Modeling Ontology and Semantic Network of Regulations in Customs and Excise

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Abstract

Regulations in customs and Excise have an important function in regulating legally every policy and decision making. Thus, the type of rules are made varies according to the hierachy of the regulator. This regulation is also changing, following policy developments that occured in the higgest government. then, what if this organization has not been able to manage its regulatory archiving? even regulatory changes can not be tracked? So, we need a well-organized system that can accomodate all of the rules and the associated changes and connectedness with other type of regulations. This system will help us to provide convenience to users to search, manage and track the history of changes as well as the relationship between the rules used by the organization. This paper propose the design of an ontology-based semantic network using a graph database that use neo4j 2.3.1 as a solution. In the application that uses the sample data, we found 13 types of nodes that contains 242 child nodes and 22 type of relation that contain 548 relation that connect all the node within 3305ms.

Keywords: Customs and Excise, Neo4j, Ontology, Regulations, Semantic

1. Introduction

Regulation in customs and excise is the kind of legislation that formed under the authority of many government such as President, Minister of Finance Republic of Indonesia, etc. These regulation have binding force to achieve the goals and spesific benefits within the Directorate General of Customs and Excise.

Directorate General of Customs and Excise is one of the directorates that governed by the Regulation of the Minister of Finance with the ten echelon 1 under the Ministry of Finance (Secretariat General, Inpectorate General, Directorate General of Tax, Directorate General of Budget, Directorate General of Treasury, Directorate General of State Assets, Directorate General of Fiscal Balance, Directorate General of Budget Financing and Risk Management, Fiscal policy Agency and Financial Education and Training Agency).

Regulation has a crucial function to the administration of the work as well as the applicable law on the organitation. Especially after the launch of the automation of Customs and Excise service activities. Regulation and any relevant rules become a major base in the bussiness process that will translate into an application. Every form of services and bussiness processes, will be computerized and connected transactions with the bank or the state treasury.

In managing the document of Regulation of Directorate General of Customs and Excise, they have a repository of regulations. There are 755 items of regulations that managed in the repository with 15 kinds of rules and 179 regulation tag (http://peraturan.beacukai.go.id). However, there are some problems in accessing the link, and a search system does not work optimally in displaying relevant, complete and current regulations. Moreover, the most fundamental problem of the repository is the lack of connectivity or relationship like between PMK and the other regulations such as UU, Peraturan Pemerintah, Keputusan Presiden, Peraturan Presiden, Keputusan Menteri Keuangan, Per Dirjen, Kep Dirjen, etc. It still look minimal and incomplete. This situation made it difficult to get the information about the rules that have to get change or relationship contained in it. Then, we can formulate, what if this organization has not been able to manage its regulatory archiving? even regulatory changes can not be tracked? This leads to the shift of users to systems belonging to other organizations

that are able to provide for their needs. While the availability of rules on the system, not necessarily true. This will result in failure of the organization in conveying information about the rules to the community. So that people, companies, importers, warehouses and others will be blind and unable to understand the customs rules they need to know. So, it is necessary to do the assessment and development of a repository that can provide solutions to these problems. Then, Modelling an ontology and semantic network is considered to be one solution that can handle the problem.

Ontology is considered as a set of representational primitives that models a domain of knowledge or discourse [1]. A few of research that discussing the semantic nertwork design and ontology of the regulatory authorities, but this following are some studies related to the development an ontology already made. Some of them are Engers, et al [2] use POWER programe that support a systematic translation of (new) legislation in The Dutch Tax and Customs Administration (DTCA). The result of this research, willl able to improve the quality of law enforcement and decrease the time needed for implementing changes in legislation and regulations with detect and report annomalies inside. Klischewski [3] try to make a solution for how to organize and present document of state administration of Schleswig-Holstein (Germany) so that the users will able to retrieve the document needed. He propose to use ontology-based approach. But we cant find the proposed design of the ontology and the semantic of this research.

Chorco, et al [4] who built a juridical ontology using methontology development methodologies and WebODE as the software platform. Furthermore, Saias and Quaresma [5] applied the techniques of NLP (Natural Language Processing). Ontology of this study was defined through OWL with logic programming framework using EVOLP + ISCO. EVOLP is a dynamic logic programming framework that allows the definition of rules for actions and events (law), are used by researchers to conduct intances ontologies and object representations. While ISCO allows easy integration and efficient. ISCO has the ability to connect an external database and used as an inference engine that can answer the query semantic content of the document.

Gangemi [6] use CODeps (Content Ontology Design Patterns) as a resource and design method engineering ontology content over the semantic web for legal knowledge engineering. Its shown taxonomy of ontology-driven tasks for legal information in general. Priya [7] proposed a personalized search engine which is hybrid system for personalized search an reasoning over users profiles. They use protege as tools that modelling the ontology, but the relation still not intuitive because the relations between the class is still look like an hierarchy. Its looks different to those studied by Putra, et al [8], he create prototype of SOP navigator that managing document SOP of Bogor Agricultural University. This SOP navigator used ruby programming language, sinatra web framework and neo4j graph database. The relations between the node/class looks very intuitive. Xu [9] was concentrate to modeling ontology knowledege management in bycicle product design through UML class diagram. It because the bycicle product design did'nt have fuzziness hirarchy.

Based on these studies, OTK method has advantages similar to Methontology. OTK had measures more complete than Methontology. Starting from the project management process, the process of ontology development orientation to the integration process. Whereas Methontology defining the detail of the features in these measures. So, OTK will be the methodology to be used in this study. As for the semantic network design, this study will use Neo4j 2.3.1 as the main tool. We try to design node, relationship and the entire regulations document. This is due to the minimal research on ontology using Neo4j with excellence as a tool for graph database, ontology and semantic. Kivikangas [10] described that Semantic data is easily represented as graphs, provides graph database more natural abstraction for such data than relational database. While Miller [11] said that the graph databases have a natural application to biology, semantics, network systems, and recommender who require this type of data model only they can offer.Graph database is also described by Malhotra [12] as the evolution of technical knowledge representation based on semantic web.

2. Research Method

In obtaining the results of research in accordance with the purpose, it takes the steps of research activity.

The steps of this research are using an ontology structure with development methods On-To-Knowledge (OTK). The selection of the method is based on the advantages of OTK method that has more spesific and detail in every single steps that it has. Corcho O [13] even said that this methodology can identify the purpose based on the analysis of usage scenario that must be achieved by a knowledge management tools.

a. Kick Off

At this step, there will be analyzing the current system such as: the form of knowledge management, knowledges stored, the type of knowledge and information produced by the current system. Doing analyzing the weaknesses of the current system and how to modelling a new system that can cover the weaknesses of the current system. Furthermore, the analysis of the users of the system and any information and knowledge that needed. To reach the goal at this step is carried out literature studies and collect every data needed (both from interviews and observations).

b. Refinement

This step determines the domain ontology, determine part of ntology and the relations that will be built within the ontology. It start from designing herarchical part of ontology, build the class and subclass relationship within semantic network which tailored to the needs and the current system. Furthermore, the design will be use Neo4j as a graph database software.

c. Evaluation

This step will testing the new system has been built with query that provided by neo4j. If there is a failure in the test results, the the system must do repairs and improvement.

3.   Results and Analysis
3.1 Kick Off

The documents of regulation had been obtained from the competent directorate. Documents to be entered dan displayed in the semantic network should be the final document. So, this study will use the document of regulation that set in year 2007-2011. The regulation that establish in the year above 2011 will not put in semantic network. This is done to avoid changes in the construction of semantic networks. So, from 755 items of rules that managed in the repository with 15 kinds of rules and 179 regulation tag, we set 106 objects that represent the theme of regulation

In this study, we used some objects as a prototype of semantic network. The scope of this research are 2 Area that have 10 of objects of Customs and Excise, 39 of Topics, 29 of article of UU, 2 of PP, 10 of KMK, 50 of PMK, 13 of Users, 25 of Per Dirjen, 16 of SE and 2 of Kep Dirjen. This regulation will called as class or node in diagram, and all of this node will connected with 22 relationship. After determining the scope of the research, we also define the scope of the topic as well as the regulation that will be incorporated into the semantic network.

3.2 Refinement

In this step, the knowledge is captured from documents that have been colleted. Any such of knowledge is represented in the form of domain ontology and semantic network. However, in the ontology building process, the computer needs a precise definition of formal knowledge; also need the knowledge engineer's participation. In addition, a domain ontology perfect is an iterative process of evolution in the construction [14]. Based on data and information relating to the regulation concerning customs and excise, it has been designed ontology of customs and excise regulations as shown in Figure 1.

The objects in the domain knowledge of the regulation concerning customs and excise identified. The objects is compiled into the class and subclass forming taxonomy. Some classes that have been identified, are:

1. Objects of customs and excise. This class is the main class that is displayed as the initial class in building a class hierarchy. Objects of customs and excise indicates the domain of regulation of customs and excise. So, all classes will be defined in the domain under this class.
2. UU or Legislation. This class stores information about the content of regulations shaped the legislation. legislation is the regulations that have highest level within the hierarchy of rules in the finance ministry.
3. UU Details. This class contains the clause of UU (Legislation).

4. PP or Government Regulations. This class stores information about government regulations that issued by the President. This regulation has a number two positition in the hierarchy of regulation of the finance ministry after legislation.
5. KMK or Minister of Finance Decision.. This class contains information about the rules that made by the finance minister. KMK is an administrative decision making by finance minister.
6. PMK or Minister of Finance Regulations.This class contains information about the rules that made by the finance minister. These regulations contain detailed implementation rules based on the rules above as: legislation, government regulations, presidential decrees, regulations of president and decision of finance minister.
7. KepDirjen or Director General's Decision. This class contains information about the directorate general regulations. KepDirjen is an administrative decision making by director general of customs and excise.
8. PerDirjen or Director General's Regulations. This class contains information about the directorate general regulations made by the director general of customs and excise.
9. SE or Circular Letter. This class contains information about a collection of circular prepared by the director general of customs and excise. This circular serve as guidance in the implementation of bussinessprocesses that require additional rules for their implementation instructions detailing.
10. Activities Diagram. This class contains a set of diagram that became a summary of all spesific business processes elaborated within entire regulations.
11. Users. This class contains information about who the actors involved in the bussines processes within all regulations.
12. Area. This class contains two subclasses, namely customs and excise. This class is the location of the objects of customs and excise.
13. Topic. This class contains information on any topic that exist in all regulations related to spesific objects of customs and excise
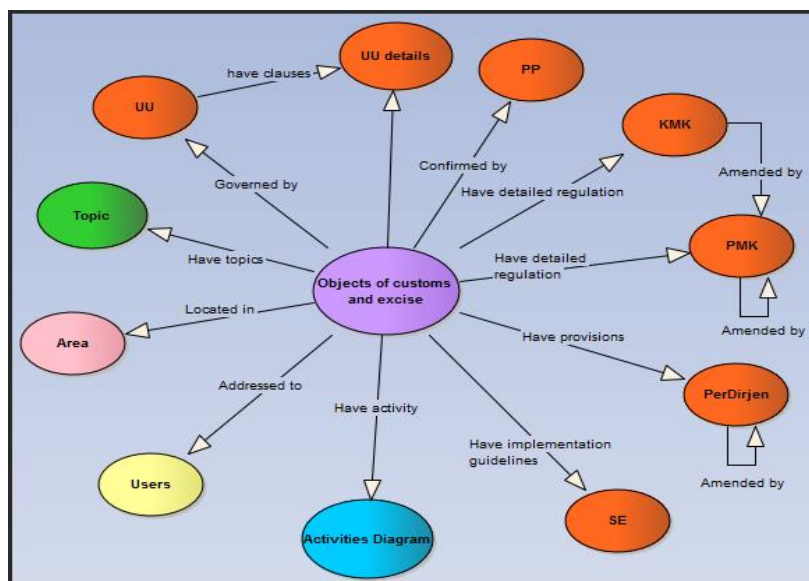
Figure 1. Regulation ontology of customs and excise

After identifying the class on ontology, relation and properties of these classes will be defined. Classes that are constructed will be represented as nodes using Neo4j graph database software. Whereas the relation will be representes as relationship type and its properties will be represented as property keys. In this step, we made a big semantic network. We used 11 types of nodes that contains 242 nodes with details as follows:

Table 1. 11 Types of Nodes

No.	Types of nodes	Number of nodes	No.	Types of nodes	Number of nodes
1.	Area	2	8.	Users	13
2.	Objects of customs and excise	10	9.	Per Dirjen	25
3.	UU	29 law article	10.	SE	16
4.	Topics	39	11.	Kep Dirjen	2
5.	PP	2	12.	UU details	29
6.	KMK	10	13.	Activity Diagram	41
7.	PMK	50			

Furthermore, we used 22 types of relationship that contains 548 relation with details as follows:

Table 2. 22 Types of Relationship

No.	Types of relation	Number of relation	No.	Types of relation	Number of relation
1.	Set_with	41	12.	Have_clauses	29
2.	Equipped_with	3	13.	Have_topics	38
3.	Confirmed_by	3	14.	Have_first_amandement	25
4.	Addressed_to	72	15.	Have_second_amandement	11
5.	Amanded_by	19	16.	Have_third_amandement	5
6.	Completes_UU	39	17.	Have_fourth_amandement	2
7.	Completes_PMK	46	18.	Have_fifth_amandement	1
8.	Have_activity	42	19.	Have_six_amandement	1
9.	Have_detail_rules	32	20.	Have_implementation_guidelines	9
10.	Have_provision	19	21.	Detailing_UU	59
11.	Have_objects	10	22.	Refer_to	42

So, we split the semantic network into two parts, namely customs and excise. The result of the semantic network that generated by Neo4j, shown in Figure 2 (ontology of excise) that displyaing 95 nodes and 227 relationship (completed with 130 additional relationship). Whereas Figure 3 (ontology of customs) displaying 155 nodes, 328 relationship (completed with 166 additional relationship).

Figure 2. Ontology of Excise

Figure 3. Ontology of Customs

3.3 Evaluation

This step will verify the semantic network that has been built. So, testing the query will be done by using Cyper. This test aims to see the nodes that connected by the relation such as:
1. Displaying the relationship of "amanded_by" by using query:

MATCH ()-[r:amanded_by]->() RETURN r

Search result with the relation "amanded_by" as follows as shown in Figure 4. The result of the evaluation indicate several nodes like PMK (19), PerDirjen(3), SE (5) and UU (4) that connected with "amanded_by" (19) and "completes_PMK" (3), the details are:
1. PMK No. 36/PMK.04/2005 "amanded_by" PMK No. 37/PMK.04/2005;
2. PMK No. 107/PMK.04/2009 "amanded_by" PMK 212/PMK.011/2011;
3. SE-11/BC/2010 "completes_PMK" PMK No. 190/PMK.04/2010 "amanded_by" PMK No. 167/PMK.011/2011; SE-11/BC/2010 "amanded_by" SE-27/BC/2010 "amanded_by" SE-19/BC/2011 "completes_PMK" PMK No. 167/PMK.011/2011; SE-27/BC/2010 "completes_PMK" PMK No. 167/PMK.011/2011
4. PMK No 09/PMK.04/2009 "amanded_by" PMK No 159/PMK.04/2009; and
5. PMK No. 22/PMK.04/2006 "amanded_by" PMK No. 67/PMK.04/2006 "amanded_by" PMK No. 64/PMK.04/2007 "amanded_by" PMK No. 177/PMK.04/2009 "amanded_by" PMK No. 27/PMK.011/2011 "amanded_by" PMK No. 70/PMK.04/2012
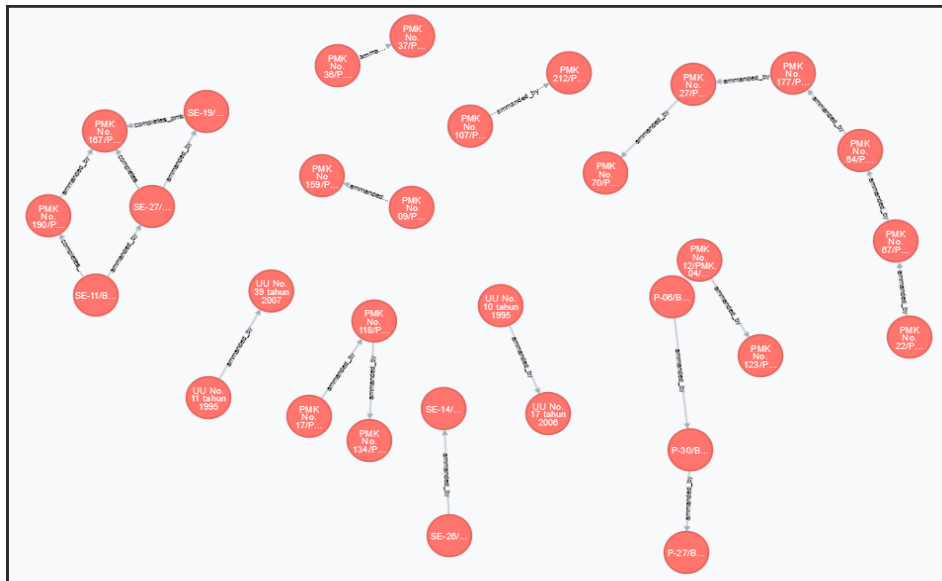6. Etc.

Figure 4. Search Result of amanded_by

2. Displaying the relationship of "addressed_to" by using query:
    MATCH ()-[r:addressed_to]->() RETURN r
    Search result with the relation "addressed_to" as follows as shown in Figure 5). The result of the evaluation indicate several nodes like Acitivity Diagram (41) and Users (13) that connected with "addressed_to" (72), the details are:
    1. Activity Diagram that connected with Importer, are :
        a. Diagram of Submission of Tariffs Application of Tobacco Importer Import Tariff
        b. Procedure of Payment, Receipt, Deposit of Import Duty, Administrative Penalty and Interest Diagram
        c. Customs Registration Diagram
        d. Diagram Submission Application for Customs Tariff of Alcohol Importer
        e. Diagram Imports Military Supplies
        f. Diagram of Submission of Import Duty and / or Excise
        g. Import Moving Goods Diagram
        h. Request for Exemption of Sample Goods import Diagram
        i. Diagram of application for the Exemption of Import Duty on the Import of Goods already exported
        j. Diagram of application for the Exemption of Import Duty on the Import of Human Therapeutic Material
        k. Diagram of Importing Government-Financed Medicines
        l. Physical Examination Diagram
        m. Etc
    2. Activity Diagram that connected with Manufacturer, are:
        a. Diagram of Submission of Tariffs for Tobacco Excise Tax;
        b. Custom Imported Ribbon Design Diagram
        c. Customs Ribbon Design Diagram
        d. Retail price pricing of Tobacco Products Diagram
        e. Design of Excise Band of Fiscal Year 2011 Diagram
        f. Excise repayment Diagram
        g. Customize Excise Ribbon Diagram
        h. Administration of Reception, Storage, Delivery and Refund of Excise Taxes Diagram
        i. Diagram of Submission of Application of Tariffs for Tobacco Excise of Factory Entrepreneurs
        j. The method of payment of state revenue Diagram

        k.   Design of Excise Ribbon for Fiscal Year 2012 Diagram
        l.   Diagram of Submission of Application of Excise Tax Rate of Factory Entrepreneur
        m. Pricing of Retail Selling of Ethyl Alcohol, MMEA and Concentrates containing Ethyl Alcohol Diagram
        n.   Etc
    3. Etc.

Figure 5. Search Result of addressed_to

4. Conclusion

Ontology and semantic network of regulation of the minister of finance concerning customs and excise has been succesfully modeled. The resulting models include node, relationship and properties that owned by each node. In the application that uses the sample data, we found 11 types of nodes that contains 242 child nodes and 22 type of relation that contain 548 relation that connect all the node within 3305ms. Mapping relationship between nodes can be done using a graph database Neo4j software. The models have been evaluated using Cyper, the neo4j query. Now the system is able to manage the rules well. in the future it can accommodate all relevant regulations and changes and linkages with other types of regulations. This system will help us to make it easier for users to search, organize and track the history of changes and relationships between the rules used by the organization.

Further development on this ontology is to map the entire semantic network in the regulation of the finance ministry till build the interface using software such as ruby, popoto, java and etc. This interface will be expected to show activity diagram that has been authorized by the government SOP (standard operation procedures). This is intended to be facilitate all users to search the regulations of customs and excise.

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