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A common vocabulary for semantic interoperability of Moroccan e-government services

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ABSTRACT

Interoperability is a critical factor for the success of e-government services, as it enables different public information systems to communicate in a consistent and accurate manner. Governments are making significant efforts to improve their public e- services interactions and promote e-government interoperability. Morocco has developed an e-government interoperability framework that lists compliance rules and references for the development of public information systems. Unfortunately, Moroccan public administrations still work independently and operate as siloed organizations. To deal with this problem, it is essential to implement a common vocabulary (CV) for public services that public administrations can share to formalize public data, enhance exchange between information systems, and ensure data interoperability. In this light, this work presents a CV to standardize public services data, define concepts and relationships. The standardized vocabulary is defined using RDF/XML serialization format and incorporates fundamental declarations to ensure digital communication in Moroccan public services. The approach is illustrated through a case study of e-health service. The study shows the potential added value of creating a national vocabulary. It helps public administrations to structure data, interoperate more effectively and accelerate digital transformation.

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1. INTRODUCTION

Digital transformation represents a great opportunity for governments to enhance efficiency, accuracy and progress in delivering public services. In the public sector digital transformation, interoperability plays a vital role in improving the provision of e-services [1]. Indeed, it enables different government agencies to share information, reduce duplication of data and decrease diversity of data formats. E-government interoperability offers a way to exchange public data and adopt common standards. This is important to provide citizens with more standardized and integrated services.

E-government semantic interoperability relates to the capacity of different information systems to interpret data in a common way [2]. It means that various public administrations could communicate and exchange information without any ambiguity. To enhance semantic interoperability and promote public e-services, developing rigorous standards at each level of public organization is crucial [3]. An approach to contribute to do this, is to establish a common vocabulary (CV) for public services. There is no specific definition of CV, it can be defined as a set of concepts and the existing relationships between them that contains an entity's core properties [4]. CV provides standardized and common description of terms and

concepts that promotes a shared understanding of data. Establishing this vocabulary ensures that information is consistently understood across various information systems. Indeed, adopting CV for public services helps government agencies to exchange public data and interoperate more effectively.

One of the main challenges in digital transformation in developing countries is to guarantee semantic interoperability between government systems. The Moroccan government, like other emerging nations has been actively working on implementing semantic interoperability. In this sense, a Moroccan e-government interoperability framework (MIF) was created in 2012, and an open data project to link public data using open formats, standards and documents was launched in 2020. As result, the Morocco e-government development index (EGDI) has improved from the 106th rank in 2020 to the 101th rank in 2022 according to United Nations E-government survey [5], [6]. Despite those initiatives, separative projects undertaken by public organizations have given rise to heterogenous systems [7]. As consequence, this structure based on silos creates a deeper division between different government entities, entails a lack of effective collaboration, and generates interoperability problems. Moreover, a national study has shown that the maturity level index of Moroccan public e-services is still low due to the deficiency of e-government interoperability [8].

Under this situation, the agency for digital development (ADD) presented a new version of the Moroccan interoperability framework (MIF V 3.0) that introduces a section dedicated to semantic interoperability [9]. From a semantic point of view, the necessity of standards concerning public services to effectively share data between public administrations is increasingly important. In this context, the following question arise: Is it possible to design a CV that Moroccan public administrations can use to clearly describe the concept of "public service" and subsequently improve e-government semantic interoperability?

The current goal of this paper is to improve our previous semantic work on the PSOM-eGOvMA ontology model [10]. This model represents a domain ontology for Moroccan public services based on a national referential. At this point, we introduce a new semantic layer based on a CV. We use both an UML class diagram and an RDF/XML serialization format for designing and presenting a core data model of Moroccan public services. This permits easy public data sharing, promotes semantic interoperability, and enhances public e-services maturity level.

This paper is structured as follows. Section 2 introduces the background and the related works about e-government semantic interoperability and common public service vocabularies. Section 3 describes the research method and section 4 presents the proposed model of common public service vocabulary. Section 5 applies the model in the case of an e-health public service in Morocco. Section 6 concludes the paper with a summary and some directions for future works.

2. BACKGROUND

In this section, the successful accomplishment highlighting semantic interoperability initiatives and relevant core vocabularies are discussed. To promote interoperability across European public services, the European Commission has created the first version of european interoperability framework (EIF) in 2004. Three main interoperability areas were considered, organizational, semantic and technical [11]. Later, in 2010 a second version was published. It includes principles and recommendations to enhance e-government interoperability, in particular, accessibility, openness, security, efficiency, and administrative simplification. In the EIF V2.0, the original three levels of technical, semantic, and organizational interoperability, now called "levels," have been overcome by the legal interoperability level and the political context level [12]. In 2017, a new version was presented by the European Commission as the new EIF. The number of interoperability layers has extended from 5 to 6 by adding interoperability governance and integrated public service governance, and the update recommended strongly the use of common vocabularies for expressing metadata in the public sector [13]. Core vocabularies are extendable data structures that capture the essential attributes of an entity, like an individual or a public institution, in a neutral manner [14].

In this light, the European public administrations program for interoperability solutions (ISA) was initiated to finance actions for enhancing semantic interoperability. The action 1.1 was the creation of a core public service vocabulary (CPSV). The primary aim of the CPSV is to facilitate the sharing of fundamental information of public services. The CPSV application profile (CPSV-AP) draws on CPSV, is a data model that specifies additional limitation such classes and proprieties that are not included in the general CPSV. The CPSV-AP was developed in the Action 2016.19 as the initial phase to establish a framework for defining public services associated to business and life events, with the goal of creating catalogues of European public services [15]. The European CPSV-AP targets to reduce interoperability obstacles and enables public administrations to provide public services with a user-centric approach [16]. As an example, we can cite the Italian initiative carried out by the Italian digital agency (AgID) to establish an Italian catalogue of public services and improve semantic interoperability [17]. Another example of the use of common vocabularies in enhancing semantic interoperability is the Brazilian e-government strategy. Since 2021, the country has

achieved significant accomplishments in digital transformation interoperability and all administrative procedures were managed online [18]. The national interoperability framework for electronic government (e-PING) defines guidelines and policies for technical, organizational and semantic interoperability. In addition, the implementation of the repository of vocabularies and ontologies of the electronic government (e-Gov) provides domain ontologies and controlled vocabularies that enhance the process of ontology engineering process and monitor the activity of publishing government data [19].

The Morocco e-government interoperability experience is insufficient compared to the cited initiatives. Despite the government strategy for a successful digital transformation, each public e-services choose its own technology, data systems and data structures. This heterogeneity challenges semantic interoperability. The new Moroccan interoperability framework (MIF V3.0) emphasizes the role of establishing a shared framework for structuring data and a CV as a starting point for improving semantic interoperability in the country [9]. Recently, the importance of semantic and technical interoperability for improving public e-services efficiency has been studied in academic researchs [20]-[23]. However, no one addressed the implementation of a national common language for representing public data.

3. METHOD

Our paper focuses on the conceptual aspect, aiming to create a data model for introducing public services descriptions. It is grounded in the e-government research domain, drawing inspiration from broader computer science areas, particularly semantic technologies. The adopted method is a structured approach aimed at standardizing public services definition by implementing a series of well-defined steps. As depicted in Figure 1, public services are meticulously analyzed in step 1. In this initial phase, The PSOM-eGovMa ontology model is used to carefully describe the concepts and attributes of Moroccan Public Services. Based on the national framework established by the Moroccan Ministry of Administration Reform and Public Service (MARPS), the PSOM-eGovMa model identifies and classifies public services in the country. It gathered various concepts and relationships to achieve semantic interoperability.

Following this, step 2 involves a deep analysis of existing public services common vocabularies, with the objective of understanding how to build a Moroccan CV. To achieve this goal, we drew inspiration from the research approaches analyzed in this article especially the core vocabulary presented in [24]. Subsequently, step 3 focuses on the design and modeling of public services. Here, UML class diagram is created based on the standardized definitions established in the previous step. As explained in this work, this diagram encompasses both static elements and relationships using UML notation. A CV is developed using RDF/XML format, reflecting the design principles and concepts defined in this step. This vocabulary serves as a tangible representation of enhancing semantic interoperability for Moroccan public services. Finally, in step 4, the approach undergoes validation through a case study centered around an e-health public service the opening of a medical laboratory. This last phase presents the validation step, which ensures that the proposed vocabulary aligns with real-world challenges and requirements, ultimately confirming the viability and effectiveness of the method in modeling public service descriptions.

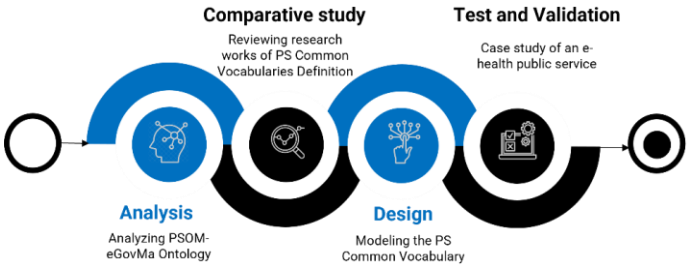

Figure 1. Steps conducted in the research method

4. THE PROPOSED COMMON PUBLIC SERVICE VOCABULARY

4.1. The PSOM-eGovMa ontology model for e-government interoperability in Morocco

In Morocco, the MARPS provides a framework for classifying public services based on the 5W1H approach. As seen in Figure 2, this method involves posing six essential questions: What? Why? Who? Where? When? and How? By answering these questions, the primary elements of the public services notion are identified, including the public services interactions (What), the public services value (Why), the public services user (Who), the time factor (When), the infrastructure of the public services (Where) and the public

services access (How). The national framework identifies three main categories of public services: procedural, general interest and informational [25]. The primary function of procedural public services is to furnish citizens administrative documents via procedural steps. This particular category stands out as requiring the most urgent digital transformation [8]. The PSOM-eGOVMA model represents a domain ontology for public services based on this national referential. In this work, a domain ontology model for public services is proposed. Based on OWL language, PSOM-eGovMA model contains a list of data elements used by different e-government services, along with their definitions and descriptions. This includes information such as user data or provider data. Each service would then use the same data elements, ensuring that there is consistency across different information systems.

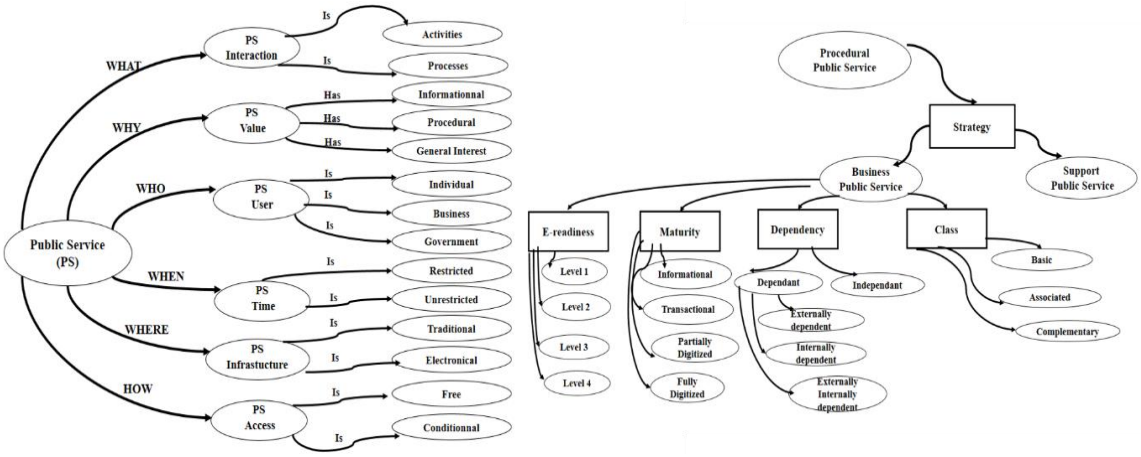

Figure 2. Public service concept description using the 5W1H method

4.2. The proposed common public service vocabulary

The aim of the proposed vocabulary is to build a set of information describing all concepts aware Moroccan public services based on a PSOM-eGovMa ontology model. It represents a standardized artefact of data elements, terms, and definitions that can be shared among different information systems. By using this vocabulary, e-government services can have identical definitions and terminologies. This, makes it easier for different systems to communicate with each other.

The UML class diagram represented in Figure 3 describes the concept of public service. UML is useful modelling language for representing data in a common way. It provides a set of standard diagrams and notations that can be used to represent different aspects of a system. In fact, the use of a class diagram for modeling the proposed vocabulary allows all public administrations to present public service descriptions in the same way, regardless of their technical background.

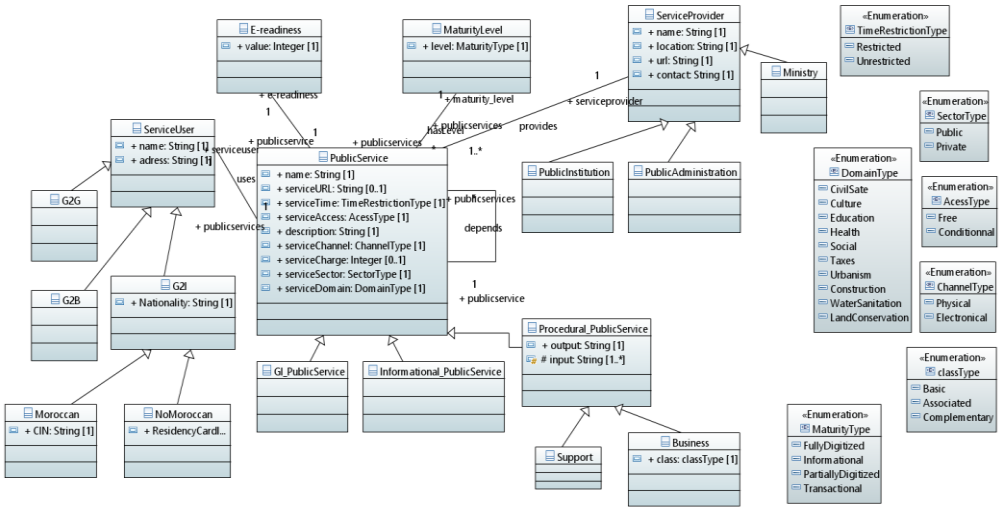

Figure 3. The UML class diagram of the proposed e-government public services CV

The public service is characterized by a name, a URL address, restrictions on time and access, a description, channels, charges if they exist, otherwise they are not specified, the sector, as well as a domain of application of the public service. On the other hand, the public services vocabulary specified the majority of attribute types as enumerations, such as AccessType, which can either be Free or Conditional, and ChannelType, which is physical or electronic. The Table 1 details the main classes of the CV.

Table 1. Description of CV classes

Class	Description	Examples
Public service	A public service is a service provided by a government to its citizens, which is intended to benefit the public as a whole rather than specific individuals or groups.	General interest public services, informational public services, procedural public services.
Service provider	An organization or entity that is responsible for delivering a public service on behalf of a government or other public authority.	Public service providers can include government agencies, public institution, and ministry.
Service user	User who utilizes services provided by government or publicly-funded institutions for the benefit of the general public.	Government to individual (G2I), government to government (G2G), and government to business (G2B).
Maturity level	The maturity level is related to the progress of online activities covered by the public administration. The Moroccan e-service model includes four categories. The higher level is fully digitized level when all steps to get the service are online. The initial level is informational, it provides only static information about required steps.	Informational, interactional, and partially digitized fully digitized.
E-readiness	The e-readiness of public service refers to the level of preparedness of public service providers to effectively use digital technologies to support their service delivery and meet the needs of their users.	A public service that is e-ready is able to leverage digital technologies, increase access to services, and engage with its users in new and innovative ways.
Public institution	Is an organization or entity that is established and funded by the government or state, and which operates in the public interest. They are accountable to the public and are typically subject to government regulations and oversight.	Police, education, and protection.
Public administration	It involves the activities of public officials and organizations responsible for carrying out the policies and delivering services to the public.	Province and prefecture.
Gi public service	It encompasses all the public services provided by the government that are intended to serve the common good.	This includes all the institutions, structures, and projects that are created to meet the needs of society, such as schools, theaters, public lighting, and any other public assets or goods contributing to health, culture, protection, education and social welfare of society.
Informational public service	This encompasses all the necessary resources that facilitate the acquisition of beneficial information by users.	It covers regulatory records, infrastructure data, directories, databases, maps, audio-visual content, and broadcast media.
Procedural public service	It represents the value obtained from the administrative procedures that take place between the government and its citizens which can be represented by an “administrative document”.	A document can take various forms, such as a certificate, a contract or an authorization required to fulfill an obligation of administrations.

The proposed vocabulary defines standard representation for e-government services. This can include defining standard workflows, as well as standard data exchange formats for different services especially procedural ones. This category includes specific interactions and requirements in order to obtain the desired public value outcome. Indeed, the procedural public services are defined by the “Procedural_PublicService” class, which contains input and output attributes to illustrate the value of this service type. This value can be an “administrative record” which encompasses documents or information, shared by public administrations. This CV removes semantic interoperability barriers and improves the overall e-readiness of e-government services.

5. APPLICATION OF A COMMON VOCABULARY MODEL

In this section, the proposed vocabulary model is applied in an e-health public service that is offered by the Moroccan Ministry of health in order to open a medical analysis laboratory to citizens. The case study is about a public service that handles the opening of medical laboratory. This public service is offered to citizens graduated in Pharmacy, Biology, and Veterinary to start their medical laboratory.

According to the public service description, it is a procedural public service that provides just online information about procedures to get the required documents [26]. This public service is at its basic stage of

maturity (informational level), mainly because of the lack of online interaction. The original service provider is the secretary general of the government (SGG). This public service depends externally to two public services (two service providers): the first is the informational public services to open and manage a private laboratory for medical biology analysis provided by the Ministry of Health [27], and the second is the public services that deliver the certificate of medical practice conformity provided by the National Council of the Order of Doctors (NCOD) [28]. Thus, each public administration is defined based on its type of membership. The SGG and NCOD are type of "PublicInstitution" class and the Ministry of Health is an instance of the "Ministry" class.

As shown in Figure 4, this public service is modeled by detailing its various properties ranging from its name to the smallest details. Indeed, we assigned values to each property. Specifically, for the serviceURL, we added the link for accessing the descriptive document of this public service. This service has a limited time frame with conditional access and a physical channel. For the description, text providing an overview of this public service was included. As for the serviceChannel, it is designated as "physical" because the digitization of the process has not been developed to obtain the document electronically. Concerning the serviceCharge, we specified the value "Yes" because the service user is expected to pay to benefit from this service. Of course, for the serviceSector and serviceDomain, this public service falls respectively within the public sector and the health domain. It is evident that this public service provides value in the form of an administrative document. This is, of course, the authorization certificate obtained after approval. Therefore, it can be confirmed that this is, in fact, a procedural public service provided by many government entities.

So, after defining the public service by instantiating the "PublicService" class, the type is specified through the inheritance relationship. Then, the input and output elements of this public service are determined. These elements represent the documents requested by the service provider, and the output, which is obviously the "Final Authorization".

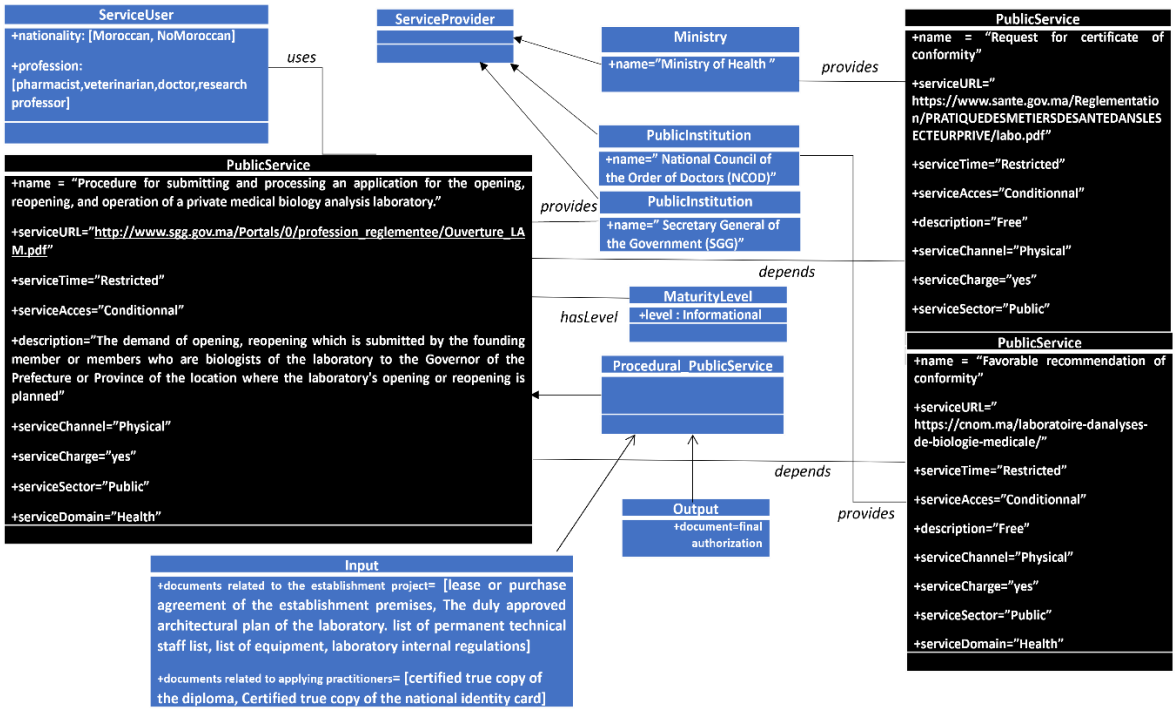

Figure 4. Applying the CV model to design a procedural e-health public service for opening a medical analysis laboratory

It is worth noting that the proposed vocabulary has been defined in the RDF/XML serialization format. This format is commonly employed for representing data in the Web. It is used to make public services content more interconnected through the axioms, declarations, classes and properties defined in the national CV. This ensures semantic interoperability between different Moroccan e-government information

systems. By using RDF/XML serialization, the CV can be easily processed by these systems and integrated with other datasets that also use RDF.

As presented in Figure 5, a portion of the RDF file is generated using the protégé tool. The various namespaces required for defining the CV have been declared, including XML, XML Schema, RDF, RDFS, and OWL. This allows an effective and efficient use of these technologies for describing and organizing the public service information. The remaining code translates the various declarations and definitions of concepts and their relationships in public services. For instance, the dependency relationship linking two public services is defined as “ObjectProperty”. Its domain and range are specified using the “PublicService” class.

```
<?xml version="1.0"?>
<rdf:RDF xmlns="http://www.semanticweb.org/root/ontologies/2023/2/cpsv#"
     xml:base="http://www.semanticweb.org/root/ontologies/2023/2/cpsv"
     xmlns:owl="http://www.w3.org/2002/07/owl#"
     xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
     xmlns:xml="http://www.w3.org/XML/1998/namespace"
     xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
     xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#">

    <owl:Ontology rdf:about="http://www.semanticweb.org/root/ontologies/2023/2/cpsv"/>
    <!-- Object Properties -->
    <!-- http://www.semanticweb.org/root/ontologies/2023/2/cpsv#dependency -->
    <owl:ObjectProperty rdf:about="http://www.semanticweb.org/root/ontologies/2023/2/cpsv#dependency">
        <rdfs:domain rdf:resource="http://www.semanticweb.org/root/ontologies/2023/2/cpsv#Public_Service"/>
        <rdfs:range rdf:resource="http://www.semanticweb.org/root/ontologies/2023/2/cpsv#Public_Service"/>
    </owl:ObjectProperty>
    <!-- http://www.semanticweb.org/root/ontologies/2023/2/cpsv#dependent -->
    <owl:ObjectProperty rdf:about="http://www.semanticweb.org/root/ontologies/2023/2/cpsv#dependent">
        <rdfs:subPropertyOf rdf:resource="http://www.semanticweb.org/root/ontologies/2023/2/cpsv#dependency"/>
    </owl:ObjectProperty>
    <!-- http://www.semanticweb.org/root/ontologies/2023/2/cpsv#independent -->
    <owl:ObjectProperty rdf:about="http://www.semanticweb.org/root/ontologies/2023/2/cpsv#independent">
        <rdfs:subPropertyOf rdf:resource="http://www.semanticweb.org/root/ontologies/2023/2/cpsv#dependency"/>
    </owl:ObjectProperty>
```

Figure 5. The CV serialization in RDF/XML format

This vocabulary can be updated and maintained centrally. So, any changes to the definitions or terminologies used by different e-government services can be made in a coordinated and consistent manner, rather than having each service updating its own terminology independently. The proposed CV of Moroccan public services refer to the standardized terminology and language used in the delivery of public services. In this section, we have shown that we were able to model public service data of the selected case study based on the defined vocabulary. This work allows a clear communication and understanding between service providers and service users. However, there are some limitations associated with it such as the Resistance to Change. In fact, implementing a common public services vocabulary involves introducing a serious change in administrative structures. This will face reluctance from public administrators who are accustomed to using their own terminologies. Another challenge to address is the complexity of the public administration jargon. In practice, many public organizations have developed technical and specialized terminology that is not easily understood by users. This can lead to confusion and undermine communication between user and public e-services.

In short, this article announces the first version of the vocabulary of public services which will subsequently be used to construct the national catalog of public services in Morocco. Overall, the public service catalog is an effective approach for ensuring semantic interoperability of e-government public services. Providing a centralized and standardized repository of data elements, terms, and definitions of public services guarantees consistency and accuracy of public data across different Moroccan e-government information systems.

6. CONCLUSION

This work highlights the importance of interoperability in e-government services, particularly within the context of Morocco. The CV is introduced to standardize public service data, enhancing communication

between systems and fostering digital transformation. Our practical application in an e-health service case study vividly illustrates the potential advantages of our approach. However, significant efforts are required to fully leverage common vocabularies on a large scale. Of utmost importance is the development of tested actions and comprehensive recommendations for public administrations to effectively model their administrative procedures using common vocabularies. These recommendations should encompass details on necessary tools, URIs, design policies, and more. Additionally, establishing an authority such as the National ADD and a dedicated working team is imperative for ensuring the maintenance and evolution of CV specifications.

Despite these challenges, our work lays a robust foundation for enhancing efficiency and fostering collaboration in Moroccan e-government, ultimately benefiting citizens and advancing the nation's digital agenda. Presently, our focus is on finalizing an OWL ontology as documentation for all public services. Furthermore, we aim to develop a tangible administrative procedure for implementing the proposed CV, which will include the construction of a comprehensive catalog of public services in Morocco. This initiative will also involve providing guidance on utilizing the national CV within Moroccan eGovernment services.

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