

# The Impact of Ontologies and the Semantic Web on Electronic Thesis and Dissertation Publishing

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## Abstract

*Ontologies are formal representations of knowledge that define the structure and meaning of information. By describing the content of ETDs with ontologies, it is possible to make them more interoperable, discoverable, and searchable. This paper seeks to investigate the influence of ontologies and the Semantic Web on ETD publishing and performance. This paper reviews the literature on ontologies and the Semantic Web and discusses how these technologies can be utilised to enhance the quality of ETD services. In addition, the paper provides case studies demonstrating how ontologies and the Semantic Web are utilised in ETDs. In each case, a comparison of features such as Ontology-based metadata, Semantic search engine, Semantic annotation tool, and Semantic portal was performed and presented in a tabular format, with a distinct section devoted to a discussion of these features. The paper demonstrates that ontologies and the Semantic Web can be used to enhance the interoperability, discoverability, and searchability of Electronic Theses and Dissertations (ETDs). It also indicates that ontologies and the Semantic Web can support more sophisticated search and retrieval functionality in ETDs.*

**Keywords:** Electronic Theses and Dissertations (ETD), Metadata, Ontologies, Semantic Web

## 1. Introduction

Electronic thesis and dissertation (ETD) refer to online-accessible digital versions of theses and dissertations. They are searchable and accessible to researchers worldwide (Goodfellow, 2009). The development of this field has been influenced by a number of factors, including the increasing availability of digital technology, the growing demand for open access to research (Copeland & Penman, 2004), and the need for researchers to have easy access to the most recent research (Macduff, 2009). However, this has also created a number of obstacles. ETDs are frequently stored in distinct repositories, making it difficult for researchers to locate and access the information they require (Ghosh, 2009). ETDs are frequently not indexed by conventional search engines, which can further complicate the situation for researchers (Schopf et al., 2014). Ontologies and the various technologies of the Semantic Web can be utilised to resolve some of these challenges. Ontologies are formal representations of knowledge that characterise the structure and meaning of information

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(Jurisica, Mylopoulos, & Yu, 2004). The Semantic Web is a vision for the web in which information is given meaning and can be processed by computers (Giri, 2011). ETDs can be described in a machine-readable manner by employing ontologies and other Semantic Web technologies. This paper attempts to address these problems and propose solutions that can be attained using semantic web technologies.

## **2. Literature Review**

The literature on the use of Semantic Web technologies for ETD publishing is limited. Though authors have gone through bibliographic databases such as Google Scholar, SCOPUS, Emerald, Semantic Scholar in search of relevant articles. Below given are some of the relevant articles arranged in chronological order.

Waagmeester et al. (2016) created two new vocabularies that encapsulate the graphical representation and the pathway logic, respectively, in order to convert WikiPathways content into meaningful triples. Peponakis (2013) contends in his study that the metadata of library catalogues can exist on their own, supplying valuable information apart from the resources they refer to, and could therefore be used as data in the context of the Semantic Web.

Based on an extant metadata description and the character of the data set, Chen, & Plale (2012) represent geoscience data sets as an ontology. The case of Vortex2 data, a regional weather forecast data set acquired during the summer of 2010, is used to illustrate how forecast data can be represented in ontology by utilising extant metadata information. To incorporate ontological context, Schuurman and Leszczynski (2006) described a framework for the construction of extended metadata for non-spatial attributes. They utilised an informatics-based definition of ontology, which refers to the complete universe of discourse associated with a given attribute. In their paper, Maedche and Zacharias (2002) proposed a method for clustering ontology-based metadata. The primary contributions of this paper are the definition of a set of similarity measures for comparing ontology-based metadata and a study of their application within a hierarchical clustering algorithm.

The literature review revealed a scarcity of research that use the properties of semantic web and ontologies in the organisation, publication, or overall improvement of Electronic Theses and Dissertations (ETDs). This gap needs to be filled and the present study is an attempt for it.

## **3. Objectives**

The main objectives of this paper are listed below.

- ❖ To explore semantic web technologies that can be used in enhancing ETD publishing.
- ❖ To discuss the impact of ontologies and the Semantic Web on ETD publishing and how these technologies can be used to improve ETD publishing.
- ❖ To discuss case studies of ETDs that use semantic Web technologies for different purposes.

#### 4. Methodology

This research will use a technique that combines a comprehensive literature review with a case study approach. The purpose of the literature review is to ascertain the advantages and difficulties associated with the use of ontologies and the Semantic Web in electronic theses and dissertations (ETDs). The case studies will serve as exemplifications of the use of ontologies and the Semantic Web in enhancing the performance of ETDs. The study included many aspects, including Ontology-based metadata, Semantic search engine, Semantic annotation tool, and Semantic portal, for comparison.

#### 5. Discussion

The term “semantic web” encompasses a collection of technologies and methodologies that are designed to augment the significance and organisation of data found on the World Wide Web (Lampropoulos, Keramopoulos, & Diamantaras, 2020). The use of semantic web methodologies in the context of Electronic Theses and Dissertations (ETDs) has the potential to enhance their structural arrangement, accessibility, and compatibility. Table 1 presents a compilation of semantic web strategies and technologies that have the potential to optimise the efficacy of Electronic Theses and Dissertations (ETDs).

**Table 1: Benefits of Semantic Web Technologies**

S1. Semantic No. Web Technology	Description	Application in ETDs	Benefit
1 RDF	Describe resources and their relationships	ETD metadata and content can be represented in RDF.	Better integration with other datasets and systems
2 Ontologies	Provide a formal and structured representation of concepts and their relationships	Can help standardize and enrich metadata	Easier to search, navigate, and relate ETDs to other resources
3 Linked Data	Linking and connecting data across different sources on the web	Can establish meaningful connections	Enhanced discoverability.
4 SPARQL	Used to query RDF data	Allows users to perform advanced searches	Explore relationships between different ETDs.
5 SKOS (Simple Knowledge Organization System)	Provides a way to represent controlled vocabularies and taxonomies	Improve consistency	Facilitate more accurate searches.
6 Open Annotation	Annotations and comments	Can be linked to specific sections of ETDs	Enhanced engagement with the content
7 Semantic Search	Using natural language processing and ontologies	Find relevant ETDs	Can help when search queries are not an exact match to the metadata.

Further analysis and examination are required for some techniques, like ontology-based metadata, semantic search engines, and semantic annotation tools. Table 2 provides a comprehensive overview of the semantic web technologies, and the features that electronic theses and dissertations (ETDs) will possess as a result of their integration.

**Table 2: Semantic Web Technologies and Attributing Features**

Semantic Web Technologies	Features
Ontology-based metadata	Enhanced Discovery and Search Semantic Interoperability Faceted Navigation Contextualization and Enrichment Cross-Disciplinary Research Quality Control Automated Processing Support for Linked Data
Semantic search engine	Conceptual Understanding Natural Language Queries Relationship Mapping Cross-Disciplinary Discoveries Personalization Advanced Filtering and Faceting Synonym and Variance Handling Content Summarization and Extraction Contextual Recommendations Language Translation and Support Visualization and Graph Representation Enhanced Search and Discovery
Semantic annotation tool	Improved Navigation and Browsing Contextual Understanding Interoperability and Integration Accessibility and Inclusivity Data Mining and Analysis Personalization and Recommendation Long-Term Preservation

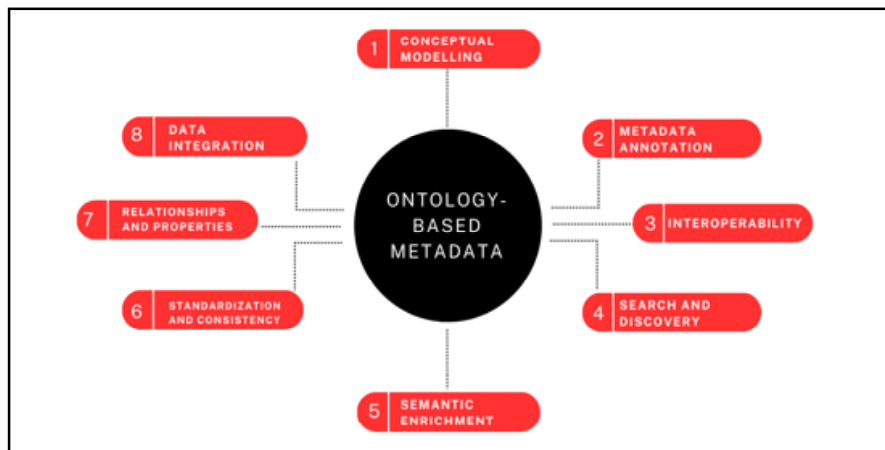
The following provides an in-depth explanation of the characteristics that are listed in Table 2.

### 5.1 Ontology-based metadata

Ontology representation emphasises semantics and provides complex semantics for machine comprehension. Rich semantics in the description, such as concepts and relationships, can improve data access, sharing,

and reusability of data sets (Chen & Plale, 2012). (Schuurman & Leszczynski, 2006) Metadata are an existing mechanism for communicating ontological information about semantic data. Due to the fact that many data sets are already represented by metadata, it is possible to construct an ontology representation for them based on the extant metadata (Chen & Plale, 2012). It can be utilised to describe the content of ETDs and permits a more precise and consistent representation of ETDs, thereby enhancing interoperability, discoverability, and searchability. The application of ontology to metadata requires the creation of a structured framework that defines the concepts and relationships pertinent to the metadata's domain. This ensures that metadata is structured, searchable, and consistently interpretable by both humans and machines.

Figure 1 gives an illustration of the features of ontology-based metadata. Conceptual modelling, Metadata annotation, Interoperability, Search and Discovery, Semantic enrichment, standardisation and Consistency, relationship and properties, and data integration were listed for the purpose.



**Figure 1: Ontology-based meta data Components**

The integration of ontology-based information may greatly enhance the effectiveness of Electronic Theses and Dissertations (ETDs). The use of ontology-based information in the context of Electronic Theses and Dissertations (ETDs) has the potential to improve several facets of their administration, exploration, and compatibility. This session discusses the potential enhancements that may be achieved in Electronic Theses and Dissertations (ETDs) via the use of ontology-based metadata.

- ❖ **Enhanced Discovery and Search:** The use of ontology-based metadata offers a systematic and organised lexicon for the purpose of defining the content, themes, keywords, and connections pertaining to Electronic Theses and Dissertations (ETDs). This feature enables a more precise and thorough search and exploration process, as users can formulate queries and investigate electronic theses and dissertations (ETDs) using well-defined words derived from the ontology. Because of this, there is an improvement in both accuracy and memory, hence facilitating the identification of pertinent Electronic Theses and Dissertations (ETDs) with greater ease.

- ❖ **Semantic Interoperability:** The use of ontology-based metadata facilitates semantic interoperability, hence enhancing the capacity of diverse systems and platforms to comprehend and exchange data in a more efficient manner. By adopting a standardised ontology, electronic theses and dissertations (ETD) repositories and databases may facilitate the seamless sharing and interchange of information. This approach effectively minimises obstacles to integrating and sharing data.
- ❖ **Faceted Navigation:** The use of ontology-based information has the potential to provide faceted navigation, which empowers users to enhance their search results by using diverse aspects or dimensions of the ontology. The use of dynamic and flexible filtering options may contribute to an enhanced user experience, as it enables users to efficiently refine their search criteria and locate the most relevant electronic theses and dissertations (ETDs).
- ❖ **Contextualization and Enrichment:** The use of ontologies facilitates the incorporation of comprehensive contextual information pertaining to electronic theses and dissertations (ETDs). The comprehensive content of academic writing includes intricate details pertaining to authors, advisers, institutions, study topics, procedures, and several other aspects. By organising and presenting this material in a systematic manner, electronic theses and dissertations (ETDs) gain enhanced significance as useful assets for scholars, educators, and many other individuals involved in the field.
- ❖ **Cross-Disciplinary Research:** The use of ontology-based metadata has the potential to facilitate interdisciplinary communication by establishing a common terminology that encompasses several fields of study. The use of this approach might enhance the conduct of cross-disciplinary research by enabling researchers to identify pertinent electronic theses and dissertations (ETDs) that may have relevance to their own work, although originating from diverse academic domains.
- ❖ **Quality Control:** The use of ontology-based metadata has the potential to contribute to the preservation of consistency and quality in the metadata descriptions of Electronic Theses and Dissertations (ETDs). The use of standardised language and relationships as outlined in the ontology may serve as a valuable tool for creators, aiding them in the provision of precise and all-encompassing information. This, in turn, can lead to a decrease in mistakes and inconsistencies.
- ❖ **Automated Processing:** The use of ontology-based information has the potential to facilitate automated processing, including tasks such as automated indexing, classification, and recommendation systems. These methods have the potential to optimise the overall user experience and boost the dynamism and responsiveness of electronic theses and dissertations (ETD) repositories.
- ❖ **Support for Linked Data:** The use of ontology-based metadata has the potential to facilitate the integration of electronic theses and dissertations (ETD) repositories into the Linked Data ecosystem. This ecosystem allows for the interconnection of data from many sources, enabling the exploration of related information via traversal. This feature improves the prominence and accessibility of Electronic Theses and Dissertations (ETDs) on the Internet.

Incorporating ontology-based metadata into ETD administration systems requires meticulous planning, implementation, and upkeep. It also requires collaboration among stakeholders, including librarians, information scientists, and subject matter specialists, in order to develop and refine the ontology to meet the particular requirements of the ETD community.

## 5.2 Semantic Search Engine

In contrast to conventional search engines, a semantic search engine holds semantic information about web resources and can resolve complex queries by taking into account the context in which the targeted web resource is located (Kassim & Rahmany, 2009). It combines Semantic Web and search engine technologies to enhance search results (Wen et al., 2006). It is possible to index the content of ETDs using semantic search engines. This enables researchers to search for ETDs pertinent to their work, even if the ETDs are not indexed using conventional keyword search methods. ETDs are more searchable with semantic search engines. Here are some ways semantic search engines can improve ETD:

- ❖ **Enhanced Relevance:** Semantic search engines have the capability to comprehend the contextual nuances, intentions, and significances embedded within user queries, hence enabling them to provide search results that are more relevant and applicable. This feature proves to be especially advantageous for academic scholars who often want accurate and detailed information.
- ❖ **Conceptual Understanding:** Semantic search engines have the capability to comprehend the fundamental ideas and associations included inside electronic theses and dissertations (ETD), even in instances when the precise keywords are absent. This functionality allows users to uncover pertinent information that may have otherwise eluded them via conventional searches reliant on keywords.
- ❖ **Natural Language Queries:** The inclusion of natural language questions allows users to interact with the search system in a more intuitive and user-friendly manner. Semantic search engines possess the capability to comprehend and analyse user queries in a manner that yields precise outcomes, hence diminishing the need for users to construct intricate combinations of keywords.
- ❖ **Relationship Mapping:** Semantic search engines provide the capability to discern and establish connections among various electronic theses and dissertations (ETD) publications, subjects, authors, and organisations. This functionality allows users to investigate the interconnections among various research studies and get a more profound understanding of the scholarly domain.
- ❖ **Cross-Disciplinary Discoveries:** Researchers have the ability to discover relevant research from several disciplines, despite the absence of expertise in those particular subjects. Semantic search engines have the capability to establish connections across diverse academic fields via the identification of shared ideas and themes.
- ❖ **Personalization:** Semantic search engines have the ability to adjust and accommodate user preferences and behaviours as time progresses. This enables them to provide personalised suggestions and enhance search results by taking into account an individual's specific research interests.

- ❖ **Advanced Filtering and Faceting:** Semantic search enables the use of advanced filtering and faceting capabilities. Individuals have the ability to refine their search results by using certain parameters, including but not limited to the year of publication, authorship, institutional affiliation, citation frequency, and other relevant factors.
- ❖ **Synonym and Variance Handling:** Semantic search engines have the capability to effectively process synonyms, acronyms, abbreviations, and variances in spelling, hence mitigating the risk of users overlooking essential information as a result of disparities in terminology.
- ❖ **Content Summarization and Extraction:** Semantic search engines have the capability to extract essential information and provide succinct summaries from electronic theses and dissertations (ETD). This functionality allows users to efficiently evaluate the significance of search results without the need to peruse the whole of the papers.
- ❖ **Contextual Recommendations:** Academic researchers have the ability to get contextual suggestions for associated electronic theses and dissertations (ETDs), references, and extra resources that augment their comprehension of the study subject matter.
- ❖ **Language Translation and Support:** Semantic search engines have the potential to enhance user access to electronic theses and dissertations (ETDs) across several languages, therefore facilitating greater accessibility and fostering international cooperation.
- ❖ **Visualization and Graph Representation:** Semantic search engines have the capability to generate visual depictions and graphs that effectively demonstrate the interrelationships and associations among various research subjects, authors, and institutions. These visual aids greatly facilitate the study of academic networks.

Through the utilisation of semantic search technology, electronic theses and dissertations (ETD) platforms have the potential to provide scholars with a more streamlined and productive method for discovering, accessing, and interacting with scholarly material. This, in turn, has the capacity to propel the domain of study and foster academic cooperation.

### 5.3 Semantic Annotation Tools

Semantic markup based on ontologies can address search, interpretation, and aggregation on the emerging Semantic Web. Semantic Web annotations go beyond conventional textual annotations of document content. (Uren et al., 2006) Semantic annotation formally identifies concepts and relations between concepts in documents and is intended primarily for machine use. Annotation of the Semantic Web offers two advantages over these systems: enhanced information retrieval and enhanced interoperability. Welty and Ide (1999) found that the ability to execute queries that exploit the ontology to make inferences about data from heterogeneous resources improves information retrieval. These tools can be used to add semantic information to ETDs. This data can then be used to enhance the discoverability and searchability of ETDs.



The use of semantic annotation tools is of utmost importance in strengthening the effectiveness of Electronic Thesis and Dissertation (ETD) systems. These tools contribute significantly to the improvement of information organisation, discoverability, and accessibility. These technologies facilitate the organisation and classification of material inside Electronic Theses and Dissertations (ETDs), hence enhancing user accessibility, searchability, and comprehension of the content. The following is an explanation of how semantic annotation tools enhance the performance of electronic theses and dissertations (ETDs).

- ❖ **Enhanced Search and Discovery:** Semantic annotation technologies enable the tagging of Electronic Theses and Dissertations (ETDs) with significant information, keywords, and ideas. The inclusion of enhanced metadata improves the search and discovery process, hence facilitating efficient content retrieval for consumers. Individuals have the ability to conduct searches on certain subjects, keywords, authors, or ideas. The presence of semantic annotations aids in the delivery of precise and reliable search results.
- ❖ **Improved Navigation and Browsing:** Semantic annotations have the capability to provide hierarchical structures, categories, and linkages inside electronic theses and dissertations (ETDs). This feature enables users to traverse the information with more efficiency. The use of chapter and section highlighting, as well as the inclusion of relevant material, enables readers to efficiently navigate through various areas of the Electronic Thesis and Dissertation (ETD), therefore augmenting the overall quality of the reading experience.
- ❖ **Contextual Understanding:** Semantic annotations provide more context to the substance of electronic theses and dissertations (ETDs). Enhanced comprehension of the connections among various ideas, concepts, and arguments offered in the text may be achieved by readers. This contextual information aids readers in comprehending the overarching story and significance of the Electronic Theses and Dissertations (ETD).
- ❖ **Interoperability and Integration:** The use of semantic annotations facilitates the establishment of compatibility and exchange of information between electronic theses and dissertations (ETDs) and many other systems or databases. By following standardised annotation formats and ontologies, electronic theses and dissertations (ETDs) may enhance their compatibility with other academic resources and research platforms. This, in turn, promotes seamless integration and facilitates the flow of data.
- ❖ **Accessibility and Inclusivity:** Semantic annotations have the potential to augment the accessibility features found in electronic theses and dissertations (ETDs). These annotations may serve several purposes, including the provision of alternate text for pictures, audio descriptions, and translations. By using this approach, a more extensive spectrum of individuals, including those with impairments or linguistic limitations, may avail themselves of the information and get advantages from it.
- ❖ **Data Mining and Analysis:** Semantic annotations facilitate the process of analysing and extracting valuable insights from electronic theses and dissertations (ETDs). These annotations may be used by

researchers and institutions to do data mining, topic modelling, sentiment analysis, and other computer investigations in order to get more profound insights from the material.

- ❖ **Personalization and Recommendation:** ETD systems have the capability to provide personalised suggestions to consumers by comprehending the semantic context of the information. This entails proposing relevant scholarly articles, book chapters, or authors that align with the user's interests and interactions, so augmenting their level of involvement.
- ❖ **Long-Term Preservation:** The use of semantic annotations may be a valuable component in the development and implementation of long-term preservation strategies for electronic theses and dissertations (ETDs). The inclusion of context and information is crucial as it contributes to the preservation of the intellectual and cultural legacy included within these texts.

In brief, the use of semantic annotation tools plays a significant role in strengthening the performance of Electronic Theses and Dissertations (ETD). These tools contribute to several aspects, including search and discovery, navigation, contextual understanding, interoperability, accessibility, data analysis, personalisation, recommendation, and long-term preservation, hence improving the overall functionality and effectiveness of ETD systems. They provide users with the ability to actively participate in and get benefits from electronic theses and dissertations (ETDs), while also facilitating smooth interaction with other academic resources and platforms.

## 6. Case Studies

A few case studies where Semantic Web technologies were utilized in Electronic Theses and Dissertations (ETDs) are given below.

### 6.1 OATD - Open Access Theses and Dissertations (<https://oatd.org/>)

The OATD project is an initiative utilising Semantic Web technologies to provide access to global theses and dissertations. Theses and dissertations' metadata are exposed via Resource Description Framework (RDF) and other Semantic Web standards, allowing for more efficient discovery and interlinking of academic resources. Figure 2 depicts a screenshot of the OATD website.

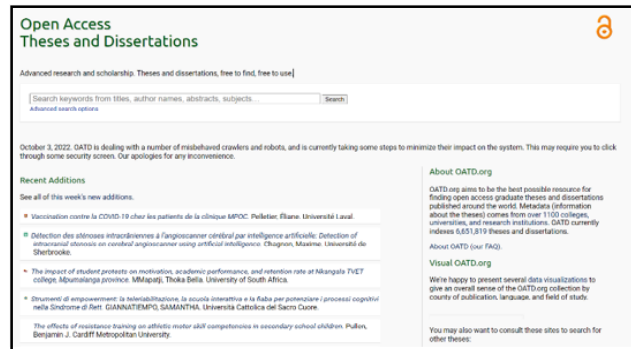


Figure 2: Screenshot of OATD Webpage

## 6.2 Thesis Commons (<https://thesiscommons.org/>)

Thesis Commons is a platform that employs Semantic Web technologies to provide a linked data representation of theses and dissertations. This platform enables writers to publish their works accompanied by enhanced metadata and semantic annotations, hence promoting seamless integration into the academic ecosystem and augmenting their visibility. Figure 3 is a snapshot of the Thesis Commons website.



Figure 3: Screenshot of Thesis Commons webpage

## 6.3 EThOS - Electronic Theses Online Service

EThOS, the UK's national thesis service, provides access to the complete text of ETDs, although it is not exclusively concentrated on Semantic Web technologies. It employs a variety of metadata standards and formats, including Dublin Core, which can be combined with Semantic Web principles to improve discoverability and integration. Figure 4 depicts a screenshot of the EThOS website.

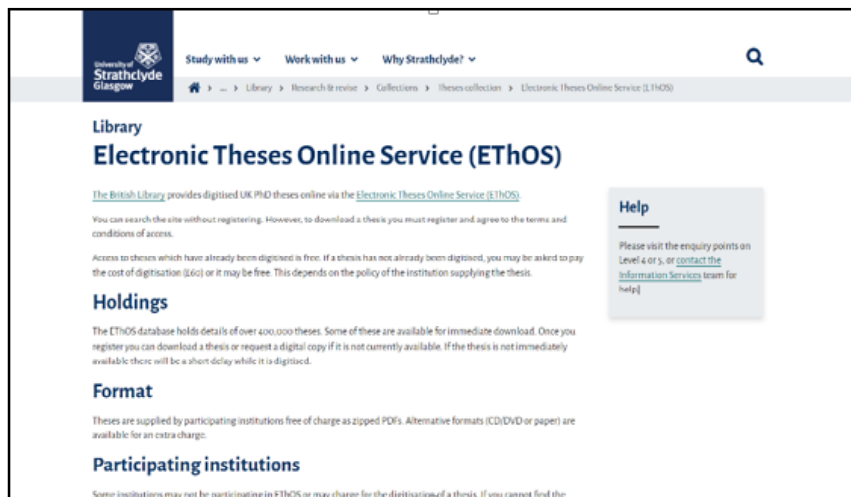


Figure 4. Screenshot of EThOS webpage

## 7. Conclusion

The use of ontologies and the Semantic Web has the capacity to fundamentally transform the way Electronic Theses and Dissertations (ETDs) are disseminated and employed. The use of ontologies and the Semantic Web might facilitate the discovery, retrieval, and utilisation of electronic theses and dissertations (ETDs) by establishing a standardised framework for the representation and dissemination of information pertaining to ETDs. This phenomenon has the potential to result in heightened levels of research productivity and creativity. Despite the inherent difficulties, the use of ontologies and the Semantic Web in the context of electronic theses and dissertations (ETD) publication has considerable potential as a subject of scholarly investigation. With the ongoing advancement of technology, it is anticipated that there will be a proliferation of inventive applications of ontologies and associated Semantic Web Technologies in order to augment the efficacy of Electronic Theses and Dissertations (ETDs).

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