BUILDING AND VALIDATING AN ONTOLOGY FOR PUBLIC PROCUREMENT: THE CASE OF CAMEROON

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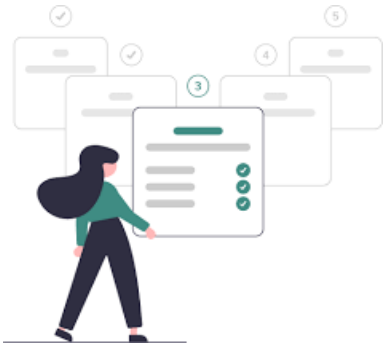
Content



1. Context and definitions
2. State of the Art
3. Methodology
4. Application and results
5. Conclusion and outlook

Context

- Obligation to publish;
- Querying several sources;
- Around 11,600 tender notices published each year.

Figure 1: Public procurement

ARMP
Agence de Régulation des Marchés Publics

Figure 2: PPRA

Context

From web 2.0 to the web of data

- Beyond documents and web pages ;
- From page to resource;
- The description of resources possible thanks to RDF language.

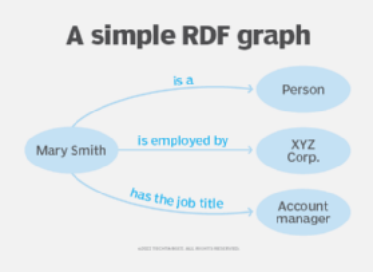


Figure 3: RDF example

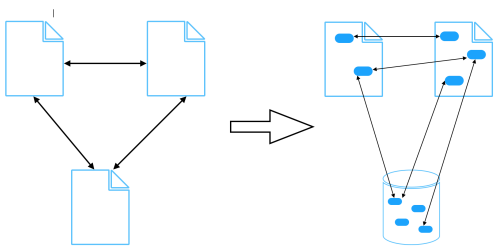


Figure 4: From the "classic" web to the web of data

Definition - Knowledge Graph

Dimitris Karagiannis, 2015

a network of interconnected and organised concepts that represents a global and coherent view of a specific area of knowledge.

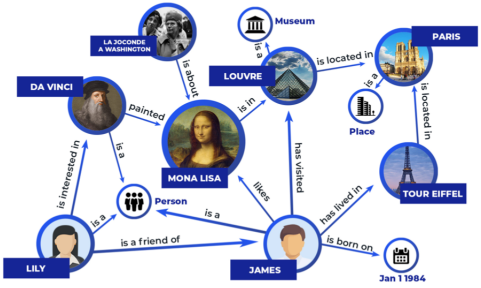


Figure 5: Example of Knowledge Graph

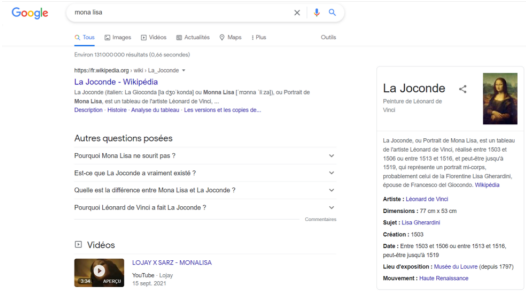


Figure 6: Google Knowledge Graph

Definition - Ontology

Ontologie(Tom Gruber, 1993)

Explicit representation of a set of concepts and the relationships between these concepts in a specific domain.

Ontologie(Grigoris Antoniou, 2005)

Formal and explicit specification of a shared conceptualisation of a domain of knowledge.

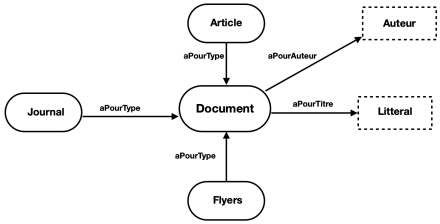


Figure 7: Example of ontology

Definition - Public Procurement

J.C Duval, 2017

Contract concluded for consideration between a public or private purchaser and a public or private economic operator.

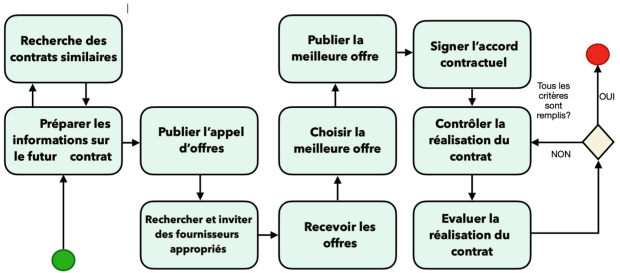


Figure 8: Public procurement process

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Ontology development methodologies

Methodologies & Autors	**LOT** (María Poveda-Villalón, 2022)	**Methontology** (Oscar Corcho et al. , 2005)	**Ontology Development 101** (N Noy, Deborah L McGuinness, et al, 2001)
Réutilisation d'ontologies	✓	✓	✓
Clear strategy for listing terms	X	X	X
Publication	✓	X	X
Ontology engineering strategy (Psyché et al., 2003)	semi-dependent on the application	independent of the application	semi-dependent on the application
Ontology developed (Psyché et al., 2003)	TN100 Ontology	Not documented	PPROC
Modelled domain (Psyché et al., 2003)	E-learning	Several domains	public procurement

Table 1: Récapitulatifs des méthodologies de développement d'ontologies

Existing ontologies for public procurement

Ontology & Autors	**PPROC** (José Félix et al., 2016)	**PCO** (Martin Necasky et al., 2014)	**OCDS** (Ahmet Soylu et al., 2019)	**LOTED2** (Isabella Distinto et al., 2016)
Level of detail required(Holger Knublauchet al. , 2004)	✓	X	✓	X
Complexity (Natalya F Noy et al., 2004)	X	✓	X	X
Goal	X	✓	✓	X
Context(Natalya F Noy et al., 2004)	X	X	X	X
Nomber of classes - property(Vilches et al., 2009)	78 - 130	22 - 51	24 - 142	22 - 101
Reused Ontology	PC, SKOS, FOAF, SCHEMA, DC-TERM, GR	PPROC, OCDS, FOAF, SCHEMA, GR	PC, FOAF, DC-TERM, SCHEMA, SKOS	GR, Lkif-Core

Table 2: Summary of ontologies for public procurement

Research question

how to build an ontology for public procurement in a Cameroonian context in order to facilitate information retrieval?

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Methodology

1. Defining the scope of the ontology;
2. **list the terms to be used in the ontology;**
3. **consideration of the possibility of reusing existing ontologies based on the terms listed;**
4. organisation of concepts into classes and sub-classes;
5. definition of class properties/attributes;
6. definition of attribute/property facets;
7. creation of bodies;
8. **publication on the web.**

Steps 3 and 8, Linked Open Vocabulary (Vandenbussche, ATEMEZING et al., 2017)

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APCO Ontology

Questions of competence

- what were the last 100 contracts awarded?
- how many contracts are there for each type of procedure?
- which are the 100 contracts with the highest forecast amounts?
- number of contracts by region;
- total cost of contracts awarded between 2017 and 2019;
- list of companies with the highest contract budgets;
- number of publications in 2016, classified by type of service.

APCO Ontology

Examples of axioms

- "A bidder makes one and only one offer";
- "An open invitation to tender is not a restricted invitation to tender";

Examples of axioms - functional language

- $\forall x.Soumissionnaire(x) \Rightarrow$
  $(\exists y.Offre(y) \wedge faitOffre(x,y) \wedge (\forall z.Offre(z) \wedge faitOffre(x,z) \Rightarrow y = z))$;
- $\forall x.AppelOffre(x) \wedge Ouvert(x) \Rightarrow \neg Restreint(x)$.

```
:Soumissionnaire rdf:type owl:Class ;
                 rdfs:subClassOf gr:BusinessEntity ,
                                 [ rdf:type owl:Restriction ;
                                   owl:onProperty :faitUneOffre ;
                                   owl:maxCardinality "1"^^xsd:nonNegativeInteger
                                 ] ;
                 rdfs:comment " person who made a bid to the contracting authority"@en ,
                              "Personne physique ou morale qui fait une offre à l'endroit
                               de l'autorité contractante"@fr ;
                 rdfs:label "Soumissionnaire"@fr ,
                            "Tenderer"@en .
```

Figure 9: axiom 1 - Turtle syntax

```
:AppelDOffreOuvert rdf:type owl:Class ;
                   rdfs:subClassOf :AppelDOffre ;
                   owl:disjointWith :AppelDOffreRestreint ;
                   rdfs:label "Appel d'offre ouvert"@fr ,
                              "open tender"@en .
```

Figure 10: axiom 2 - Turtle syntax

APCO Ontology

Metrics

Axiom	304
Logical axiom count	96
Declaration axioms count	66
Class count	30
Object property count	12
Data property count	19
Individual count	3
Annotation Property count	7

ontology address: https://github.com/AI4Africa/apcoKG

Knowledge graph - Working environment

Material tools:

- Laptop with 16 GB RAM;
- 3 GB dedicated graphics card.

Software tools:

- MacOS BigSur 11.7
- Power BI, Excel
- Protege 5.5.O, Open Refine, GraphDB.

Dataset:

- Public procurement data (2016 - 2021).

Adress:

- `linkedvocabs.org/dataset/dump_apcoKG.ttl`

Knowledge graph - Architecture

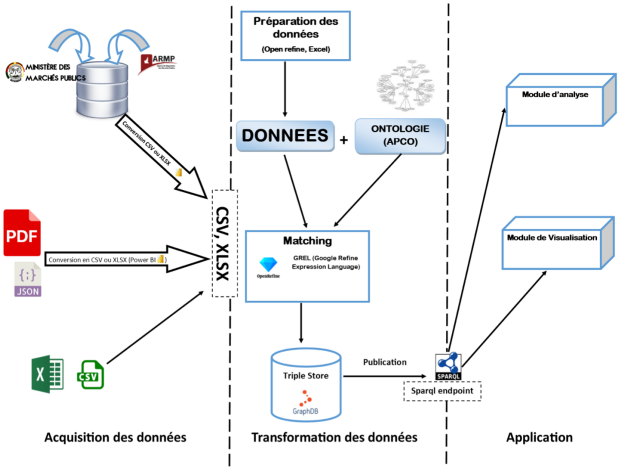

Figure 11: Knowledge graph architecture

Validation

- Validation of the ontology structure: **pellet, ontocheck**;
- Validation with the FAIR principles (Findability Accessibility Interoperability and Reuse of digital assets).
- Semantic validation: domain expert (skills questions);

Validation - Question of competence

2- Combien y a t'il de contrats par type de procédure?

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX apco: <http://data.apco.cm/onto#>
PREFIX pproc: <http://contsem.unizar.es/def/sector-publico/pproc#>
PREFIX dcterms: <http://purl.org/dc/terms/>
PREFIX pc: <http://purl.org/procurement/public-contracts#>
PREFIX gr: <http://purl.org/goodrelations/v1#>
PREFIX dbpedia: <https://dbpedia.org/ontology/>
PREFIX geofla: <http://data.ign.fr/def/geofla/20140822.en.htm/>


SELECT ?TypedeContrat (count(distinct ?contract) as ?nombre)
        WHERE {
   {?contract pc:procedureType ?TypedeContrat}

}
GROUP BY (?TypedeContrat)
```

	TypedeContrat	nombre
1	"Appels d'Offres National Ouvert"	"31775"^^xsd:integer
2	"Demande de Cotation"	"7460"^^xsd:integer
3	"Appel à Manifestation d'Intérêt"	"5296"^^xsd:integer
4	"Demande de Proposition."	"78"^^xsd:integer
5	"Appels d'Offres National Restreint"	"1973"^^xsd:integer
6	"Appels d'Offres International Ouvert"	"1088"^^xsd:integer
7	"Appels d'Offres International Restreint"	"405"^^xsd:integer
8	"Appels d'Offres"	"197"^^xsd:integer
9	"Bon de Commande"	"6"^^xsd:integer
10	"Gré à Gré"	"5"^^xsd:integer

Figure 12: Competence question 2

Validation - Example

Figure 13: scdp - web 2.0

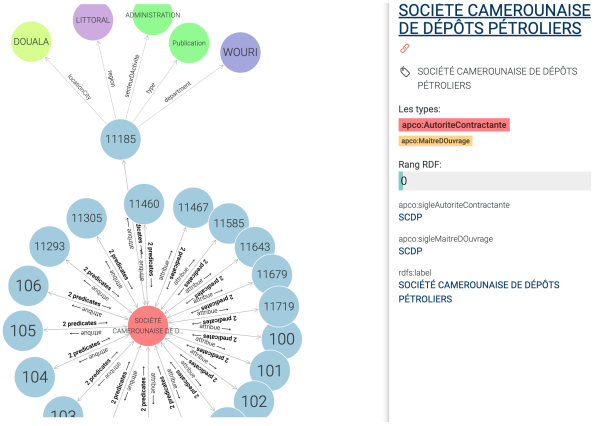

Figure 14: scdp - Knowmedges Graph

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Conclusion

- Search for information in public contracts;
- provide an ontology for public procurement;
- development methodology;
- APCO ontology;
- ontology validation;
- Knowledge graph for public procurement;

Outllok

- Verify the use of the ontology in other countries;
- Provision of a semantic search engine for public procurement;
- Add dereferencing of generated URIs to facilitate reuse in other applications;
- aligning data with other existing data in the Linked Open Data cloud;

Reférences

Ahmet Soylu, Brian Elvesæter, Philip Turk, Dumitru Roman, Oscar Corcho, Elena Simperl, George Konstantinidis, and Till Christopher Lech. Towards an ontology for public procure- ment based on the open contracting data standard.

In Conference on e-Business, e-Services and e-Society,

pages 230–237. Springer, 2019

Isabella Distinto, Mathieu d'Aquin, and Enrico Motta. Loted2 : An ontology of european public procurement notices. volume 7, pages 267–293. IOS Press, 2016

Proceedings of the AAAI conference on artificial intelligence 1(32).

María Poveda-Villalón, Alba Fernández-Izquierdo, Mariano Fernández-López, and Raúl García-Castro.

Lot : An industrial oriented ontology engineering framework. volume 111, page 104755. Elsevier, 2022.

N Noy, Deborah L McGuinness, et al. Ontology development 101. Knowledge Systems Labo- ratory, Stanford University, 2001, 2001.

Thank you for your kind attention