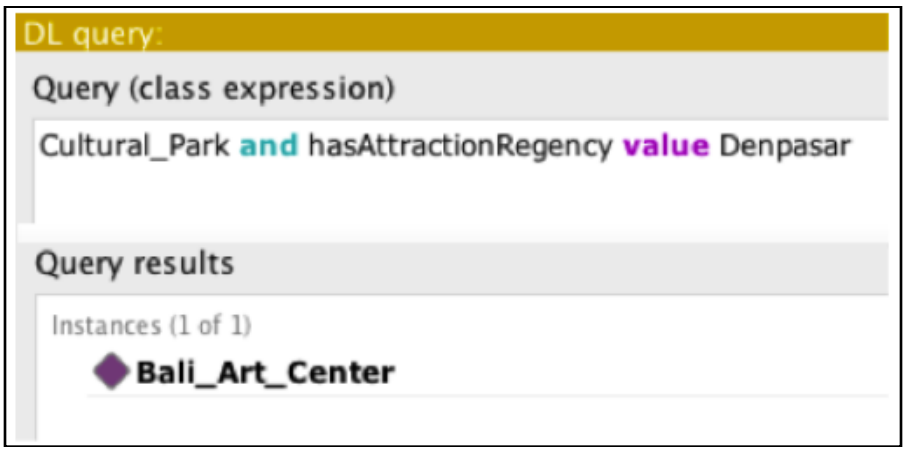

Figure 6. Description Logic (DL) queries and outputs are generated

The end result of Dwipa Ontology III (enriched ontology) contains 4 main classes, 15 subclasses and 199 instances / objects; in summary the final result is given in Table 2. The illustration of the results of its ontology development is given in Figure 7. The extent of knowledge generally adds the concepts / subclasses under the class of Attraction: Cultural park, artist and monument.

Tabel 2. Evolution of Dwipa Ontology on the tourism domain

Class & Subclass	Dwipa Ontology I (Initial)		Dwipa Ontology II (Populated)		Dwipa Ontology III (Enriched)	
	Feature	Number of Instances	Feature	Number of Instances	Feature	Number of Instances
Class: Accommodation	v	28	v	37	v	37
Class: Attraction						
Subclass: ArtVillages	v	10	v	11	v	11
Subclass: Diving and Snorkelling	v	11	v	12	v	12
Subclass: Ecotourism	v	11	v	21	v	21
Subclass: Historical Building	v	4	v	7	v	7
Subclass: Lake	v	5	v	5	v	5
Subclass: Museum	v	14	v	16	v	16
Subclass: Rafting	v	2	v	3	v	3
Subclass: Surfing	v	24	v	24	v	24
Subclass: Temple	v	12	v	26	v	26
Subclass: TraditionalArtMarket	v	13	v	13	v	13
Subclass: Waterboom	v	1	v	1	v	1
Subclass: Watersport	v	1	v	1	v	1
Subclass: Cultural_Park	-	0	-	0	v	1
Subclass: Artist	-	0	-	0	v	3
Subclass: Monument	-	0	-	0	v	2
Class: Event	v	7	v	7	v	7
Class: Regency	v	9	v	9	v	9
Total Instances		152		193		199

IV. CONCLUSIONS

This research has succeeded to summarize some research result related to ontology enrichment development on tourism domain from 2014 until 2017. Currently, some ontology enrichment approach using machine learning such as support vector machine (SVM), Conditional Random Fields (CRF) and kNN. Several studies have also been successful in evaluating ontology enrichment results with several parameters such as precision, recall and f-measure.

In addition, this research succeeded in enriching Dwipa Ontology II which has been successfully done by population to object / instances. The method used in this research is ontology enrichment method. This technique or method is used to extend the knowledge (ontology) of the background by adding new concepts and relationships through the process of information extraction. The enrichment process is done on semi-automatic web document (corpus). The process of selecting candidates or terms instances is done by a statistical and linguistic approach. By applying logical tests using description logic (DL) queries and data-

driven evaluation techniques, Dwipa Ontology III (enriched ontology) is generated containing 4 main classes, 15 subclasses and 199 instances / objects with new concept extensions: Cultural_park, artist and monument.

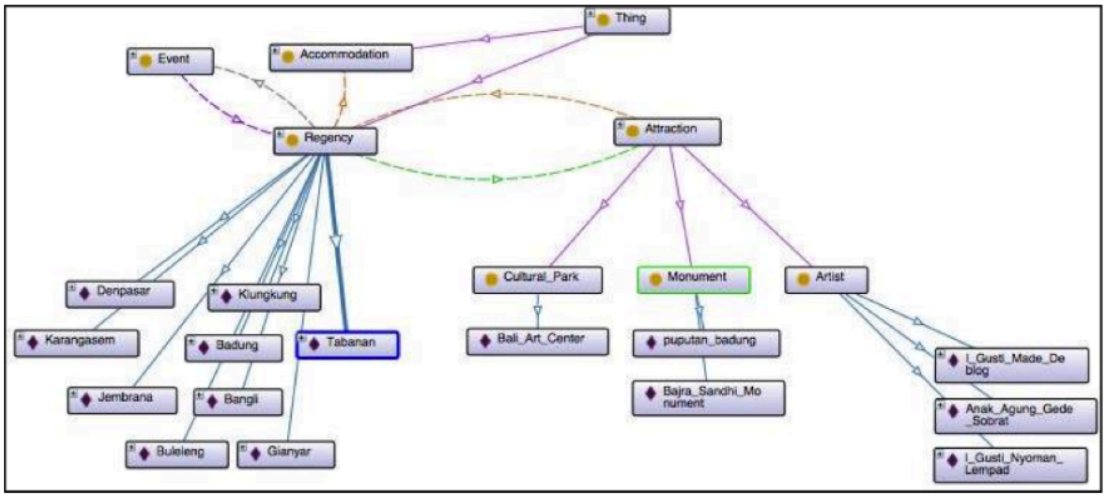

Figure 7. Dwipa Ontology III: The final result of ontology enrichment using Ontology Enrichment method on tourism domain

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