TITLE OF THESIS – AN INVESTIGATION INTO ONTOLOGY BASED ENHANCEMENT OF SEARCH TECHNOLOGIES FOR E-GOVERNMENT

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Abstract

The field of e-government has always been a distinct area of standard testing for software research. To expound further, the e-government field presents a variety of principled elements, which makes the system more challenging and further encouraging than other electronic scenarios (e.g., e-business and e-commerce).
To a certain extent, selecting an appropriate Web modelling technique (e.g., ontology) illustrates the critical role of establishing a successful e-government system.
Ontology has been used in e-government to describe and define services provided to citizens. In addition, ontology technology is expected to play a pivotal role in enabling semantic web services.
While creating the ontology for e-government remains a significant task concerning its planning and implementation, there are still a few investigations to deal with the ontology technology's effect on the government's capability to deliver its due services.

Because of the noticeable failure in large parts of e-government projects, the current study stands out as an attempt to improve their performance in terms of service delivery, appropriateness of applying modern technologies, and finally, a research-driven application. Factors for conducting academic research will lead to refining knowledge-building related to design procedures and setting up the ontological framework within the e-government domain.

This research aims to verify whether the ontology technology can be described and considered a reference technology for providing e-government services over the Internet. Consequently, the research presents a practical method established on experimental research that moves nearer to the fact of the true function of ontological procedure in the field of e-government.
In this study, the educational system in Singapore is used to represent the domain of e-government in which research questions are raised and addressed; also, general impressions can be tested and originated.
The research methodology utilised in the research has the advantage of being consistent in the case study. Inside the case study, both quantitative and qualitative methods are applied to collect data and gain access to an answer to the research question.

Concerning the establishment of ontology for the Singapore education system (OSE), which creates the educational system in Singapore, an implementation of Methontology seems to be an extremely suitable methodology for applying ontology for the Singapore education system (OSE) structure in this research. Methonlogy defines a comprehensive ontology development methodology. Moreover, the separate actions for ontology structure achieved the problem in seven stages.

The ontology evaluation of Singapore's education system (OSE) will be based on the ontology assessment process implemented by Gómez-Pérez's approach, which comprises the binary essentials: specifically, verification and validation of the (OSE) system. However, the criteria for the evaluation concerned with delivering services to perform efficiently, performance, and easy access of services in e-government; more specifically, system recall, semantic search, data/service integration, response time, and natural language interface. Ontology (OSE) is reviewed by experts in the field where experts fill values assessment in a survey which consists of several questions related to these criteria.
Although the domain experts have the knowledge and were able to evaluate ontology in various concentrations, for example, philological, language, concept, and data to ensure that the expected ontology conducted components are established.

The research study is involved in and tailored for the following contributions:

- Creating an ontology model for the Singapore education system (OSE) environment to integrate e-government with design science.
- The educational system model is a practical foundation for building the e-government framework, as the study relies on the ontology analysis of the educational model in the e-government framework.
- Identify the priority of services.
- Design the Ontology for Singapore Education system Website (OSEW).
- Adapting Methontology that appears to be an extremely suitable methodology for applying ontology for the Singapore education system (OSE) structure in this research.
- Evaluation and testing of the (OSE) system.

The study's findings found that the ontological technique can be employed to reach a successful electronic system.
The OSE ontology indicates the fulfilment quantities of specialists, including OSE ontology. The system showed a high rate of acceptance and satisfaction in the four layers of the evaluation represented in clarity\ vocabulary and lexical, structural, representational, and semantic, and data \ application layers.

Keywords

Semantic Web Framework, E-Government, Ontology, Design Science Research, Expert Judgment, Protégé OWL.

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1.Chapter 1: Introduction

The Enhancement level of services provided by e-government to various sectors is considered no longer an innovative or uncritical topic. The continuous growth in the level of services and delivery methods by e-government, which corresponds to the expansion in the technologies used, is one of the most important topics worthy of attention for many governments and researchers.

The electronic government, which carries different names such as e-gov, e-government and e-governance, seeks to "utilize various Information and Communication Technology (ICT)" (Wang et al., 2011) for converting the method of government work, engage citizens, and offer services to citizens (Abdullatif et al., 2013).

Success and reducing the chances of failure are certainly the goal of various e-governments, mainly based on successfully providing various services. However, in a successful e-governance system, services will expect to be offered conveniently, efficiently, and transparently (Aadi et al., 2015).

The e-government system is distinguished from other electronic circumstances (e.g., e-business and e-commerce), with a large interaction capacity with many segments and purposes. In addition, the role of e-government is expanding and involves providing interaction between the government and the concerned stockholders including citizens, businesses, and agencies' relations (Gronlund and Horan, 2005). Contrasting other electronic circumstances allows businesses to interact with each other more efficiently and bring customers closer to companies.

The extreme requirements for e-government data, along with the variety of required processes such as search, retrieval, and presentations, entail creating and developing a web-based e-government system, not an effortless task that requests further consideration.

Over the years, many e-governments have recorded a failure for various reasons that appear in the loss of economic opportunities, the chances of enhancing effectiveness, the inability to reach the targeted goals, failing to reach the desires of the customers or the beneficiaries of the project, and the undermining of efforts (Taherdoost et al., 2012).

The characteristics of the e-government system are distinguished from other electronic types such as e-business and e-commerce, which made e-government a fertile environment for the enhancement and usage of software technologies. For example, formalism distinguishes many of its structures, the diversity of stakeholders, the vast amount of information, and the open manner of the e-government system (Zhou, 2011).

To increase the efficiency of government services, e-government uses various modelling techniques that include web modelling techniques, semantic (ontology), and non-semantic techniques.

Ontology as a meaning and a concept has differed between the past and the present. Previously, most otologist researchers considered ontology to have a philosophical meaning (d'Aquin et al., 2012). However, meaning has become more concerned with practical concepts than simple absolute philosophical expression (Delbru et al., 2012).
Mainly in e-government, ontology is used to illustrate and define e-government services because of its ability to enable semantic integration and interoperability of electronic services (Khattak et al., 2009). In addition, ontology technology is supposed to perform a key role in allowing semantic web services (Al-Kalani et al., 2010).

In this research study, the proposal submitted by Abecker et al. (2006) and Zhou (2011) has been modified, and application-based research has trailed as a standard for semantic web assessment in offering e-government services, with a vision to find the greatest

consideration of the design and structure of processes used in creating and supporting e-government environment.

Three e-government systems (i.e., Singapore, Bahrain, and Oman) were examined regarding the services provided to select a wide-ranging system that provides further services in various domains (e.g., Education, Health, and Manpower). The services were recognised and selected as a first step towards creating (i.e., using OWL technology) the e-government system that will be tested in terms of recall, search accuracy, service integration, response time, and support of natural language queries.

This chapter presents the fundamental research issue, which supplies an associated overview of the domain and its origin, aims and objectives, problem reorganisation, motivation of the research, description of the research question, sub-questions, research methods, and research structure.

1.1 The Cyberspace the WWW and the Web Services

Basically, the cyberspace or Internet links parties of devices; more accurately, it expresses a wide-ranging network of networks. Globally, it connects multitudes of computers, allowing connecting computers that can communicate with any other computers if there is an Internet connection.

The Internet is not the same as the World Wide Web (www). The www, or as an identifier, the term "web," is a tool that expresses how information is retrieved from the Internet. More obviously, it is a method of delivering information placed on top of the Internet. Web browsers are also similarly used to access web pages connected via hyperlinks; examples of these well-known browser tools are Internet Explorer, Google Chrome, and Firefox (UN survey, 2016).

The term of Web services, which use HTTP to make available functions, connect using the web to distribute information and permit switching business logic.

1.2 Semantic Web

In a linguistic sense, the term semantics is used to describe the "study of meanings," however in computer science, this term is used more to distinguish between the meaning of teaching a form (d'Aquin et al., 2012).
The Semantic Web is "a scheme that aims to change an extension of the current Web, that allows to deliver an easier way to finding, distribute, reprocess, and combine information" (UN Survey, 2018).
Yet, the Semantic Web is based on machine-readable information, which develops based on tools such as XML, RDF, and OWL. However, these tools can identify customised tagging schemes or offer a flexible approach to representing data (d'Aquin et al., 2012).
The Semantic Web offers shared layouts for exchanging information, wherever on the Web simply provides substitution of details.
In addition, the semantic web application, used to describe web-based applications, integrates various semantic web technologies such as RDF, OWL, and all other possible metadata standards.
Web 2.0 is clearly intended for people to spread information, while semantic web work is focused on giving devices the functionality of understanding. Thus, the web requires a basic human operator, using the capabilities and facilities integrated in the computer to retrieve data.

1.3 E-government

E-government dominates an increasing role in extremely business and citizens' lives, the term electronic government (e-government) stresses of "uses Information and

Communication Technology (ICT) to change over the method of the government work" (d'Aquin et al., 2012).
Accordingly, numerous e-government systems (i.e., more than 193) are existential to propose a plethora of services to their beneficiaries or user groups (UN survey, 2016).

In recent years, the progression and growth of the World Wide Web (WWW) has categorically led to changes in people's attitudes toward obtaining services provided by the government (Al-Kalani et al., 2010).
However, providing and improving access to various services is one of any government's most important aspirations and goals. In this circumstance, using the e-government system, the services are expected to be offered in a suitable, effective, and clear manner (Layne and Lee, 2001).

Contrasting the e-business scenario demonstrates that the e-government differs radically by type, categories, and even the number of services provided.

The diversity of the target groups is plainly displayed by the variety of target categories. However, e-government attempts are classified into three distinct groups of citizens, governments, and industries (d'Aquin et al., 2012).

E-government employs various developing techniques to boost the government services' productivity offered to people, organisations, firms, and groups. Such techniques include both semantic web modelling and non-semantic techniques (d'Aquin et al., 2012).

Despite the tremendous technological development (i.e., semantic, speed of the Internet), it was accompanied by increasing diversity and a greater demand for services among various target groups. In e-government projects, many governments recorded a clear weakness that led to failure to meet the citizens' needs for accessing available services (Layne and Lee, 2001). A large percentage of this failure is due to the usage of unsuitable tools to deliver the services provided by the e-government system (Liu and Hu, 2012).

In e-government, the ontology technique is primarily employed to describe and define e-government services to enable semantic integration and interoperability of electronic services (Delbru et al., 2012). In addition, ontology technology is supposed to perform a pivotal role in facilitating semantic web services.

1.4 Sematic E-government

The field of e-government has extended continued experience intended for a standard trial of software research. In particular, the field of e-government extends around magnificent structures, which makes it more encouraging and challenging than other electronic models (Zhou, 2011).
The following figures reveal why e-government is a potential candidate for semantic web resolution:

- The high-level formality that defines various of its structures.
- The variety of stockholders within the same process.
- An enormous volume of information that must be recovering and retrieved crossways several systems.
- Connections are found at different levels in regional, local, and global organisations.
- The architecture of the e-government is distinguished as an exposed architecture.
- The difficulty in the realisation of the physical integrated system.
- There is no reliable identification agreement through the numerous department and systems.
- Singapore has e-government creativity but requires offered dependent on the semantic web.

Moreover, there is a significant concern, and the subject matter of considerable research in the government domain represents an appropriate research area for the semantic web, as government data is essentially official (d'Aquin et al., 2012). Principles taken from W3C considered adopting a semantic technology that might enable access to services in a more efficient and easily accessible manner.

1.5 Motivation of Study

The research motivation is constructed on four visions illustrated in Figure 1-1.

1. E-government failure. Many e-government projects have failed in their ability to deliver their services in an effective, high-performing, and easily accessible manner (Faqihi et al., 2012). However, a large proportion of this failure falls into the use of appropriate techniques and their role in describing the content and delivery of services. In an attempt to maximise the chances of success of e-government by offering services in a more efficient, high-performing, and easily accessible manner, there is a pressing need to search for new, suitable technology, specifically ontology technology (Dombeu and Huisman, 2011).
2. According to (W3C) opinion, an adaption of semantic web technology leads to significant improvement in the way of web constructs information and responds to different segments of users.
3. E-government domain appropriateness. The e-government domain has always been categorised as a productive area for a standard assessment of software research. Particularly, the domain of e-government presents various unique features, which makes it further challenging and more encouraging than e-business circumstances.
4. There is a great preference to use application-driven research with actual-world use cases to validate the benefit of software knowledge.

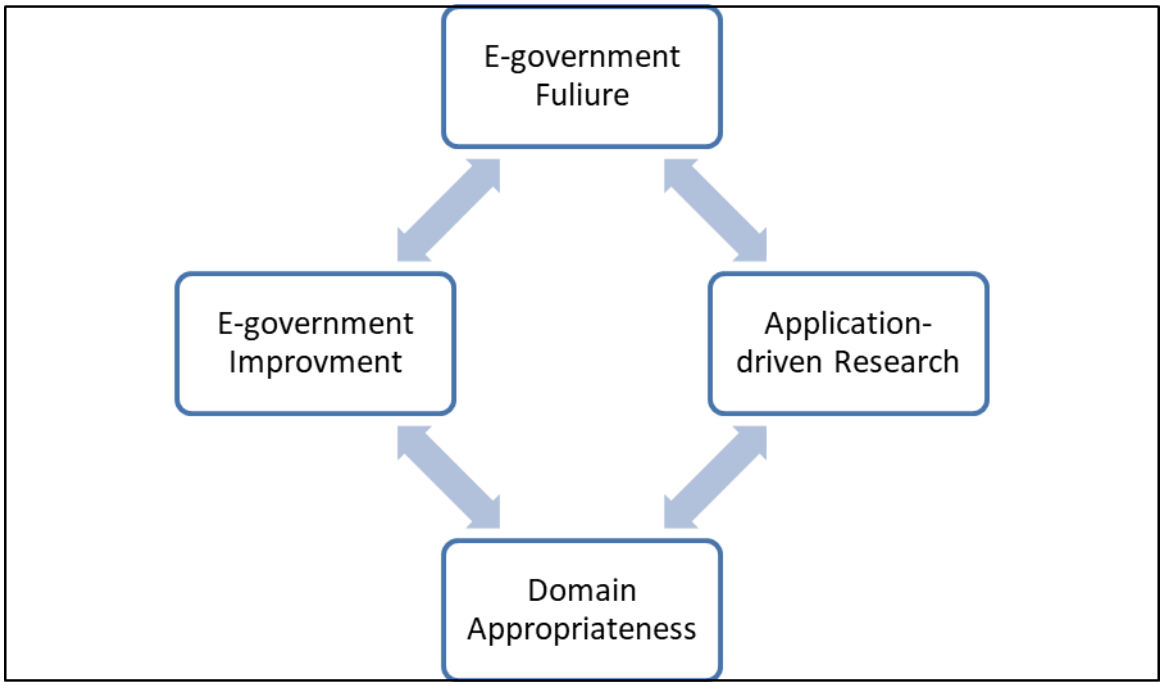


Figure 1-1 The Motivation of Study

1.6 Research Aims and Objectives

This research study aims to verify whether ontology technology can be described and considered as a reference technology for providing e-government services over the Internet.

To achieve this main aim, a set of objectives are titled as follows:

- Build and develop a model of ontology for the educational system to represent the domain of e-government.
- Establish a framework of ontology for educational services in the e-government domain.
- Classify and arrange the electronic services provided by the e-government based on the importance of their appearance.
- Select an appropriate methodology to establish and develop the ontology for the educational system in e-government.
- Select ontology tools and languages to create and develop the ontology for the educational system.
- Develop a system that allows conducting the evaluation of the established ontology for the educational system.
- Assess the ontology for the educational system according to the validation and verification method.

To deal with the solid impression among several large-scale experts that the internet has not yet reached a complete position of transferring information, the number of inventiveness, applications, projects, and network support groups got introduced. However, these projects focused on the theory of using the semantic web and ontology technology. Examples of these projects are reviewed as follows:

- Some major international companies such as Oracle, Facebook, and IBM have sought to build their development system using the semantic web to solve the problems that some systems may face (World Wide Web Consumer (W3C), 2009a).
- Application areas such as information systems, health care, and data science, have attempted to combine data by using the semantic web as a possible method of resolving several of their research and expansion difficulties.
- W3C's hold-up e-government concern unit has also been progressed to create a global network of encouragement to act with governments on concerns of effectiveness, transparency, and responsibility for wide-open information.

The explanation for this confidence is that as soon as using the non-semantic web, the information that links the data elements is desirably missing since losing the connecting assets that link data elements simultaneously. While the frameworks, which are collected ontologies, regenerate various of those missing properties and therefore permit query language implements to recover information that is deeper and further cohesive.

1.6.1 Problem Identification

The exciting questions that possess a strong relation to the problem are raised below:

How can we build an e-government model with so many e-services?
What is the methodology?
What are the methods to evaluate the system?

The research problem is built on three viewpoints, which are described in Figure 1-2.

1. Wide-ranging of services offered by e-government.
2. Difficulties faced in the implementation.
3. Support and evaluate the ontology system.

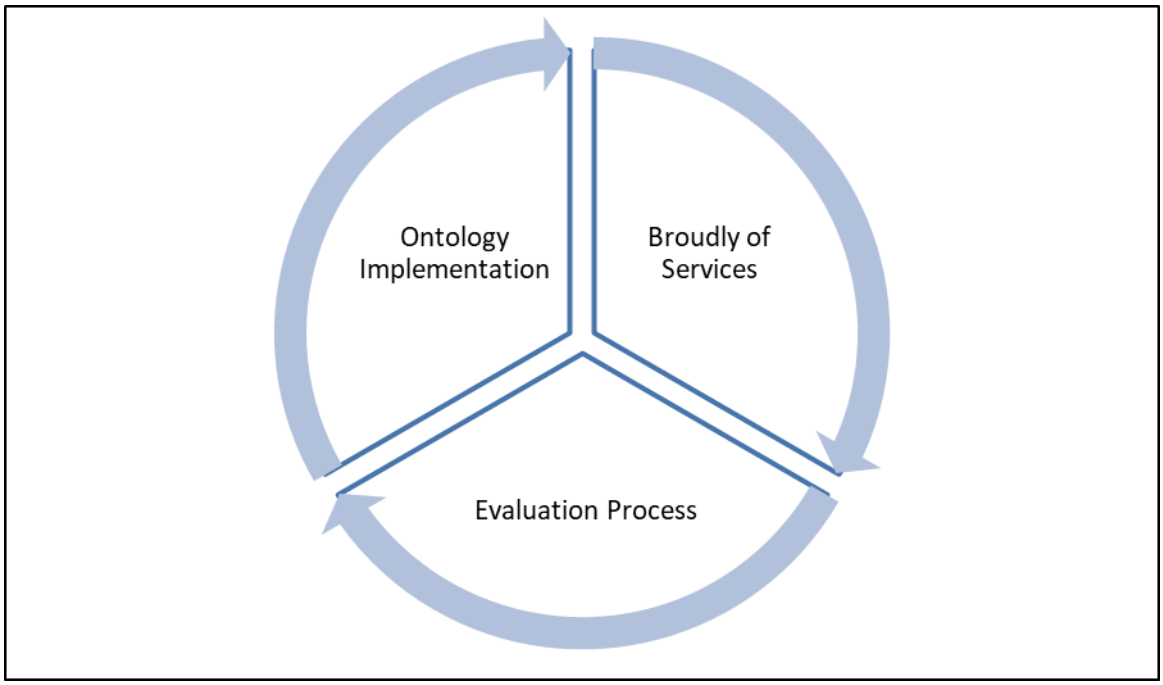


Figure 1-2 Problematic Viewpoints

Furthermore, the description of presented services in e-government is increased from archive information to election, excise, and further facilities that increase the demand by a large set of viewers such as individuals, groups, citizens, business environments, banks, and private companies.
Also, the extended number of e-government (i.e., more than 193) offered services to many viewers (UN survey, 2016). However, these descriptions make selecting services to build the system considered a difficult task.

The challenge of implementing the ontology, using appropriate execution technology, has been distinguished in the new technology designed to create the ontological system.

Additionally, selecting the appropriate methodology to build the ontology of the e-government system must pass specific criteria. So far, there have been suggestions for several methodologies since the 1990s to create semantics (e.g., methodology and SENSUS). Every single methodology requires a different method (Sawsana, 2013).

1.6.2 Problem Domain and Scope

Figure 1-3 shows the scope of the research, which expands to the three layers described as follows:

1. The wide field is represented in the outside level, representing semantic web application research-motivated, which utilises physical-world usage cases.
2. The second layer is characterised by the field of research, which merges both e-government and the semantic web.
3. The inside layer covers the Singapore e-government, particularly the education system. The last is the presentation domain of the research.

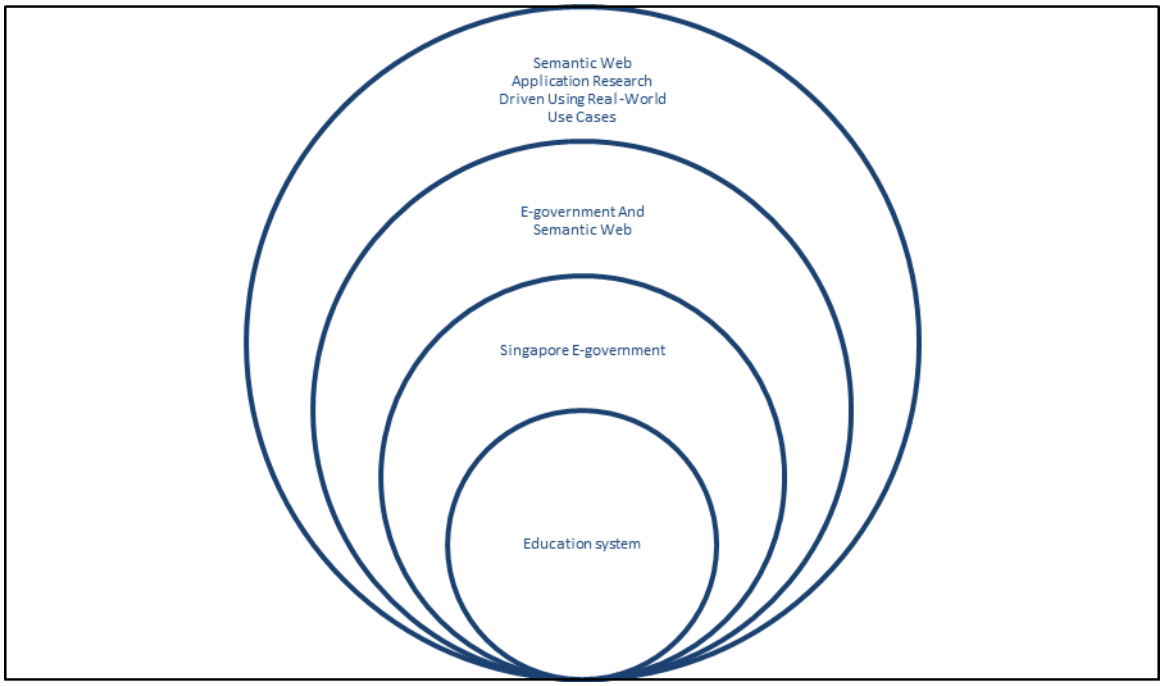


Figure 1-3 Research Domain and Scope

The area is widely considered to be the proper expressive of the large scale.
Many components and rules of different governments and countries are consistent with the Singapore government and environment. For example, the educational services we find in systems such as Australia, Bahrain, and Oman are necessarily adapted and are very similar to the education system in Singapore, where all e-governments include services and information about students, jobs, schools, and the education system.

1.7 Research Description and Research Question

The research aims to verify whether ontology technology can be described and considered as a reference technology for providing e-government services over the Internet.

Consequently, the research presents a practical method established on experimental research that moves nearer to the fact of the true function of ontological procedure in the field of e-government. Moreover, this research is concerned with the issue of whether ontology technology can be designed, developed, and implemented on various components of government.
In this study, the educational system in Singapore is used to represent the domain of e-government in which research questions are raised and addressed; also, general impressions can be tested and originated.

1.7.1 Research Question

An application-intensive research method is used to examine the ability of ontology semantic web to deliver services and information for the e-government domain, leading to the following question:

Can an ontology within the e-government framework create and describe a recommended standard for succeeding in delivering governmental services and information?

1.7.2 Research Sub-Questions

To sustain the research undertaking, the following sub-question would be addressed:

1. What is the framework, philosophy, paradigm, and research theory assumed in the research?
2. What are the research standards, procedures, and study techniques that should be assumed?
3. What method is used to select e-government and services to represent the domain?
4. What services are considered most requested by e-government users?
5. What are the ontological languages required to design and build the ontology model?
6. What are the composing tools mandatory for generating and organising the e-government ontology environment?
7. What methods are used to validate and evaluate the ontology application system?

The research outcomes enhance a body of the understanding related to the progress of the design and building of the ontology framework, which would serve the deliveries of the e-government domain.

1.8 Contribution

The research study is concerned and customised for the following contributions:

1. Creating an ontology model for the Singapore education system (OSE) environment to integrate e-government with design science. To the best knowledge of the researcher, the educational model in Singapore is a unique model, as no researcher or developer has created and developed such a model using ontology technology. This is due to the difficulty of the system model in creating and developing, as hundreds of interconnected services need to build many links and relationships to form meaning; in addition to the ontology language as new languages (i.e., OWL), few developers are sufficiently familiar with them. The creation of the OSE model system is described in Chapter 5 and section (5.2).
2. The educational system model is a practical foundation for building the e-government framework, as the study relies on the ontology analysis of the educational model in the e-government framework. In addition, the developed model represents a formal framework built with employing (OWL), which is almost the only comprehensive framework for the educational system represented the framework of the e-government. Also, services in the educational environment in any e-government, such as Australia, UK, and Oman, are very similar, so we build a formal practical framework, as (OSE) builds concepts for educational services, properties, and links between services. The descriptive concept of the framework is described in sections (2.1.5), (2.3), (3.6), (3.7), and (5.3). The (OSE) ontological statistics are categorised by a vast number of classes, specifically 835, in addition to 193 assertions, with more than 80 regulations and interactions, to handle the strong intelligence articulation capacity. However, the strength of the (OSE) was clearly established in the large number of Axiom numbers exceeding 2600.
3. Identify the priority of services. As the study will provide a mechanism for selecting the most requested services, it will classify services in order of their importance in e-government. Data collection (services) will be according to a new mechanism based on more than one item to collect and compile data; more specifically, the mechanism applied a qualitative (i.e., survey) and quantitative (i.e., mathematic metric) approach for identifying the value of public services in the e-government system. The identification and selection of services are described in Chapter 4.
4. The Design Ontology for Singapore Education system Website (OSEW) is described in section (5.9). (OSEW) is a website created by the researcher author to create an interactive environment between the researcher and experts to evaluate and develop the system. OSEW allows the user of (OSE) to view and explore the Ontology for the Singapore Education system (OSE).

However, (OSEW) comprises comprehensive descriptions of (OSE) ontology, enabling the client to fill in the form designated to evaluate the system easily and clearly. (OSEW) allows the user to investigate the (OSE) system (i.e., classes, properties, individual, system viewing).

5. The research-developed ontology for the Singapore education system (OSE) model, which creates the educational system in Singapore through adapting Methontology that appears to be an extremely suitable methodology for applying ontology for Singapore education system (OSE) structure in this research. The distinct procedures for ontology structure completed the problem-solving in seven stages described in section (2.6) as supported by the implemented Methontology methodology described in section (5.1).
6. The research-formed ontology for the Singapore education system (OSE) model uses OWL to implement the (OSE) model. The description of using OWL is found in sections (2.8.1) and (5.4). OWL is applied to ontology languages. Also, the Protégé ontology managing tool is implement, which presents a graphic user interface for characterising ontologies. It also includes a concerted ontology development nature for the Web, specifically, Web Protégé. The Protégé ontology managing tool described in section (2.8.2)

7. Evaluation and testing of the (OSE) system. The ontology evaluation of Singapore's education system (OSE) will be based on the ontology assessment process adopted by Gómez-Pérez's approach, which comprises two essentials: verification and validation of the OSE system. However, the criteria for the evaluation concerned delivering services to perform efficiently and allow easy access of services in e-government; namely, system recall, semantic search, data/service integration, response time, and natural language interface. The ontology evaluation approaches are described in section (2.7) and supported by the implemented evaluation approaches described in Chapter 6.

1.9 Methodology and Implementation

The research methodology utilised in the research has the advantage of being consistent in the case study. Inside the case study, both quantitative and qualitative methods are applied to collect data and gain access to an answer to the research question.

Regarding the establishment of ontology, a suitable methodology for constructing an ontology is promoted as a major first stage of the development of an ontology. Nevertheless, the choice of methodology to be followed in developing the ontology represents the proposed rules in every step that depends upon the utilisation of the ontological approach.

To properly construct ontologies, a specific methodology should be adopted, among the various sets of suggestions for various methodologies that have been adopted since the 1990s. However, each of these approaches has a different method, such as Methontology and SENU. But there is a common view that there is no shared understanding of a specific procedure for creating and designing the ontological system. However, the selection methodology varies based on its function and use.

While a single ontology methodology must be selected, it is proposed to apply the Methonlogy method as it is mostly recognised and defines a comprehensive ontology development methodology. Furthermore, the separate actions for ontology structure achieved the problem in seven stages (NOY, N. F. 2004).

Consequently, the research-implemented ontology for the Singapore education system (OSE) creates the educational system in Singapore. Therefore, an implementation of

Methontology is extremely suitable for applying ontology for the Singapore education system (OSE) structure in this research.

The ontology evaluation of Singapore's education system (OSE) will be based on the ontology assessment process adopted by Gómez-Pérez's approach, which comprises two essentials: verification and validation of the OSE system. However, the criteria for the evaluation are concerned with delivering services to perform efficiently and allow easy access of services in e-government, namely, system recall, semantic search, data/service integration, response time, and natural language interface.

Furthermore, Ontology OSE is reviewed by experts in the field, where experts fill values assessment in a survey, which consists of several questions related to these criteria. Even though the domain experts have knowledge, they were able to evaluate ontology in various concentrations, for example, philological, the terminology, hypothesis, and information confirm that the expected ontology conducted components are established.

1.10 Thesis Structure

The thesis structure demonstrated in Figure 1-4 is divided into seven chapters, combined with a reference part and an appendix. Chapter 2 displays the background study and survey analysis. Chapters 3 and 4 report five of the seven sub-questions. Ontology Construction is covered in Chapter 5. Chapter 6 discusses the Evaluation (7^{th}sub question), and the last chapter is concerned with the Conclusion and Future Work.

Chapter one: Introduction

The primary chapter provides an introduction, which delivers a related outline of the topic area and its original problem, goals, purpose of the investigation, description of the research question, sub-question, research methods, and research structure.

Chapter two: Literature Review

The "Literature Review" collates and investigates serious facts of standing information, including practical findings and hypothetical and procedural offerings to e-government. The review identifies and analyses information that provisions the design structure and deployment of semantic frameworks.
It also contributes to a review of the previous studies to deliver background material on the key components of the research.

Chapter Three: Research Strategy

In this section, the research process is defined as an arrangement of clear stages. The research process involves a comprehensive study of the evidence collected, concluded the study, critical assessment, and an assumption of the methods used to gather and evaluate the information.

The key outcomes of the section are the response to the following research sub-questions:

- What is the framework, philosophy, paradigm, and research theory assumed in the research?
- What are the research standards, procedures, and study techniques that should be assumed?

Chapter four: Service Collection and Identifying Services

This chapter describes the services provided by e-government to characterise the data entry of the e-government environment. Even so, selecting services from an extensive set of services must involve standards of eligibility.

The key outcomes of the chapter are:

- the answer to the research sub-questions:
    - What method is used to select e-government and services to represent the domain?
    - What services are most requested by e-government users?

- Priority index has addressed the domain services provided in the three cases of the government sector (Singapore, Bahrain, and Oman).
- The Education domain in the Singapore e-government sector was selected to represent e-government as it contained the highest number of services among other domains and government sectors.

Chapter five: Ontology Construction

The construction of the e-government ontology is defined in this chapter. Evidence is collected from Singapore's education website and another respectable source to instantiate the environment issues and sub-domains. It offers several screenshots and instances of the organisation system. The chapter considered the helpfulness of both use cases and Protégé OWL in the provision of the construction and design of the ontology.

Chapter six: Evaluation Methods and Analysis

This chapter provides methods for assessing the OSE ontological system. These methods are focused on some ontology assessment requirements toward reflecting the issue of:

- What methods are used to validate and evaluate the ontology application system?

Chapter seven: Conclusion and Future Work

Figure 1-4 Thesis Structure

2.Chapter 2: Literature Review

The chapter proposes an analysis of the works and substantial associated resources correlated with the research problem. The fixed themes and sub-themes are as follows: The chapter starts with a robust background resting on the research topic area and presents an indication of some aspects of Singapore government collection. Then, it illustrates the manner of e-government constructions, which may perhaps be described all throughout the semantic framework.
The larger subjects of important conceptualising of the e-government combined with preparation e-government services, along with illustrations of e-government creativities in Asia and Europe, are then presented.
The next section of the chapter then introduces some context knowledge regarding using semantic tools and methodologies for developing and constructing ontologies. Reference papers describe the languages and semantic technologies that support their use in building the e-government ontology.

Then the last section of the chapter presents some previous studies and methodologies presented by a group of researchers to arrive at what has been achieved in this field and attempt to build on it.

2.1 E-government

Rapid advancements in technology and the great access of various segments of society to the Internet give the tremendous power to redefine government and its services. Encouraged by the demands of the government that become more accessible, leaders in the public sector have been dealing with the exciting issue of how to utilise new technologies in the most efficient manner on the path to distribute services to the public.

The government uses information and Internet applications on the Internet to improve citizens' access to government services and permit citizens to complete online transactions. By replacing the traditional method of transferring paper services directly over the Internet, providing e-government services to people becomes the fastest and most appropriate way to earn government services (UN survey, 2016).

In the next section, a comprehensive review of the e-government term, including experiences of the benefits and drawbacks of e-government, is supplied.

2.1.1 An overview of E-government

The e-government concept appeared in the first half of year 1990s. At the same time, the history of computing in governmental organisations dates back to the early stages of computer history (Guo, 2010). Still, the term of e-government has been experienced in the active environment since the opening of the usage of computers (Peristeras et al., 2010).

Although e-government practice conveys to the usage of IT within the government, recent e-government publications often relate to external use, such as services provided to citizens (Grönlund and Horan, 2005), and in addition, may perhaps include:

a) E-government (or digital government) strategies come in service concepts, such as employing the Internet and offering government data and public services to different service recipients (UN survey, 2016).
b) Use of information technology (IT)/ information communications technology (ICT) to increase the success of service distribution in the public sector (Guo, 2010).

E-government has been used on every possible scale, meaning providing government services on the Internet to exchange electronic transformation of the set of information and

services provided by the government with citizens, businesses, and different service beneficiaries.

Traditionally, it considered the e-government and the usage of knowledge and all available technology to enhance the effectiveness of government work to offer electronic services. Later, the e-government plan expanded to include the deployment of ICT with the government to conduct a wider range of relations with citizens and companies and permit a modern technological revolution in governance effort (Buraga et al., 2006).

According to the published United Nations Analysis in the year 2018, e-government missions remain "selecting all necessary preparation in the use of information and communication technology, concerning overseeing various government processes and reaching public purposes through digital methods."

The basic belief of e-government, backed through a successful e-governance functional structure, is to improve the inner operating methods of the public segment by dropping economic expenditures and operating periods to improve the business environment and operations. Similarly, enabling the efficient usage of resources among different audiences and sector agencies to find viable solutions. Through the engagement of e-government, governments can be further useful, offer excellent services, answer to citizens' needs in clarity and accountability, and be more comprehensive, therefore, reconstructing citizens' trust in their governments (Un survey,2016).

2.1.2 UN E-government Report

The UN has released, since 2001, a periodic survey issued every two years to assess the performance and development of e-government. Next on earlier versions, and up to currently its elevenths' publications (Buraga et al., 2006), the survey presents an assessment of the growth created in the employ of e-government.
The assessment report is the single worldwide information evaluating in the e-government development centre for all UN member states (UN survey,2016).

The report indicates the evaluation rates of e-government performance in countries relative to each other, rather than being given a pure rate.
However, the report demonstrates that each country must determine the degree and scope of e-government programs in position with the main concern of national development and achieving governments' development objectives.

The report is concerned with the effectiveness of e-government measures in providing public services and designs taken by countries in developing e-government and presentation, along with weight countries and regions that have not yet fully exploited the possibilities of employed (ICT); Therefore, support capacity development is conducted in a beneficial manner (Buraga et al., 2006).

The report represents a tool for the development of countries where it allows countries to become a source of learning from each other, identifying the powers and problems they face in the field of e-government besides formulating their plans.

The report also aims to facilitate the deliberations of international bodies, including the United Nations and various sectors, including the universal gathering and the great-level political and economic opportunity, on subjects associated with e-government development, and the serious position of ICT in business.

The survey largely boards numerous sectors, including government officials, researchers, civil civilisation, the private segment, and other specialists in e-government.

The methodology adopted by the report is mainly based on the analytical aspect of the survey by reviewing the forms and analysing the survey data.

Collecting and citing innovative and implemented practices by different countries is also illustrated to demonstrate how information and communications technology is utilised to change management and public institutions to encourage environmental development. The approach used for the report is based on a framework founded on the principle of collecting and evaluating data for the various e-governments, then looking at a comprehensive approach to the e-government, which includes three values that permit the public to take advantage of facilities and information on the Internet, the three important values are described as follows:

1. Sufficient communication structure.
2. Human resource facility to encourage, use of information and communication technology.
3. Convenience of internet facilities.

Providing services via the Internet is the basis on which the survey is based so that it evaluates several related features. The evaluation process includes the elements that form and are close to the government and its services and includes opening government data, e-participation and providing services via multiple channels, mobile services, and digital devices. For innovative partnerships using information technology, however, statistics are gathered via many researchers under the guidance of UNDESA.

Corresponding to the (EGDI), Denmark, charted by Australia, takes the global lead in offering government public services across the cyberspace (UN survey, 2018).

There is a clear indication of an increase in e-government development in various regions, largely driven by an improvement in the Internet services index. Investigation into the general index for the different regions indicates the superiority of European countries in developing e-government. However, both the Americas and Asia are still roughly equal shares within a group of middle-level EGDI (UN survey, 2018).

2.1.3 The public sector

The basic principle that leads to successful e-governments is to effectively deliver various services, which various e-governments seek, to various public sectors (UN survey, 2018). However, once users wish to obtain a service from the e-government, the website or any other available medium should facilitate the process of communicating and interacting with users via the internet using graphic user interfaces (GUI), instant messaging (IM), and identifying government problems through presentations / audio and video. But seek to avoid simple methods based on simply sending email to the address mentioned on the website.
The rapid e-government work seeks to enhance the value of the participants by working on transformation and using appropriate technology to facilitate access to the public and provide government services to the whole users. Consequently, the e-government participants are mainly from the public sector (Buraga et al., 2006).

If e-government is successfully utilised, it can be a powerful tool to strengthen the interaction between the citizen and the government to advance public administration, as well as provide public services and improve efficiency for internal government (Guo, 2010).

Furthermore, it is assumed that the quality of public service is improved and understood to adequately reflect citizens' requirements for clarity and responsibility (UN survey, 2016).

The accelerating business and ease of enhancing the knowledge forced the creation of an incremental revolution in the public sector. Nevertheless, with the vast influence of the sector, managements continue to be accountable for the value and morals of standards and public services.

According to a questionnaire prepared by the United Nations in 2018, the public sector is generally considered a strong important institution in the ability to integrate and use information systems successfully, and even the integration of policies to facilitate the provision of an integrated approach in which the government represents the public sector and the participation of the private sector. Hence, the public sector, the main provider of public services, needs to properly prepare the chain of services to provide a high standard and customer service. This, in turn, needs a series of necessary measures required to provide high capabilities and skills, adequate financial support, qualified human resources, a set of policies and strategies, and finally, legal, and regulatory frameworks.
In brief, the services offered must be in position with the requirements and deliver the proposed social, economic, and environmental consequences.
Consequently, it was not observed that opportunities to use ICTs for the project or even use these technologies on a large scale to distribute public services have increased significantly in many countries. However, ICTs are expected to expand significantly, with greater access to lessons learned that support this trend. The main goal of all these measures is an attempt to maximise success by providing good quality services to the beneficiaries of the services, by providing the appropriate environment for supportable development through which all possible services are provided to all target groups, whether community, commercial, and environmental needs (UN survey, 2018).

2.1.4 Advantages of e-government

The expected profits of e-government illustrated in Figure 2-1 include improving service delivery, effectiveness, clearer availability of public services, manageable community development, and additional simplicity and accountability.

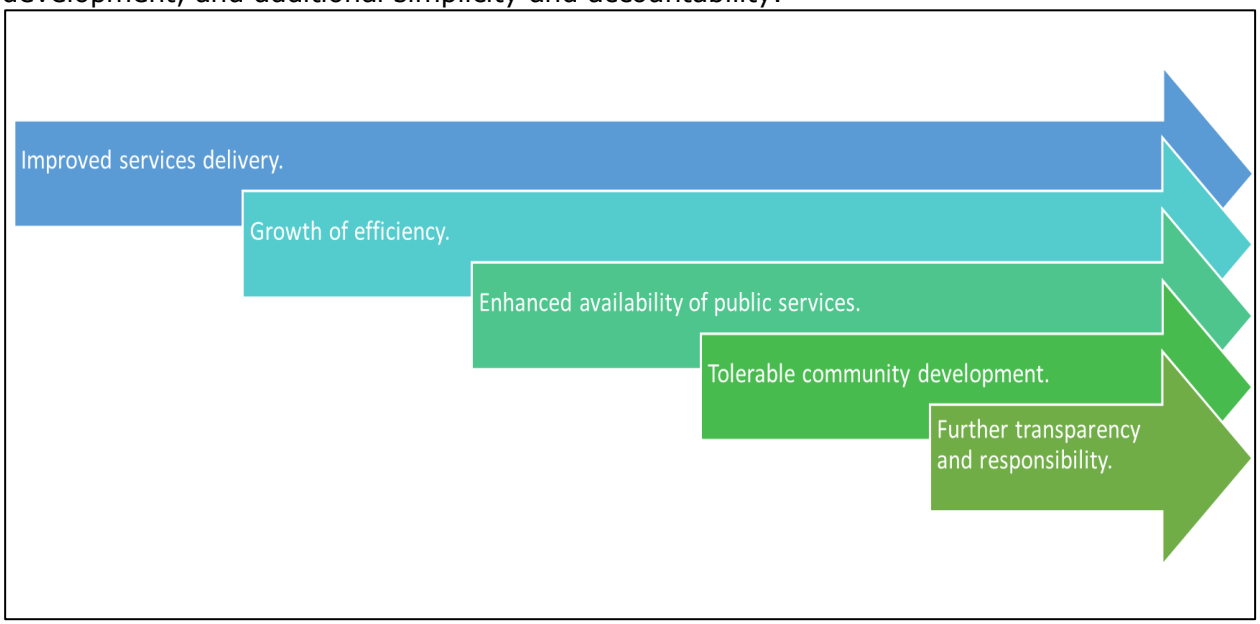


Figure 2-1 E-government Benefits

Still, the target of the e-government is to expand the assortment of facilities to customers in an effective and expense-useful approach.

E-government helps create easier procedures and government information more easily accessible for public sector interests.

2.1.5 Examples of e-government

In this part, two geographic ranges are identified, where the technological revolution has led to increasing the efficiency and effectiveness of the government procedure and seen similar development in delivering e-government creativity, exclusively in Asia and Europe.

2.1.5.1 E-government in Asia

Asia has the most considerable quantity of states offering facilities (representing 28% of 193 UN). Asia's countries are divided into six geographical regions. However, Asia is not merely an extremely populated zone, it is also the biggest continent by area.
In Asia, the trend is characterised by diversity in e-government in all countries of the region.
Three countries in Asia were placed among the highest ten in the world, respectively, the Republic of Korea (first in Asia and third in the world), Singapore (seventh in the world) and Japan (tenth).

Giving to the United Nations survey in 2018, the United Arab Emirates has the uppermost EGDI between the GCC (GCC), trailed by Bahrain, Kuwait, and Qatar.

2.1.5.2 E-government in Europe

Later in the appearance of the earliest version of the United Nations e-government study in 2003, Europe maintained a steady level of progress, consistently topping the EGDI between areas. In the UN report 2018, the nations and district levels, with five out of 10 countries in Europe, ranked highest globally.

While there are fourteen countries out of the top twenty ranked in this region instead of the European countries that are ranked in the EGDI high ranking.

2.1.5.3 E-government in Bahrain

The first strategy, which was launched by the Bahrain government early in 2007, contributed to achieving impressive success that enabled the Kingdom of Bahrain to reach a leading country in e-government. During this period, numbers and achievements were seen in various levels, which we summarised as follows:

- Ranked first as the leading country in the world in e-government (UN survey, 2014).
- Ranked 1st in the Gulf (UN study, 2016).

E-government Efficiency
The main principle of the e-government strategy is to improve facility distribution via e-empowerment in stages of services. However, the provision of services through electronic means provides the possibility to always benefit from all services along with circumstances and requested services from any place where the recipients of the services are located. However, determining the customer's channels is one of the serious issues related to achieving effective e-government.
The e-government in Bahrain will allow the supply of services via various outlets such as:

- General Gateway
- National Interaction Middle
- Service Middles and e-government Stalls
- E-government Application.

2.1.5.4 E-government in Oman

Changing the economy in Oman to become based on a supportable information-based economy started with the financial visualisation site of the Sultanate concerning the 2020 strategy of e-government in the Sultanate of Oman, which was approved in March 2003, the shares of this shift in terms of the development of the digital society of Oman and e-government. It has a review of e-government strategies, and numerical knowledge, and the increased efficiency of Omani peoples (Sarrayrih et al., 2015).

The Ministry of Technology and Communications is the uppermost authority responsible for setting the plan for e-government and various applications in the Sultanate of Oman. The primary objective of MTC is to enable and work to implement the leading government e-services and thus improve the efficiency of the state benefit from innovative technology, besides establishing a society characterised by a digital society in Oman.

The element of MTC job includes a sequence of duties that stay deeply committed to achieve, such as building the human resources required to shift towards digital reading and writing for successful implementation and adoption of e-government services besides increasing citizen participation. It assists ministries and other government agencies in the effective execution of IT projects.

More than that, Oman provides a set of what can be called electronic offers for citizens that lead to providing many of the qualitative advantages and additions through which Digital Oman has provided a wide range of services, which include training, both at the level of communications and information technology, down to a set of regulatory legislations. All of this establishes a fundamental change in the user's life for the better in receiving government services easily and effectively (Sarrayrih et al., 2015).
While e-government presented the Omani services objectively and confidentially and in a cohesive structure that permits simple entrance for the uses (Oman Portal, 2019).

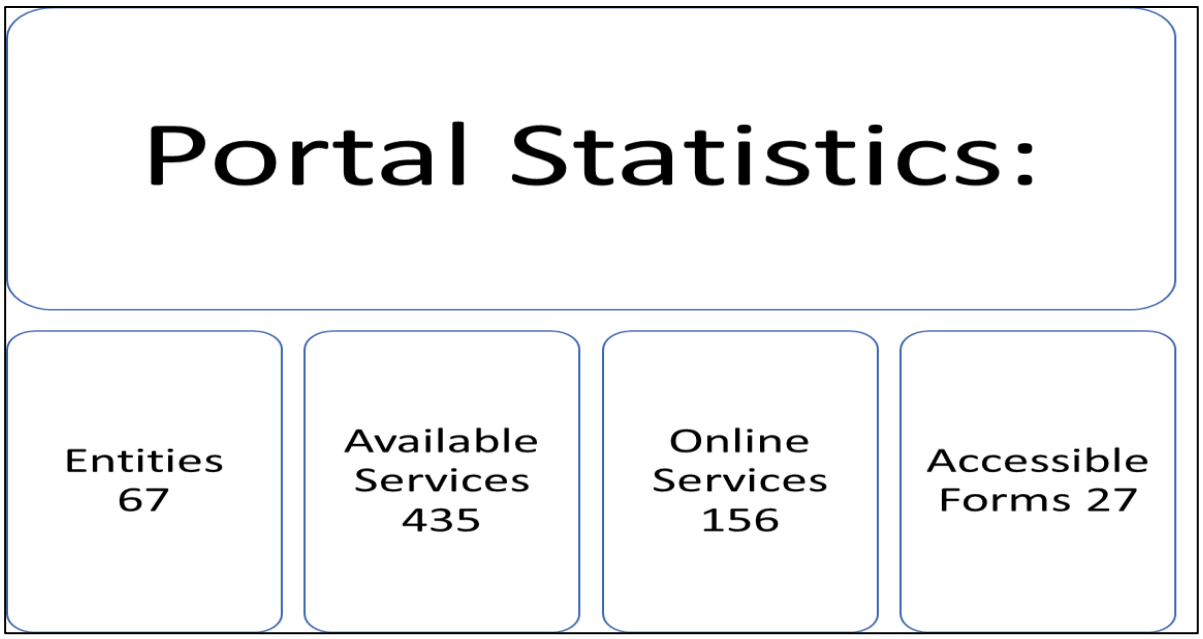


Figure 2-2 Oman's Portal Statistics
Source: Oman Official eGovernment Services Portal.

As shown in Figure 2-2, with more than 400 services provided by the Omani e-government, e-government concluded e-services employ a set of services (see Figure 2-3) for the business and commercial community to cover the various stages of establishing until the end of a business, including starting, respectively, promoting and closing businesses, and various services for example regulations, procedures, employment, permits, and government support business. Electronic services for business entry, transfer, income tax, and education in Oman.

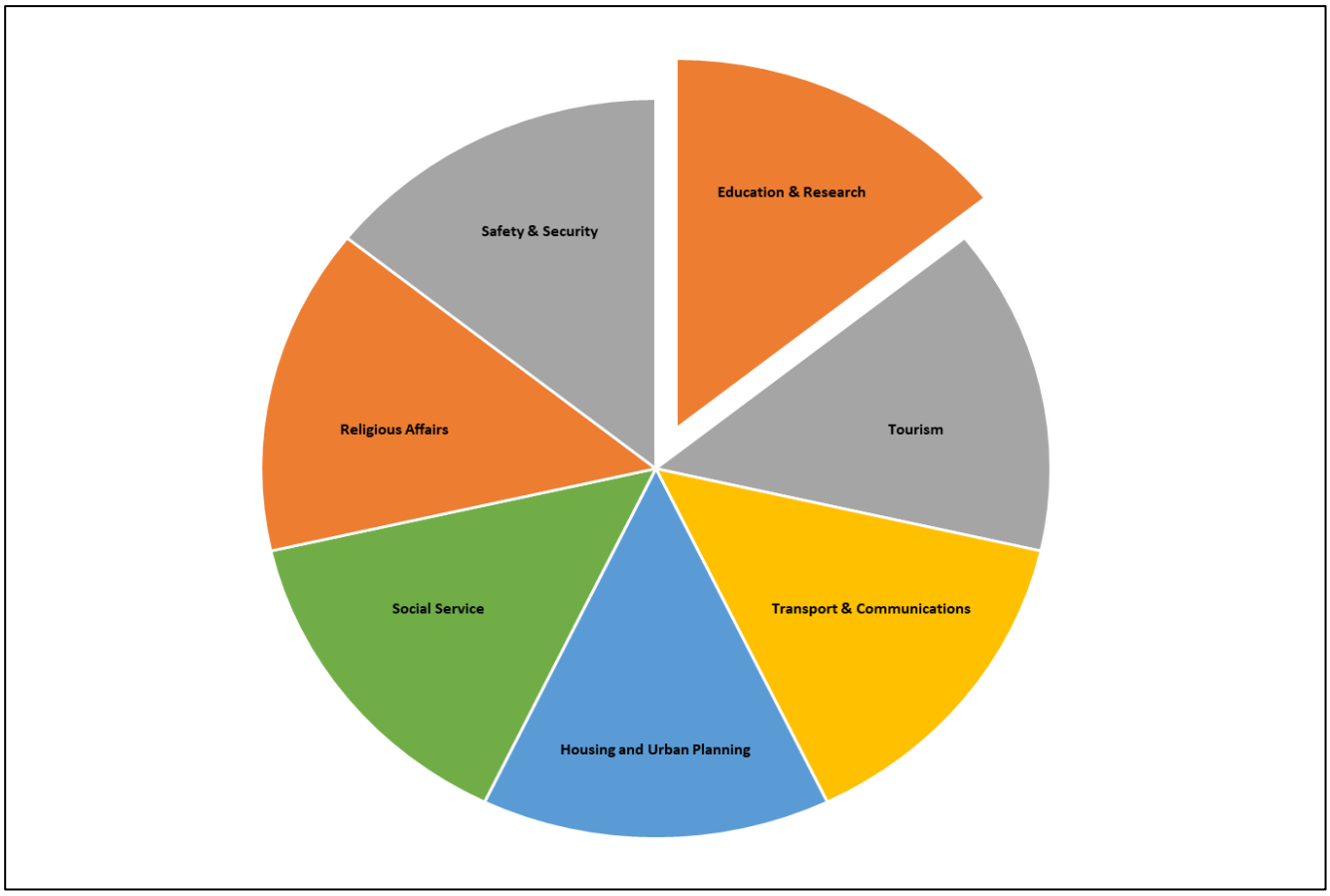


Figure 2-3 Oman Services Sectors

2.1.5.5 E-government in Singapore

Fundamental Government in Singapore

In this sector, an overview of the government plan, the e-system in Singapore is included, then a general explanation of the Singapore government system is provided. First, however, familiarity with Singapore's government and the education system is well represented and reproduced to construct the intended e-government ontology demonstrated in chapter 5 of the thesis.

Structure

Singapore is a country located in Southeast Asia. Singapore was under Malaysian rule until it gained independence in 1965. According to the Singapore constitution, the country's system is characterised by the country's constitution as a joint representative democracy represented by a Parliament and government with the President as the head of state. The country has the advantage of holding democratic elections with a multiparty political system.

The legal authority is an independent organisation of the authority formed by a parliamentary work and supervised by an authorised organisation. Disparate government agencies and sectors that are parts of departments, legal panels that thought the public employees do not manage besides having more freedom and flexibility in their operations (Weiling, 2004).

Administration

Singapore is a capital government with a ruling arrangement modelled on the British scheme of governmental authority. Moreover, the period Authority of Singapore can have several separate implications. At its broadest, it can describe communally the three conventional departments of government: the Director, Judicial (combine both the president and parliament), and Justice branch.

Figure 2-4 displays the body's devices. Ministers appointed by the prime minister to oversee departments, or ministers in the prime minister's department, so there are two statutory councils empowered to oversee and manage the government system.

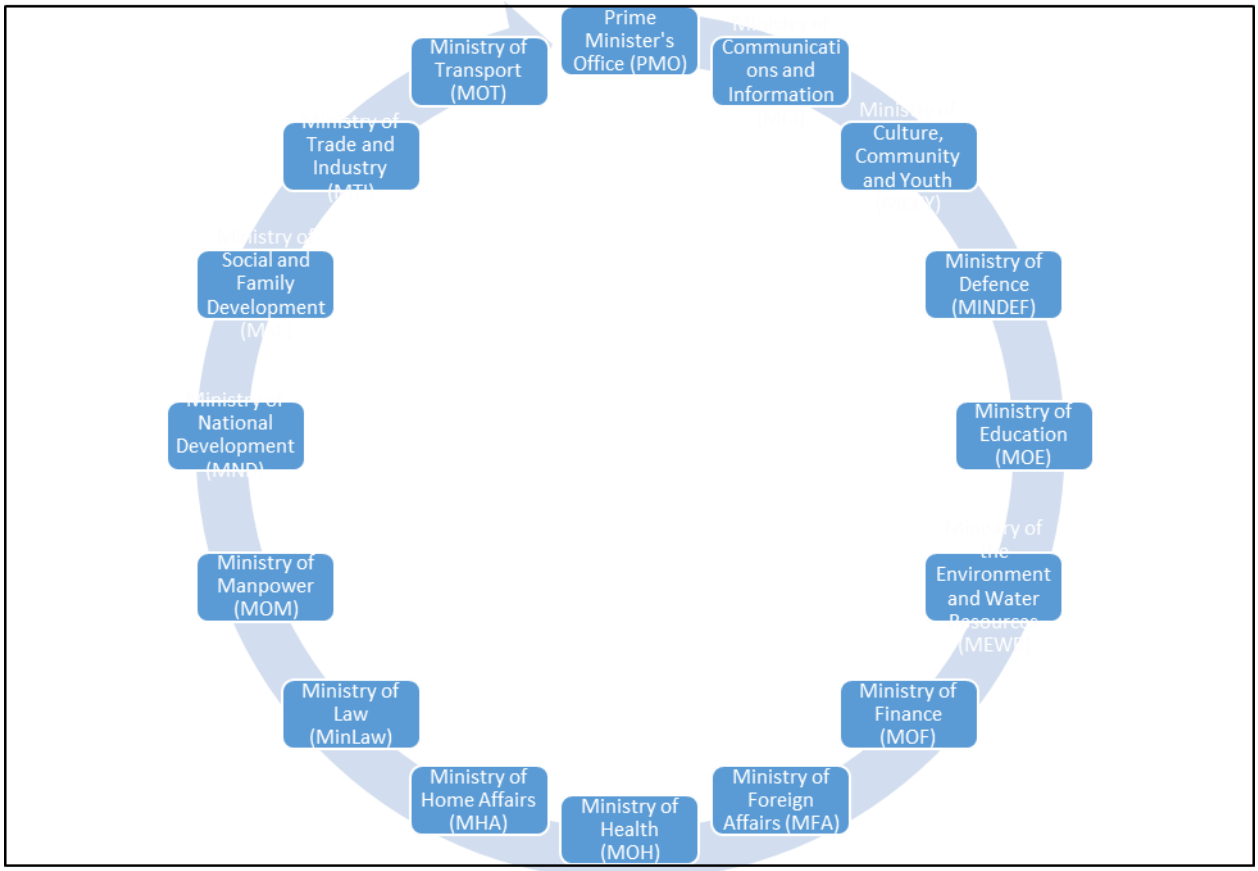


Figure 2-4 Singapore Government

Electronic System in Singapore

By the early 1980s, the Singaporean government's effort in communication technology (ICT) began. Later, the Singapore government kept abreast of the rapid advances in information and transformed public administration and service delivery to the sectors transparently (Weiling, 2004).
However, citizens and businesses have benefited in many ways, providing greater comfort and cost savings by increasing productivity and effectiveness in providing services. Despite the approach taken by the Singaporean government, it focuses mostly on providing information to the public, with little interactive dialogue between the government and citizens.

Singapore's shift to e-government on the robust base of CSCP using four major indicators of improvement is described as follows (Weiling, 2004):

- The Social Maintenance Automation Plan (1981 to 1985).

- The State IT Plan 1986 to 1991,
- Guide Strategy 1992 to 1999, and
- Infocomm 21, introduced in 2000.

The Digital Government Blueprint (DGB) characterised in Figure 2-5 proceeds of six-turn, through a method to create a digital government.

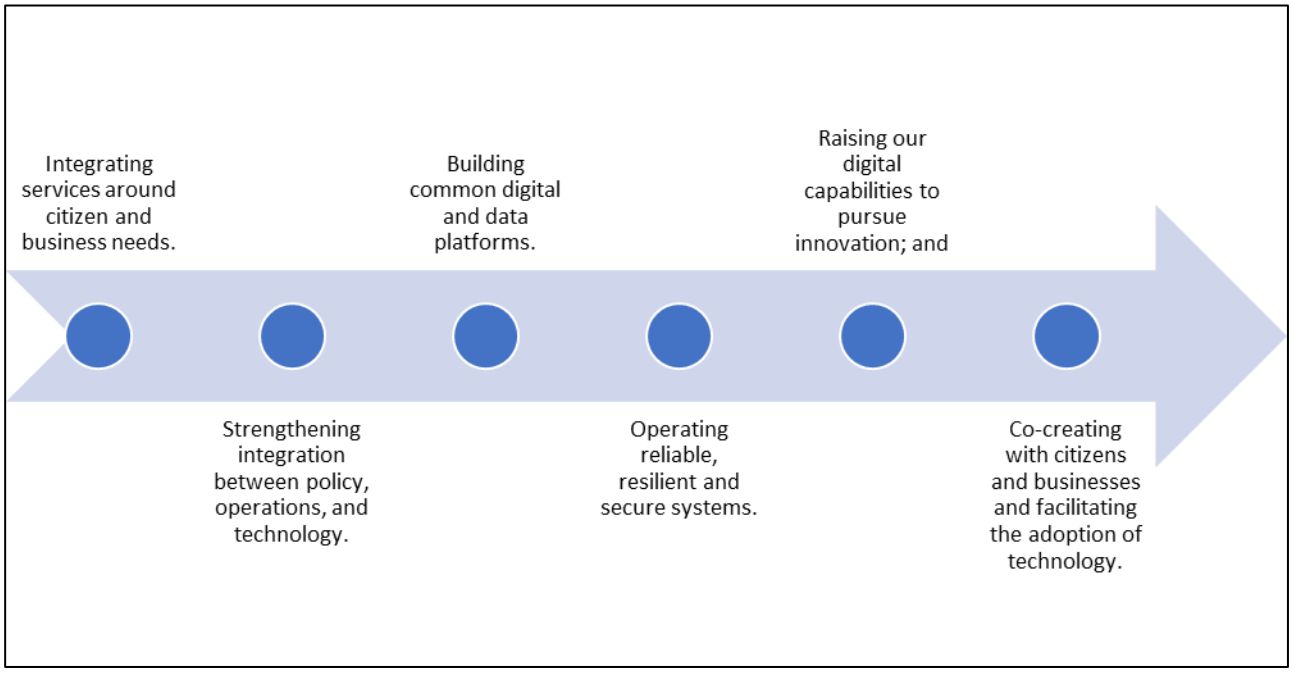


Figure 2-5 DGB Plan

Additionally, the DGB expresses specific targets for initiatives and regions that the authority will board. These forces are increased iteratively as technology develops and wants transformation (Weiling, 2004).

2.1.5.6 Education System in Singapore

In 2010, the Singapore Education Framework was described as 'world-leading,' encompassing individuals selected for a grant by a former UK Director of Education (Weiling, 2004).

Education in Singapore is run by the Ministry of Education (MOE), which supervises educational services. MOE is the authority responsible for managing and providing its electronic educational services through the ministry's official website.
However, MOE operates the expansion and supervision of public schools that receive taxpayer funding. Also, Singapore's education system has an advisory role besides management concerning the private schools (MOE official site).

The educational services provided electronically are ranked ahead of the rest of the electronic services provided by the Singaporean government, as educational services are characterised by comprehensiveness, diversity, the large number of services, and the many sectors served.
The educational services are characterised by comprehensiveness, as it includes services proceeding a wide range of sectors such as educational services for both students and parents, admission, registration, jobs, news, archiving, and financial matters. However, these services diverge into three types of services: archival, interactive forms, and participatory.

The great diversity of services presence made the education system rank first around the number of services offered by the Singapore e-government. Moreover, services covered large segments of society, such as students, parents, job seekers, and employees.

Through its official website, the Ministry of Education provides more than 780 various electronic services (The Official Site of MOE), as indicated in Figure 2-6. These services are distributed into six categories. The news category occupies the largest share of the number of services (i.e.,267 services), while about us is the lowest (i.e.,32 services).

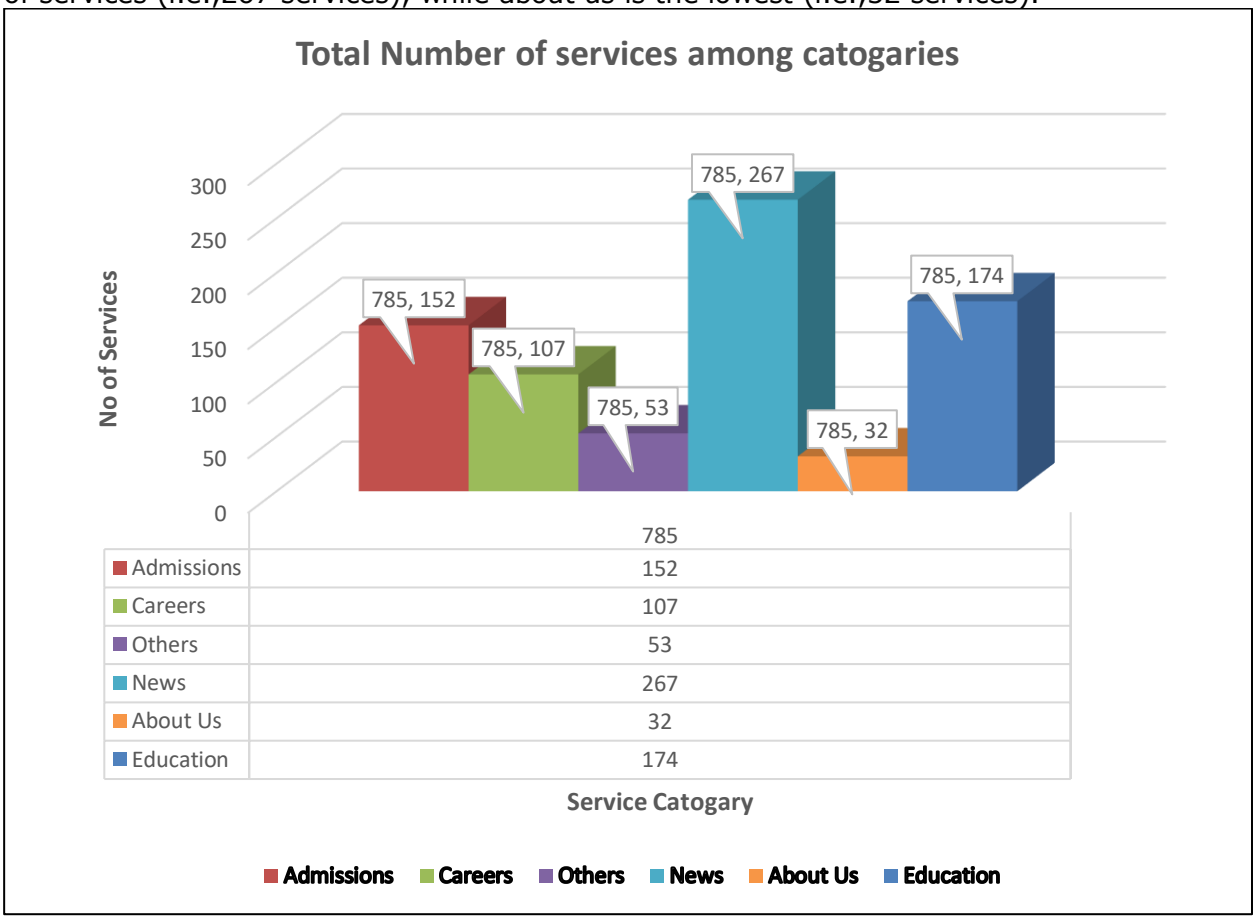


Figure 2-6 Category of Services in Singapore Education System

Service category/Education

Figure 2-7 shows the education service category in the Singapore educational system. The education category includes 174 electronic services distributed into seven facilities of groups(directories). The school programs group includes the largest number of services, with 47 different services, while both types of examinations dates and secondary schools sit on a single service for each.
The group of services that fall within the category of education includes the following:

- School grades level the school grades in the Singapore education system:
    a) Nursery schools in Singapore deliver up and around three years of kindergarten for kids ages three to six.
    b) Main education is a four-year organisation stage which is usually beginning at age seven.

- Gifted Learning Curriculum. This system searches for gifted kids, and it emphasises greater demand on imagining and innovative thinking.

- Co-Curricular events. Compulsory at the main and secondary degrees, indicating that all students should join in at least one interest.
- Pre-university and post-secondary education studies centralized foundation is meant for learners who want to follow a community-university degrees following three years before joining the university.
- Private and international schools in Singapore are present to several worldwide schools. International and not public schools.
- Financial support (FAS), the Ministry of Education launched the Monetary Support Program to deliver financial support for learning.

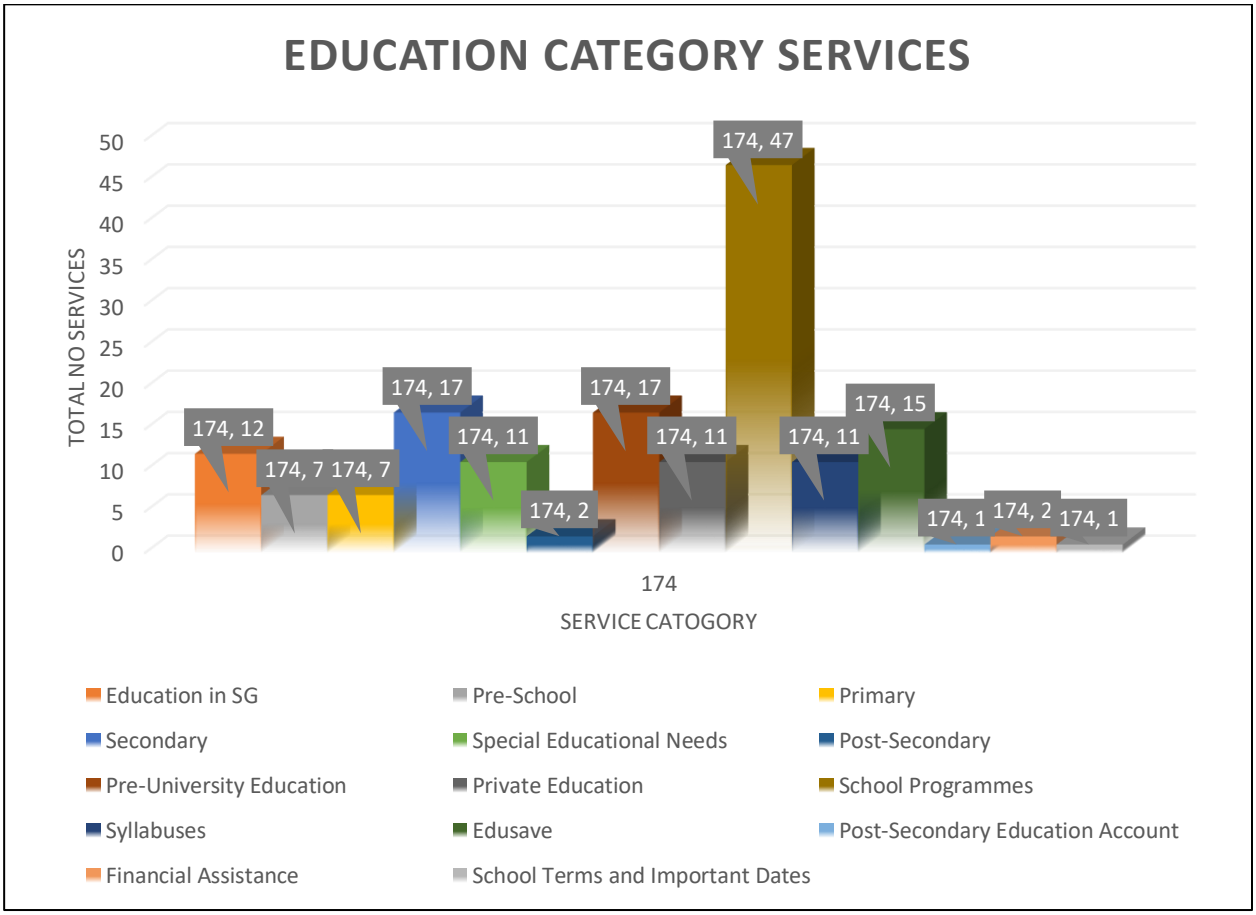


Figure 2-7 Education Category Services

Service Category /Admission

Figure 2-8 displays the admission service category in the Singapore educational system. The admission category includes 152 electronic services spread into eight facilities of groups(directories). The Scholarship group includes the largest number of services, with a total of 45 dissimilar services, while both sorts of Joint Admission and Primary school Transfers are sitting on a single service for each.

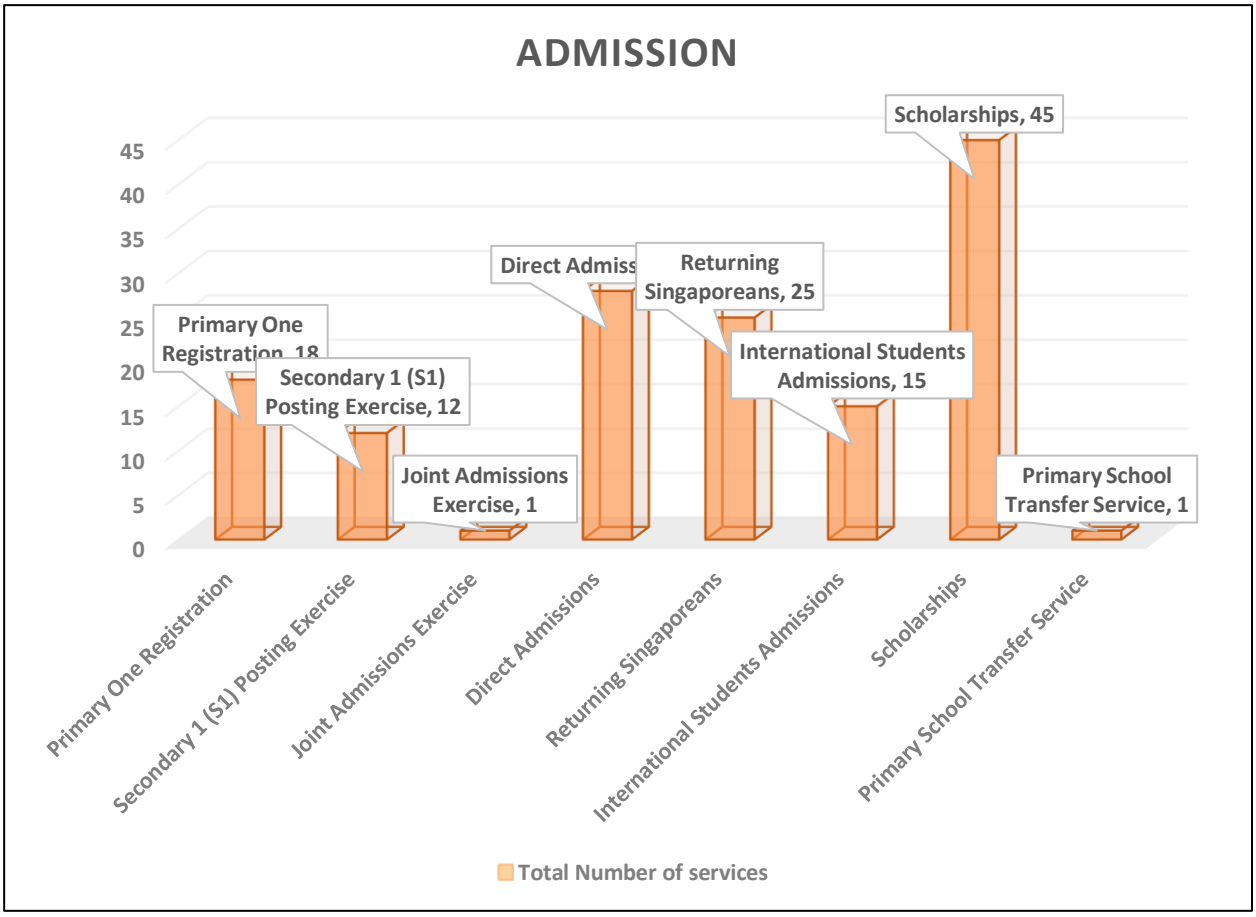


Figure 2-8 Admission Category

Service Category /Career

Figure 2-9 shows the Career service category in the Singapore educational system. The Career category includes 107 electronic services spread into five facilities of parties(directories).
The Teach group includes the largest number of services, with 53 different services, while Special Education Teacher is sitting on a single service.

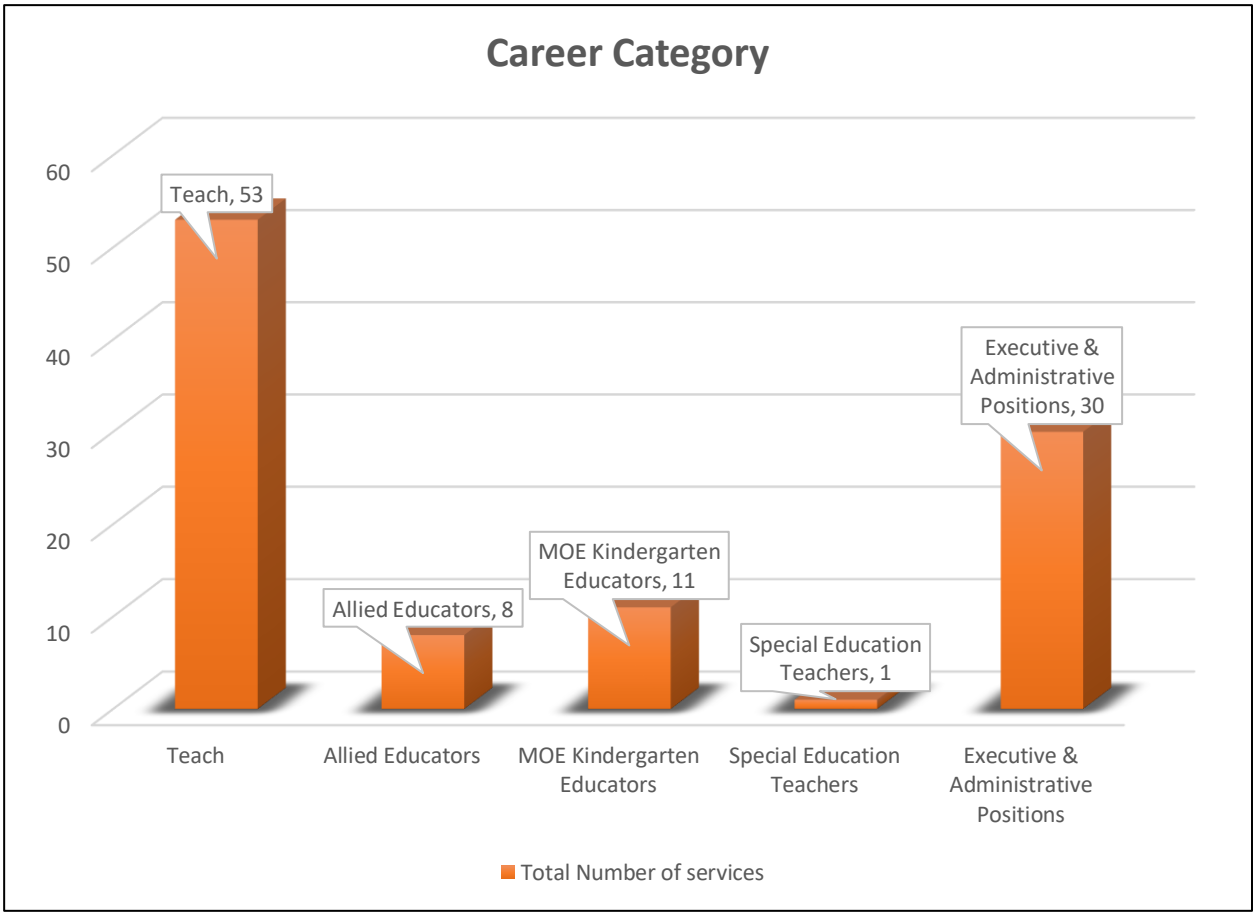


Figure 2-9 Career Category

Service categories / About Us-News-Others

Figure 2-10 shows the three categories of news about us and others in the educational system of Singapore. The news category includes the largest number of services, with 267 electronic services distributed into four service classifications.
While the sector about us occupies the least number of services.

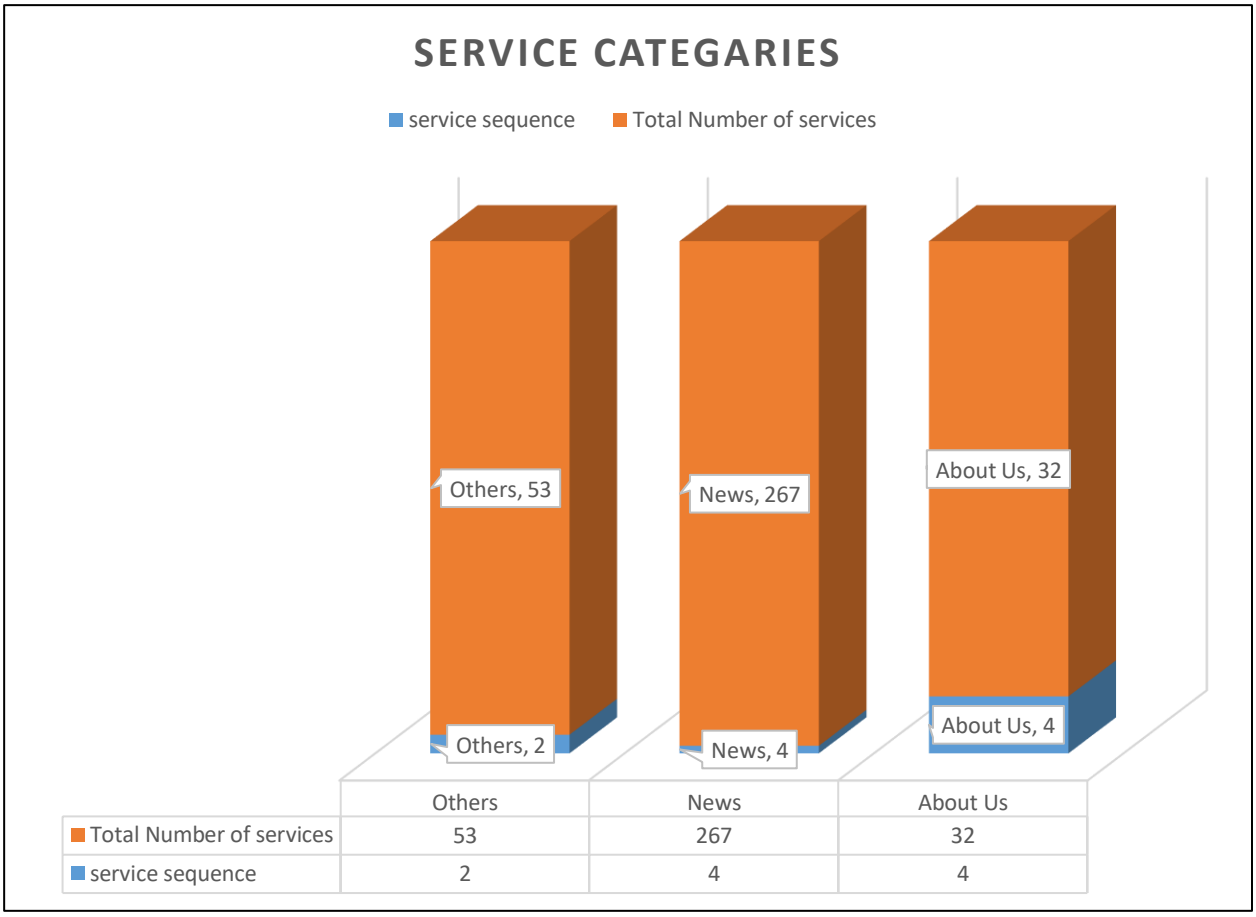


Figure 2-10 News, About us, and Other Categories Singapore Education System

2.1.5.7 Challenge Issues Faced Singapore's e-Education System.

In the current Singaporean e-educational system, there are many challenges and problems facing the e-educational system. These challenges are related to obtaining the maximum chances of success of the e-educational system to deliver various educational services in a more easy, effective, and smart mode.
Moreover, the need continually remains to utilise all potential techniques and methods to increase success and reduce the failure in providing service through an e-Education system. Table 2-1 illustrates a set of challenges and problems that appear in the e-Education system in Singapore.

Table 2-1 Challenge Faced Singapore's e-education System.

Challenge	Problem faced Current Singapore e-Education	Description	Example
Easy access of services	Difficultly in access services	The ability to search and access various services provided in an easy and uncomplicated approach	Difficulty in finding an international certificate equivalency service, as the search for an investigative service is required with more than one available service category.
Clarity	Complexity/Ambiguity and concealment of	Clarity in offering and showing services to	Inquiry service about student transportation.

	services within unclear subcategories	reach the possibility of accessing various services in a clear manner.	It requests entry and search in more than three categories until it was found in an internal third sub- category of Others.
Trust	Lack of confidence in the accessibility of the service	Confidence in the ability to access the service as soon as it is available	A school site search service when investigating this service does not appear, which suggests that the service is not available, but the service exists and can be accessed, which creates a lack of confidence in the existence of the service.
Semantic search	Unavailability of smart search for services	Provides smart search for services in the sense of finding the services to be searched for in a smart way that depends on the meaning of the word	Smart search is not available in the system.
Effective access to services	Ineffective search for services	Adopting the method of offering and searching effectively for services, not the traditional method of offering and finding services by searching for the expected and under-rated categories of services.	Introducing and creating a local school service that is not actively proposed, as it is found in other's category and there is no school category.

Concluded clearly from Table 2-1, the educational system lacks fundamentals that seem very important, such as ease of access and efficiency, which calls for the need to consider and focus on building a new electronic system by employing all the necessary technologies that meet the basic requirements by providing a series of services in an easy-to-access, effective manner, and more intelligence.

2.1.5.8 Environment and challenging Issues in Singapore

There are a series of challenges and issues associated with the environment in Singapore's e-government represents as follows:

1. According to Leifer (2000), Maniam (2011), a minor national as Singapore e-government had the capability to meet increasing tasks and difficulties presented as follows:
    - **Security:** essential services (& numerals in the market).
    - **Shortage:** cost-effectiveness.
    - **Complexity:** variation-readiness, adaptively.
    - **Diversity:** citizen engagement & centricity.
2. Problems and challenges characterised in replacing with technological growth. As the Singapore government produced a great effort to deal with apply technology, see Figure 2-11, which demonstrated Singapore's attempt to deal with automation, e-service, efficiency, and digitalisation.

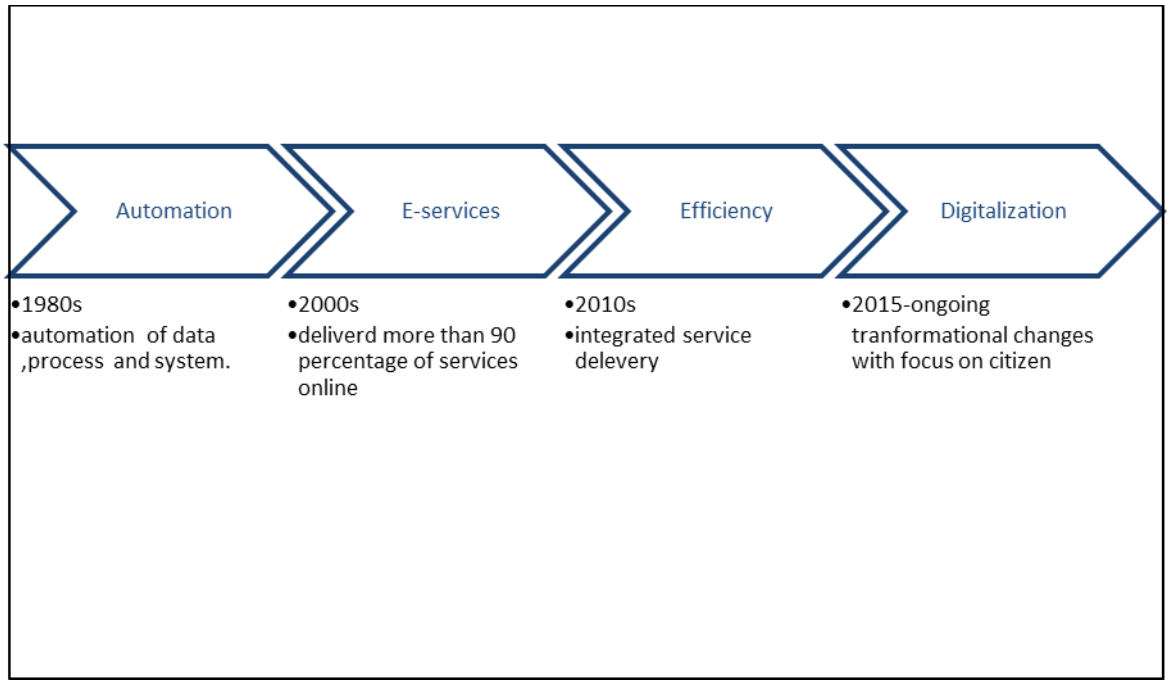


Figure 2-11 Singapore's Determination with Technology

3. Turn into a Singapore Smart nation. According to Smart NDG 2018, three-element components have signified the digitalization of the economy, government, and society.
4. Construction of the strategical national projects. Includes five projects National Digital Identity:
   - Instants of Life
   - E-Payments
   - Smart Urban Upward Mobility
   - CODEX:
   - Re-engineering Authority

2.2 E-government issues

2.2.1 Data Accessibility and Privacy

The data provided to the various segments of government service recipients are distinguished as open data, meaning that the information is edited in a way that can be read automatically, meaning that there are difficulties or prohibitions in accessing it and modification to it is done in a way without the human element interference. In addition, it remains available in a wide variety of documents or otherwise in general standards. In practice, open government means that the directory data is available online (nevertheless from the procedure, but with open testimony). In addition, the structured printing of the data is available automatically, in a non-proprietary format that is available without restriction, however open standards from the World Wide Web Consortium (W3C) are used, and the relevant data is provided openly.
Corresponding to the W3C body nearby suggested three actions to distributing wide-open government information, which involves:

1. Delivery of data in unprocessed structure and in a properly recognised building (for example, XML, RDF, OWL).

2. Establishment of an electronic collection of the unprocessed information, therefore citizens understand it is obtainable and includes knowledge concerning the data.
3. Producing information together humanoid and system-readable, after availability requests.

Incomplete data cannot be used properly, or that data is presented in non-standard formats. Likewise, the quality of the published data varies with the data, whether it is supplied in full or whether only parts of the data are shared. Corresponding to the study's findings in 2016, the largest number of countries released data sets on government expenditure in machine readable structures (e.g., 128 further than 193 representative countries) concerning societal safety, employment, and the natural environment (Unsurvey, 2016).

2.2.2 Security issues

The e-government security system requires cooperation between suppliers and service recipients likewise to guarantee that the machines are secure by model. The clients can cooperate with each other to make revisions and deliver plans of modifications and other factors.

While the digital change must be managed thoroughly and revised to guarantee security and its significance on the direction of organic development.
Authorities must construct and execute a strong cybersecurity plan to secure their e-government structure. It must involve an efficient plan to safeguard the essential data infrastructure and create a public tractability strategy. The creation of the plan must be open for discussion to ensure that all essential stakeholders might produce confidence and clarity in the government and ensure that everyone gets the advantage (UN survey, 2018).

There is growing attention in information-distribution and transmission in governments, collaboration over teamwork and message, and applicable stakeholders, such as fundamental governments, local public authorities (UN survey, 2018).

2.2.3 Trust and confidence

Principles of trust mean that the government will be e-responsive when citizens request or deal with gain services being provided to users. However, Hébert (2012) defines confidence as an "established of prospects that responsibilities will be reliable regularly."

The association between people and authority plays a major role in building trust in government network services (Mpinganjira, 2015). Consequently, a citizen's trust in the government must immediately change to confidence in government web services.
In other words, the e-government service is basically an alternative to government delivering public services to people across conventional offline stations.

Consequently, if the government clarifies the genuine protection of citizens and can effectively perform its facilities, citizens are further expected to have confidence in the existing e-government services. It appeared excellent following the government to meet their requirements.

Several informed instructions can be reviewed as illustrated in Figure 2-12.

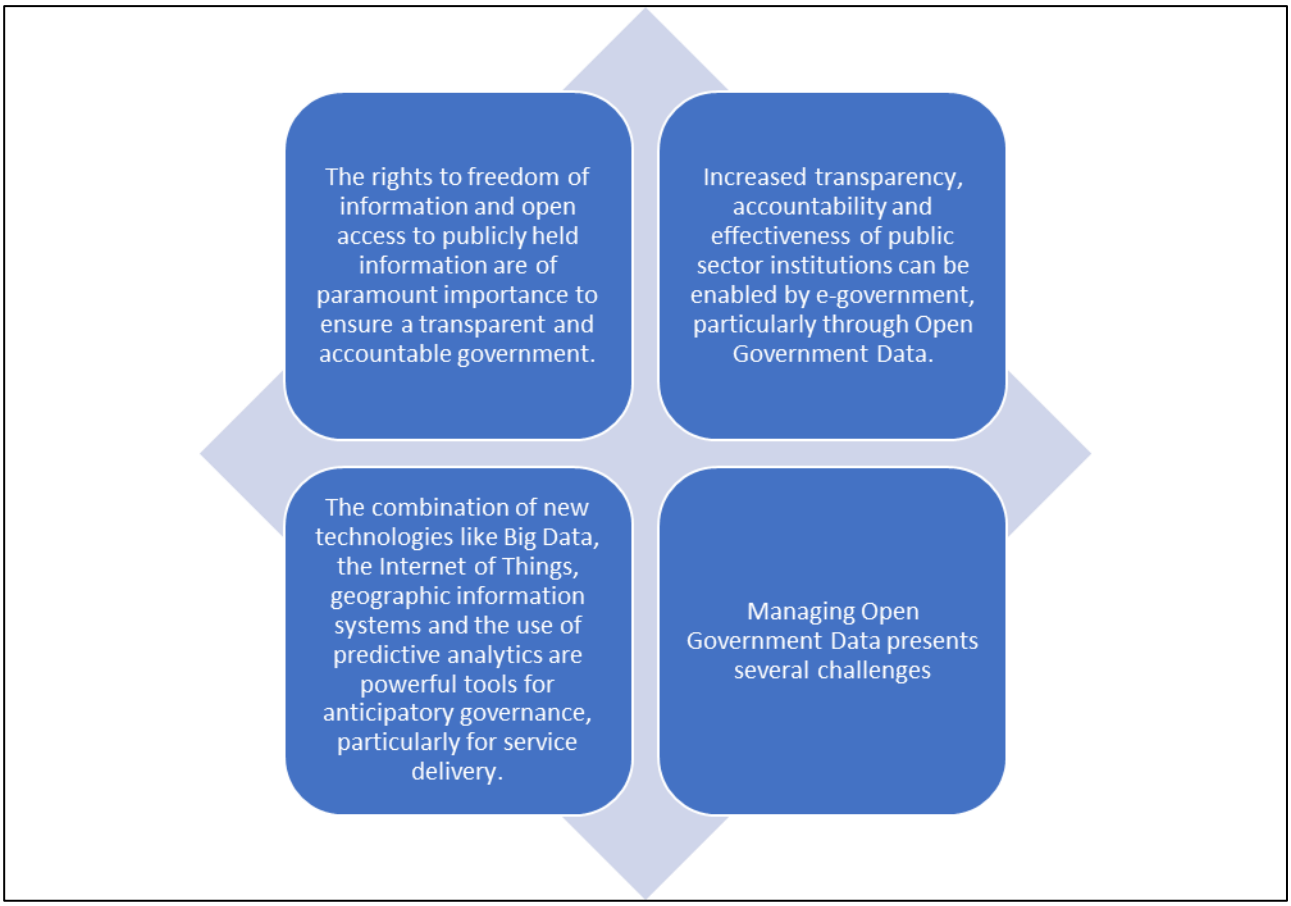


Figure 2-12 Trust policies

2.3 Education system

Education is continuously enhanced by innovative tools, particularly with the evolution of computer-associated intelligence equipment (UN survey, 2018).
However, mobile phone and wireless processing have facilitated mobile phone learning or m-learning.

Furthermore, in referred to the United Nations Annual Report, 2018, to build solid illustrations of the structure of the educational system around the world, review a set of statistics and results defined as follows:

- The total of nations offering online services via emails, SMS/RSS supply revises, mobile phone applications, and downloadable systems require improvement in the whole areas although the natural environment.

- Public Services offered via mobile Applications are increasing quickest, by 52 percentage, in the education, employment, environment areas.

- Significant expansion in non-machine-understandable systems that do not read in the past two years through a variety of fields, especially in the educational field, in which a significant expansion has been observed over the past two years.

- Numerous nations presenting archived data, the Education area inhabited the biggest evidence.

From the above statistics and figures, it becomes clear that there is a continuous increase in educational services, which have always occupied the first place in the various electronic services offered by electronic governments at the country, continent, and global level.

2.4 The Semantic web

The term semantic web (SW) is an idea based on the transformation and provision of the current global network to include new elements or descriptions; besides, it permits for this description the opportunity of providing meanings with the terms of supply to be the subject of interpretation using the machine to distinguish the information and data that have been published. In other words, we add more metadata to content and data descriptions on the Internet (Abdellatif et al., 2013).

As a result, it enables computers to hold meaningful explanations such as information processing, allowing a person to achieve what he wants to access information.

Through the standards established through (W3C) the Semantic Web is formed on the principle of giving an extension to the World Wide Web, providing a set of standards that allow the promotion of common data models and protocols for exchange on the Internet. However, the semantic web is developed using specific languages or tools such as RDF and OWL (Abdellatif et al., 2013).

As the W3C claims, "The Semantic Web provides a shared workspace where data is available to be shared and reused through controls applied by organizations and society." Hence, the semantic web is considered an integrated model that contains both content and information as well as various applications and systems.

This phrase was created on the Cyberspace by Tim Berners, who made it possible to deal with data and content by devices; this means that the data could be given a meaning that can be read automatically. In comparison, the intended benefit of using this term constitutes a series of broad areas of applications such as library science, information, industry, and biology.

Semantic Web Elements

The expression "semantic web" is regularly utilised to describe the models and techniques that permit to give meaning and concepts. SW permitted to collect, organise, and retrieve related data through techniques provided.

Semantic Web Application

The use of SW in applications aims to enhance its usability. It also has benefits on the web and the information contained within, through semantic creation of web services. However, models of applications that can take advantage of employing the Semantic web are illustrated as follows (Delbru et al., 2012):

- Servers that display data systems using existing RDF and SPARQL requirements.
- Documentation of capabilities with semantic information.
- Providing shared vocabulary with metadata using ontologies and it allows adding drawings between vocabulary.
- Mechanism agents to perform tasks for semantic network users using this data.
- On-line services (often with their private agents) offer information exclusively for clients.

These can be useful services for both the general search engines and knowledge management within the organisation. Beneficiary business applications include:

1. Merging information from different sources becomes an easier process.
2. Reducing ambiguity in the terms used by companies.
3. Improve the information retrieval process and thus reduce the information overload and increase the accuracy of the data retrieved.
4. Retrieve more relevant information regarding a specific field.
5. Provide an opportunity to provide decision-making support.
6. Better management of an organisation's user groups and management capable of implementing the guidelines.

2.4.1 Semantic web and e-government

In the past few years, the use of ontology has been realized in developing a large-scale e-government field (Dombeu and Huisman, 2011); however, the main intended benefits are attempted to describe various services provided by the government to citizens in a more effective manner. Accordingly, enabling e-government to provide more descriptive expression up to citizens, it also allows maps, the integration of various e-government services, and provides semantic interoperability and the integration of e-government services.
The following are the main reasons for the development of semantic in e-government (Dombeu and Huisman, 2011):

1. Provides a common means that enables the correct understanding of the expressions between the various segments of the service recipient.
2. It enables users of different slides to extract information from different sources, and it also provides an opportunity to prepare documents.
3. Provide the support needed to reuse knowledge in an existing field.
4. Provides a clear leadership framework that provides communication and facilitation in understanding complex concepts and their details.
5. Provide an informative description of the semantic information and independently of the data representation.
6. Allow comparison of the different factors that are integrated into the various concepts of non-homogeneous.
7. Formalising knowledge and coding models for a higher level of data.

The joint description structure of public administrations (PA) has made it easier to produce and manage government information, as well as joint work with other government agencies.
In many cases, a proposal such as combining two ontologies into one represents service ontology, which is essentially the application of ontology in a specific domain. This scope aims to reach an arrangement at the SW stage among the different groups.
But these lexical entities could not stand isolated; there is need for an independent domain improved semantic innovation.

One of the creative ways to build an e-government system is what both researchers indicated (Jain et al. (2018) and Kumbhar et al. (2010)); the idea is mainly based on adopting domain-independent. An independent field source of indications gives the scope of coverage of shared terms, while field ontology specifically gives an intensity of analysis through supplying evidence based on the conditions and relations of the application.

Furthermore, the existing conceptual proposal for semantic web entrance centred on tierce gatherings, ontological scale, impartial ontology ground, and service ontology.

- Ontology scale: Ontologies commonly characterise the glossary level of various viewpoints.
- Independent ontology ground: it offers the frequently utilised terms.
- Service ontology: It includes the semantic web software descriptions. It enables single to finalise the explanations of the supports:

i. services employed by methods of Web services,
ii. The e-governance procedures that can be showed as an arrangement of Web services, and
iii. Using of SW facility for e-governance demands of public services.

An important potential of the ontology software tools is the ability to integrate and recycle dispersed and diverse data into a useful system and form a common data link that can be obtained as a basis for communication between general e-government associate groups and individual citizens.
However, it was observed that there is insufficient evidence for using the semantic web in electronic management. The insufficiency is represented in the following aspects:

a. Decrease of expense and threat.
b. Rise the flexibility.
c. Computerized combination, cognitive, and arbitration between varied information resources and procedures at separate government concentrations.
d. Finding of modern or formerly undetermined services.
e. Combining services on the core of user likings.
f. Improved services to population collaborator groups and private citizens.

2.5 Ontology

The description characterized by the formalization of knowledge is known as ontology, which can relate relationships with each other by creating a link between the concepts within the field and the relationships that bind them together. But to enable such a description to perform tasks accurately, the need to formally define the basic components of an ontology that establishes such a task, for instance, individuals (states of things), classes, traits, relationships, limitations, rules, and intuitions.

As a result, ontologies provide a shareable and reusable representation of knowledge, together with adding new-found knowledge about the field (Sawsana, 2013).

Multiple methods use formal specifications to represent knowledge, including vocabulary, classifications, thesaurus, subject records, plus reasonable prototypes.

However, creating distinct classifications or enriching links in databases can allow linking relationships, making them more descriptive and enabling connecting.

Since ontology links are characterized by linking and meaningful qualities, the formation of such links can be used to determine the correct representation of commonly used modelling formed from heterogeneous database links and distributed systems, as well as enable interconnected base assemblies built to search in a shared database and manage knowledge more efficiently.

A series of main characteristics of semantics is that they guarantee a common understanding of information.

As a result, interconnectedness and joint action make it an ideal solution to a set of challenges represented by the difficulty of accessing and querying data, especially of large data such as e-government. Also, by improving the characterisation of the data and providing it with the source (Sawsana, 2013).

The OWL Model and Ontology Standard

Recently, there are many supporting indicators taken to accept conveying ontologies and applying ontology languages, i.e., Web Ontology Language (OWL).

OWL is considering an SW tool intended to signify powerful and complicated information about issues and their dealings. It also offers comprehensive, reliable, and significant differences between groups, assets, and relationships.
By identifying the purpose of the ontology component, i.e., classes properties and relationship and their categorised request, OWL enhances ontology developing in "semantic graph." Additionally, it confirms the disambiguation among various cases that reveal similar names or explanations.
The Advantages of Applying Ontologies:

a. Allow automatic logic concerning data.
b. Ontologies operate as a "brain."
c. Offer added consistent and simple steering as clients shift after a single model to an alternative ontology composition.
d. Simple to expand as connections and model identical are simple to combine to present ontologies.
e. Offer the methods to characterise several information layouts.

Ontology Use Cases

The ontology used defines the terminology used by clarifying the domain of knowledge. Likewise, ontology is employed in several products to obtain interactions and improve information management. Among the common examples of applications or solutions applied for ontology are the following (Sawsana, 2013):

- The implementation of ontologies facilitates connection mining in pharmacy by classifying linked specific interactions to connection relative ontology.

- Semantic web extracting, quarrying health documents for intuitions, deception exposure, and semantic printing.

- In the outer layer, ontologies are structures that correspond to sharing and re-use knowledge through a field.

- In both information science and computer science, an ontology comprises a declaration, official identifying, and clarity of the classifications, assets and relationships among the models, data and individuals that confirm single, several or all areas of discussion.

- As modern ontologies are produced, their usage positively expands problem-resolving.

Ontology Components

Common ontologies define individuals, classes (theories), attributes and relations. In this segment, each of these components is discussed in Figure 2-13.

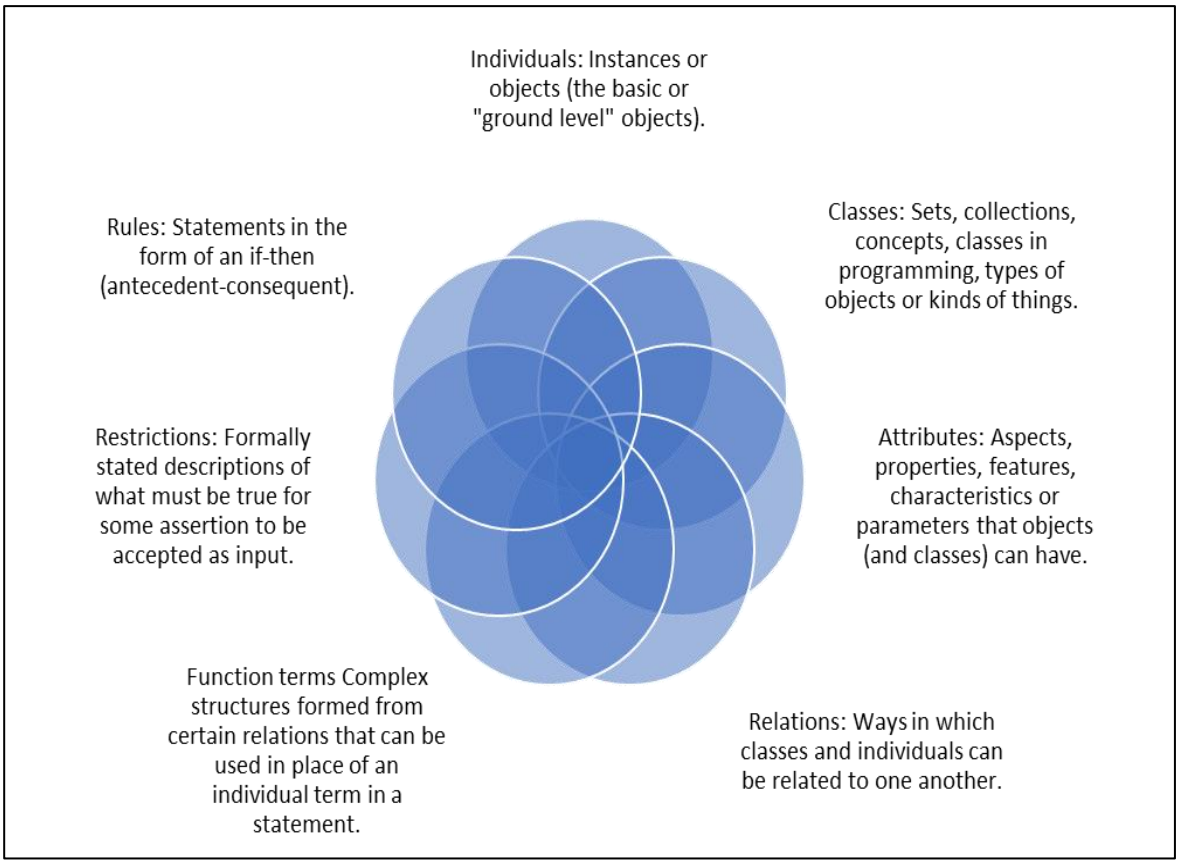


Figure 2-13 Elements of Ontologies

2.6 Ontological approach semantic e-government

The detection of semantic conflict is one of the basic steps that must be implemented effectively to develop a common framework that combines the semantic web and the various services provided to various segments.
Towards achievement, the ontology shows the mainstay of the innovation method, which requires its implementation to ensure that it is at a great level of accuracy.

However, selecting a methodology for building this ontology is highly challenging, as several methodologies have become known to guide the ontology development process (Sawsana, 2013).
Therefore, this section aims to evaluate and compare the most acceptable and used methodologies to select a useful methodology from the viewpoint of ontology engineering and used to build semantic conflicts revealed ontology.

2.6.1 System Development Methodologies

In the perspective of ontology development methodologies, many literature surveys have been done by Jones et al. (1998), who conducted one of the first surveys; this study was designed to detect the major concerns of methodologies contained by the study, which should be addressed. Nevertheless, classified methodologies were reviewed into two companies: comprehensive and incomprehensive methodologies.

Fernandez-Lopez (1999) assessed and analysed a set of methodologies that were widely used and promoted. The IEEE Standard 1074-1995 (IEEE Standard for the Development of Lifecycle Program Operations) was selected in this survey. In Fernandez-Lopez (1999), the goal of the research is to assist researchers in ontology methodologies to choose a methodology appropriate for their work.

An alternative viewpoint, Gómez-Pérez et al. (2004), performed a complete survey. They examined and matched the evaluated methodologies centred on three distinct standards: design management practices, ontology expansion-oriented methods, and vital procedure.

Also, Pinto and Martins (2001) performed a wide-ranging survey in conjunction to illuminate exactly how ontologies are created. The survey offered no more than the typical methodologies applied for developing ontologies as of scratch.

They evaluated these methodologies centred on the popular ontology stages endeavours. In fact, ontology is respected as the strength of the SW.

2.6.2 Ontology Development Process

An active ontology research process led to a remarkable set of well-known methodologies. The used ontology methodology clarifies the series of basic activities that must be performed. It also shows how to perform each activity and arranges these actions and methods that should be utilised to execute and complete the necessary maintenance of the ontology (Gómez-Pérez et al. 2004).
In this part, a full review of the methodologies mentioned in the literature was provided. However, after reviewing the methodologies in relative terms, it was suggested that most of the methodologies be introduced based on the procedures reviewed in this study.

Proposed methodologies for the development of ontology derived as of the extensive study of the reality and approaches of different ontologies, which express the cognitive description of the methods used in establishing an ontology within a specific field; however, the analytical consideration of several ontologies and their use for different purposes within many different fields.

So far, a significant number of attempts to recommend methodologies for ontology development have been published, which is the inherent outcome of the truth that constructing ontologies are still undergoing research.
Despite the vast quantity of methodologies planned and described in the literature, barely the highly well-known ones have been described in Figure 2-14.

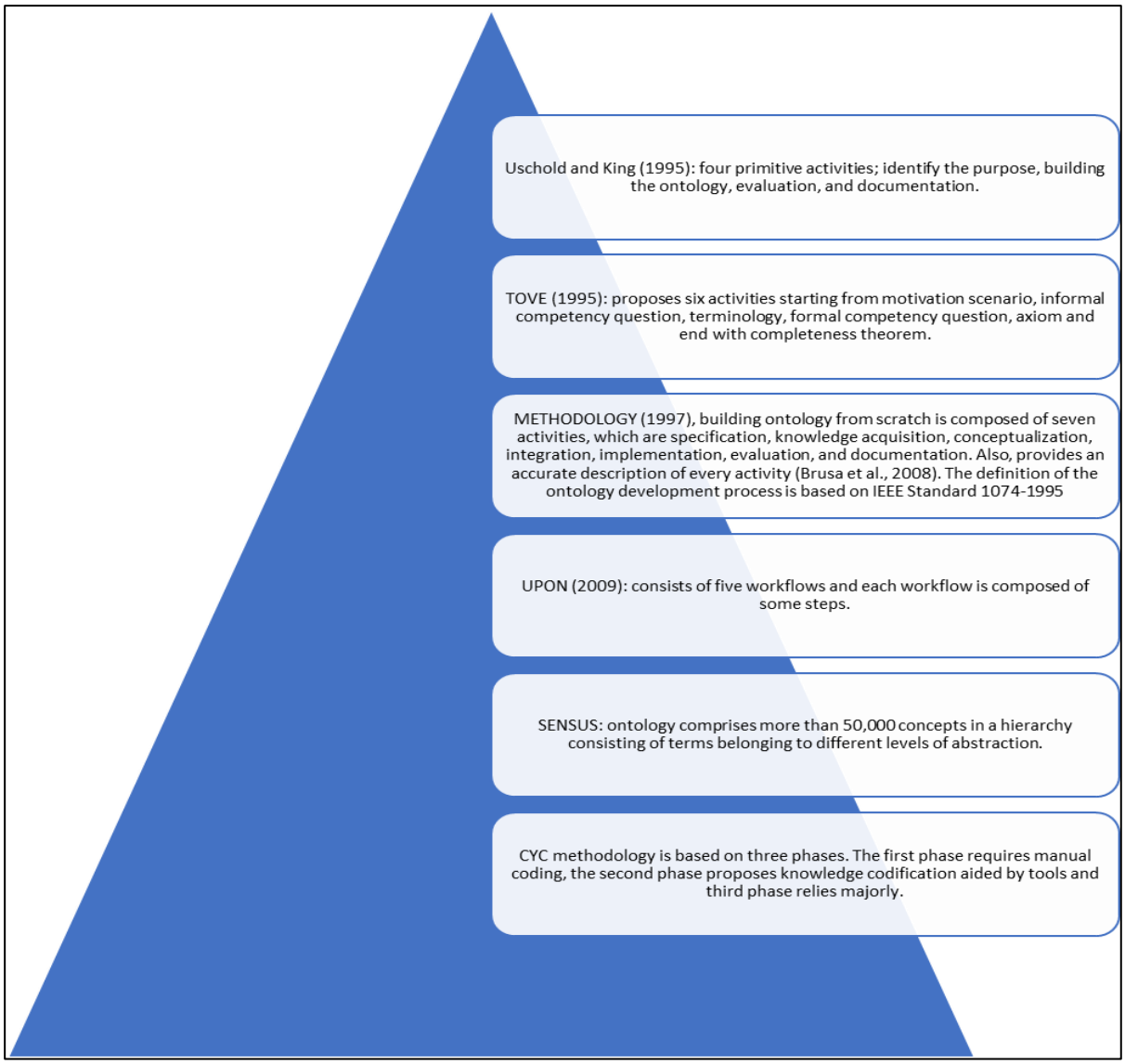


Figure 2-14 Ontology Development Methodologies

Source Bushra etc. al

2.6.3 Ontology Development Methodologies Assessment

Focused on the proposed Gómez-Pérez et al. (2004), building ontology, it requires reaching an agreement; however, reaching an agreement is based on the coverage of the ontological engineering process. Several methodologies have been recommended to organise this process and facilitate its development. Several products have validated the achievement of these methodologies.

Numerous methodologies for using ontologies specified (Sawsana, 2013).
Binary classes of methodologies are able to be considered out:

1. The cluster of knowledge-centred methodologies characterized outlined in the TOVE and the Uschold and King methodology.
2. The cluster of methodologies that suggest a set of actions to build ontologies focussed on their life cycle and the model style, i.e., Methontology methodology and the Ontology Enhancement Approach.

Usually, the ideal solution depends on the application for which it was found. On the one hand, ontology applications can decide to use, and concerning the second set of methodologies, it is important to highlight that Methontology is the approach that suggests

the ontology life cycle model and that it provides the most accurate description of each activity.

The comparison standards shown in Figure 2-15 are established on the actions engaged in the ontology improvement growth. The popular ontology enhancement lifespan as of ontology engineering viewpoint includes the resulting actions:

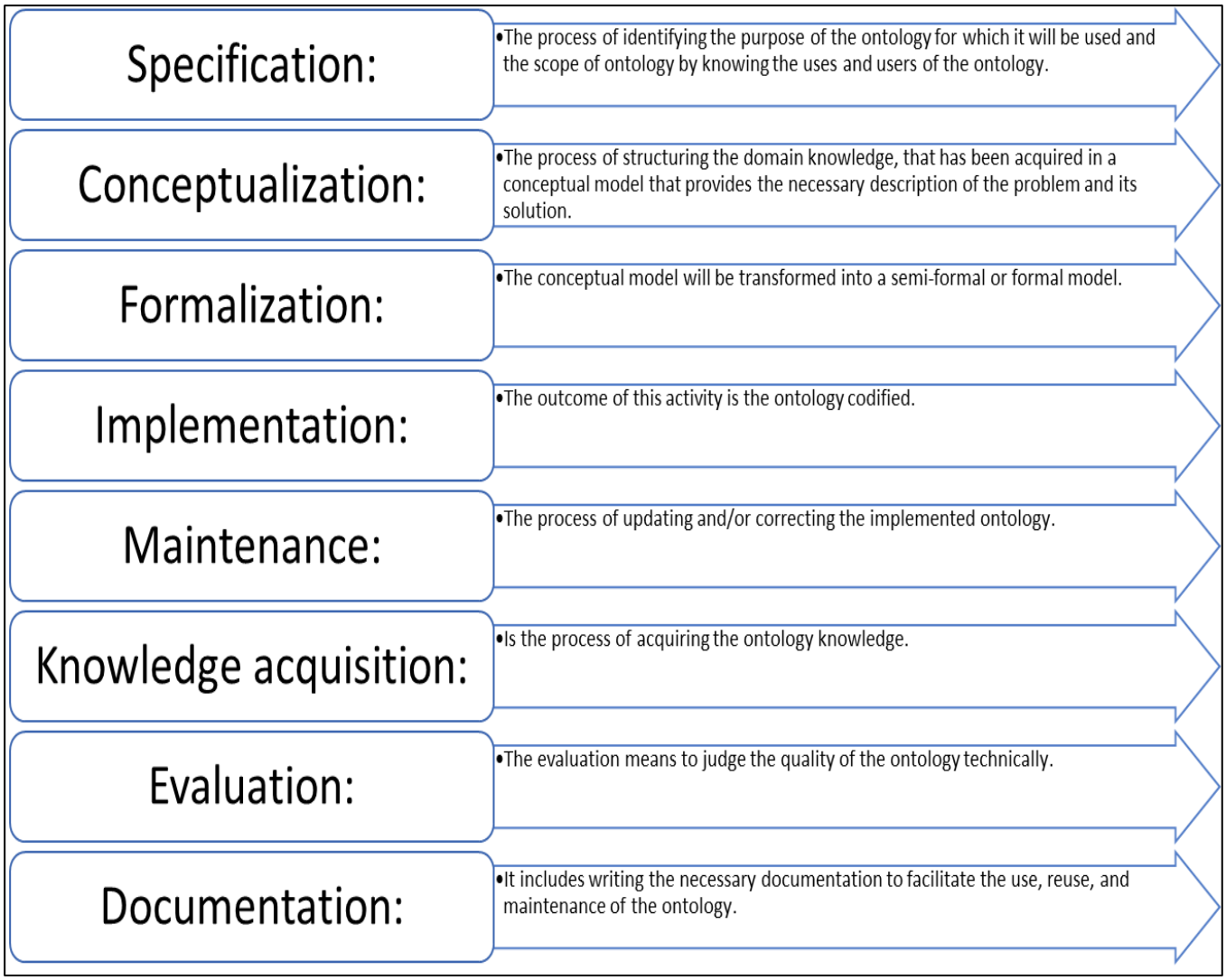


Figure 2-15 Methodologies Certain

Corresponding to Mariano Fernández López (2004), the IEEE 1074-1995 standard (IEE96) explains the software development procedure, the endeavours selected taken out, and the methods that can be utilised for creating software.

These procedures are pointed in Sawsana (2013) and described as follows:

a) The scheme managing procedure; comprises the formation outline for the ontology development.
b) An ontology progress progression that is separated obsessed by three fragments:

- Ontology before development that is associated to the possibility revision.
- Development conniving of the ontology plus
- Employment of the ontology.

c) Ontology after development includes all operations and training keys.
d) Combined procedure involves the achievement of the development successfully. It begins with taking knowledge, structure, assessment, and documents.

2.6.4 Evaluation methodologies

The Methonology is the extremely proper methodology for implementing SCDO. However, UPON is almost the last and a derivative based on the Unified Process (UP). In addition, Methonology was accepted as a reliable model methodology to be used in implementing ontologies in various fields (Zhou, 2011).

Noting that none of the methodologies can be utilised to employ SCDO, but without getting confident that the ontology will meet up the model value standards. For example, TOVE can be utilised to apply SCDO.
From SCDO's viewpoint, this methodology has some constraints, which will decrease the value of SCDO. Among these drawbacks, this methodology does not provide the evaluation movements, as assessment is essential for SCDO and value assurance (Zhou, 2011). In general, the ontology life cycle activities discussed earlier in this study are minimal and essential to ensure the quality of SCDO.
Therefore, any methodology that accomplishes these activities can be suggested for application and suitability in SCDO.

Corresponding to the IEEE standards analysis, we came at the resulting inferences:

1. Not Any of the methodologies are completely stable when we evaluate them along with the IEEE specification.
2. Methontology is extremely stable; nevertheless, proposals for the pre-progress procedures are necessary, several actions and procedures must be stated in further detail.

2.7 Ontology Evaluation Approaches

Today, ontology is widely used to represent knowledge and is considered the basis for the semantic web. However, with ontology's widespread usage, the question of its evaluation received more attention.

The ontology assessment is based on the measures taken and the methods used to study a set of criteria (Zhou, 2011).
Approaching evaluation of ontology basically disagrees on targeting many of these criteria, which is the main motivation behind the evaluation of classification. However, these methods can be classified list into six varieties described as follows:

1. Gold level.
2. Corpus-centred.
3. Assignment founded.
4. Criteria-built methods.
5. Verification and validation of Ontology Gómez-Pérez et al., (2004).
6. Ontology consistency metrics: Quantity of Core Class: (NoR) Quantity of Leaf Classes: (Nov) Typical Intensity of Legacy Family Tree of Leaf (ADIT-LN).

Gold guideline-established methods, which are well-known as ontology configuration or ontology planning, are the extremely consecutive-forwards method. It approaches a comparison of ontology with a formerly produced reference ontology known as the gold standard. This gold standard exemplifies the ideal result from an informed algorithm. Nevertheless, an appropriate gold ontology can be a task because it must be produced in similar circumstances with parallel goals to the studied ontology. For this reason, some methods create specific rankings with the help of human rights experts to use as a gold

standard. While other curricula prefer reliable use, classifications are popular in a similar field for consideration as their reference class because it provides a great deal of work.

Corpus-built methods, similarly identified as information-focused methods, are employed to assess how far ontology satisfactorily includes a provided field. The theory of this kind of method is to evaluate the discovered ontology with the subject of a wording corpus that contains substantially a provided field. The benefit is to evaluate one or other ontologies along with a corpus instead of assessing only ontology with an additional remaining one.

Task-built methods based on measuring the extent of tasks help ontology to improve the results of a task. This type of assessment is aimed at ontology given a specific task and is assessed only according to their performance in this task, regardless of the underlying attributes.

The guidelines-built method used to the extent of measures, as well as the adoption of ontology or classification on certain criteria desirable. We can distinguish between measures related to the ontology structure and more sophisticated measures. However, it consists of two approaches which are expert-based and complex structure- based structures.

Gómez-Pérez et al. (2004) suggest a separate method that includes splitting the ontology assessment into validation and verification.

Ontology verification the assignment of assessing when ontology has been constructed properly. Moreover, it tests the coding of the design mistakes, such as spherical class orders, unnecessary axioms, unreliable identification systems, etc. Therefore, verification validates that the ontology constructed corresponding to certain required ontology value standards.

Ontology validation suggests examining whether ontology descriptions exemplify the true world, corresponding to the aim of its establishment.

The focus on the objective of the semantics evaluation is to confirm whether the models are characterized properly or non-stable.
However, validation of ontology conveys these principles:

- Stability requires ontological elements to find a paradoxical result.
- The completion of about at any degree ontology signifies the actual world.

To measure quality ontology, the approach used is validation, which is an important component of the evaluation. It can be achieved routinely by DL intellectual. The DL intellectual operates a determined of reasoning categories since most of the findings are unstable.
Built on the validation method, excellence principles are reviewed. Field experts can evaluate the literature corresponding to quality criteria illustrated in Figure 2-16.

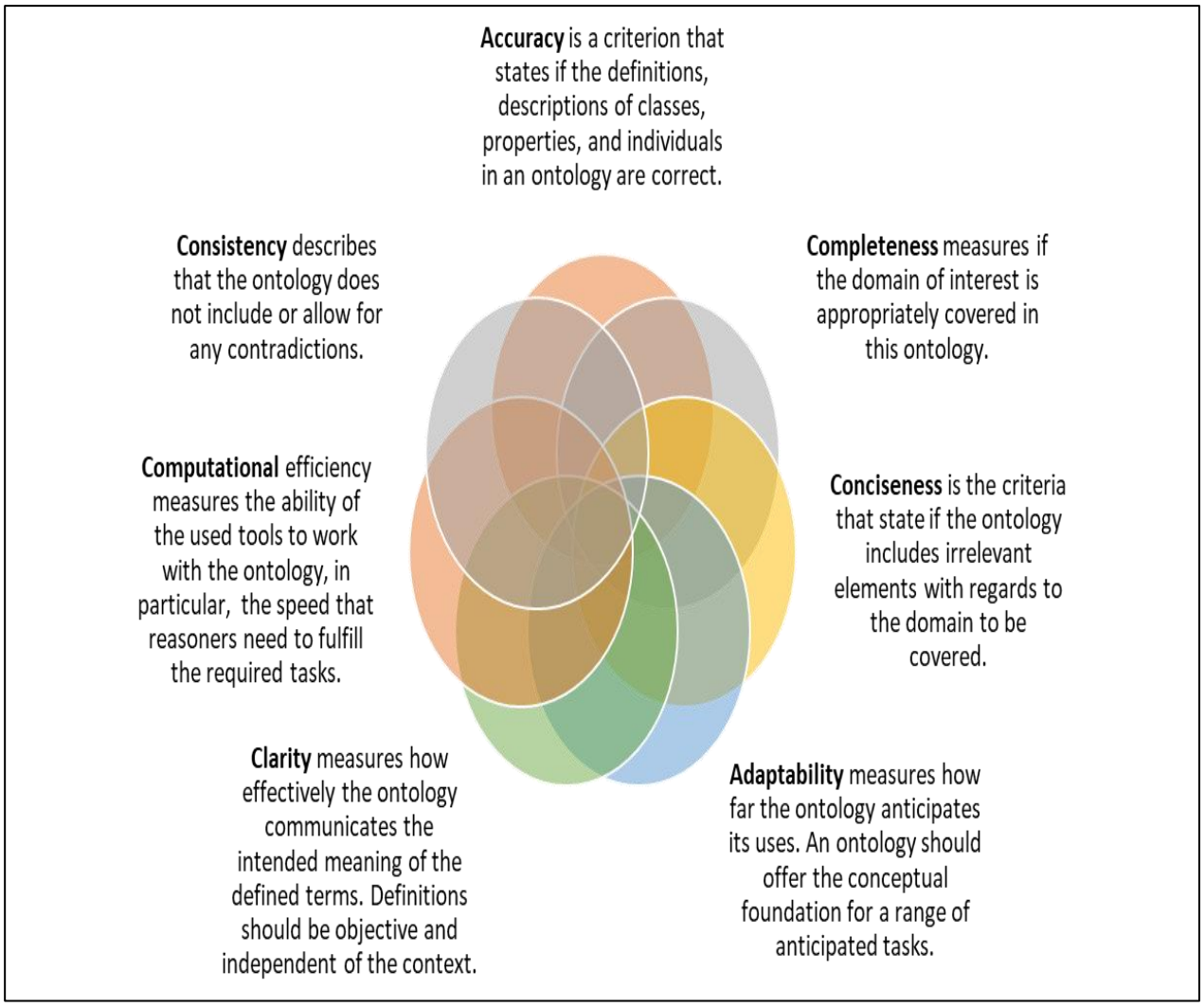


Figure 2-16 Validation Criteria

Source Gómez- Pérez '2004

However, the Ontology for Singapore Education System (OSE) ontological system was established by Gómez- Pérez's method by letting expert fill a questionnaire (see Appendix 1).

2.8 Employing languages, Techniques, and Tools

The section is separated into binary segments. In the first segment, display the languages are used to generate a semantic web system. The second part presents the supportive techniques that might be used to produce and arrange the ontology system.

2.8.1 Supportive languages

Currently, the information provided through the World Wide Web (WWW) is often ambiguous content where an unclear structure can be obtained while most unique objects and information are unreadable or hidden that can be characterized to become less of human interest. Although WWW followed a revolution in the exchange of information between quiet computer applications, interoperability between many applications cannot be achieved without some arrangements necessary to occur and be performed by humans (Zhou, 2011).

The next generation that drives change towards building on previous achievements and adding elements that lead to alleviating the problem must build a network of information with quicker and more efficient access to network resources. However, individuals and

beneficiaries of the information network have not yet had the opportunity to benefit from adding semantic information in the machine and a clear system for dealing with the pattern (Khattak et al., 2009).

Potentially, the SW provides an expansion of the existing web in which data is properly characterised signifying, improve-allowing machine, and citizens operate in collaboration (Lee et al., 2011).

Ontology is the pivotal technology for creating reality to create and function the semantic web.
However, the selected technologies play an essential role in giving the character of a smart web by providing common, well-defined resources that machines can understand and manipulate (Sawsana, 2013).
A typical ontological hierarchical description consists of significant ideas and their relationships in a field, mission, or service.

The method used to define these explanations could differ from normal language to logical formality, but the expanded form and consistency make the device easier to understand. At this point, it may clarify the requirements of different languages for web ontology.

The greatest significant attributes required are those of language must be well designed for intuitive users without losing the appropriate expressive force; it should be well defined with the installation of a specific and clear proper semantics; it must be well-matched by present Web standards, therefore, providing the section attempt to get extensive attention of the many existing web ontology languages.

The Web of data aims to allow machines to make a more valuable effort and create a reliable connection across the network systems.

2.8.1.1 The Stack of Semantic Web

The expressions of SW languages should convene several conditions labelled as follows:

- Require a solid syntax.
- Be extremely instinctive to people.
- Need a properly dined proper semantics.
- Characterise individual understanding.
- Involve logic assets.
- Possibility for building information bases.
- Get a suitable link with present web values to confirm bury-operability.

As the target of the SW is to allow computers to identify the smart search, or sense, of knowledge on the WWW.
The basically three kinds of languages: specifically:

- Resource Description Framework extended family, which includes three languages i.e., RDF & RDFS.
- Ontology Web Languages family, which described as theoretical languages of the OWL 2.
- Rule Interchange Format languages of the extended family RIF.

The distinguishing of the languages illustrated in Figure 2-17 that all are founded on XML; also, the syntactic design characterised as sensible formalisms.

For query, the query language SPARQL specified and thought of as one of the important tools of the SW.

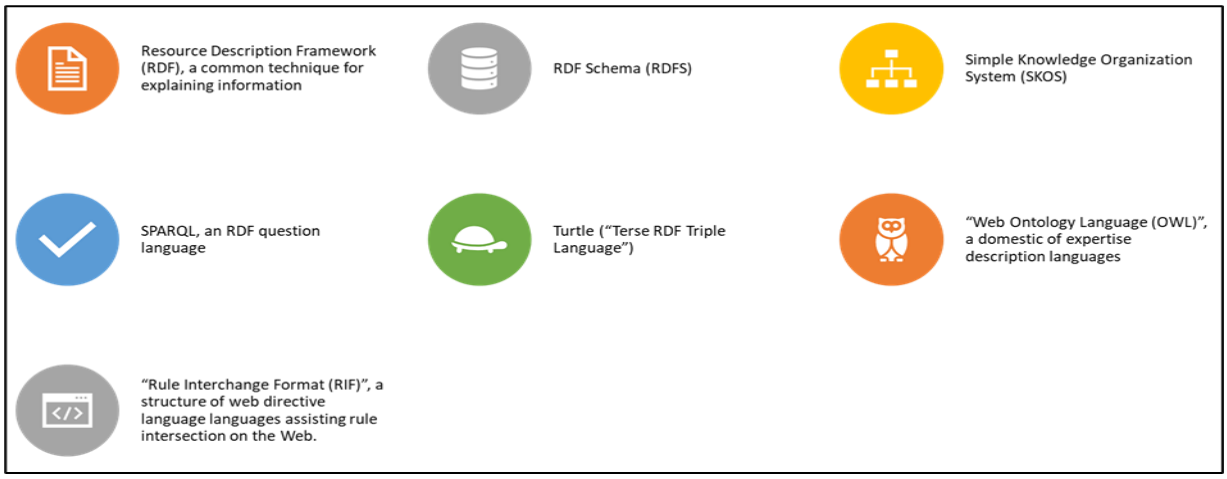


Figure 2-17 Semantic Web Languages

2.8.1.2 Extensible Mark-up Language (XML)

XML is a well-known and distinct language widely used on the Internet, which is characterized by its use as a basis for software development. The principle of XML syntax is based on creating a balanced tree of starting (< >) and ending tags (</ >) to form nested sets, each of which can include several pairs of values with a specific characteristic. This allows the possibility of adding definitions for every single opening tag.

Table 2-2 displays the landscapes of the observable language and defines characteristics and disadvantages (Zhou, 2011).

Table 2-2 XML Description

Language Features/Advantages	Drawback
The native language used to distinguish follow-up tag from web content.	Lacking to give connotations between concepts.
Language provides an opportunity to facilitate the task of a specific representation of data within a specified scope.	Difficulty determining the intended interpretation of special tags due to the lack of a description for each code.
XML development goals include easiness, universality, and online usability.	The language is primarily intended to define a document's structure.
Strongly supports text data formatting by using Unicode to represent different human languages.	Does not allow adding a description of the content.

To develop XML work by giving it more capabilities to accept and include the ontology in its work, DTD has been included or added to give the possibility of adding restrictions on phrases or concepts within tags.

A DTD, or what might be called a syntactic moderator, is used to give the ability to examine groups (concepts within phrases) of what is permitted or rejected in terms of a specific attribute.
However, the DTDs are the closest idea to improve XML to become the modelling ontology language.

Definitively, ontology still has a more robust approach to building a semantic web than XML. While XML considers the shortage of expressiveness (Sawsana, 2013).

2.8.1.3 RDF and RDFS

The RDF is the language that the WWW gets designed to be used as a standard for identifying data on web pages.
The tool provides redundancy through its features to give a detailed description of the data, thus understanding the data by the machine in an improving method.
However, this allows an exchange of information between the machine and the human and the machine's understanding of the requirements of individuals in an easier way.
Furthermore, the possibility of using a substitute language to give a detailed description of the resources available on the web. At present, it became a compelling language widely used in describing data on web pages to form a common language between the machine and the user, allowing the machine to understand the available data better and increase the chances of obtaining the data from the machine.

The syntax of an RDF formula depends mainly on three components: subject, document, and object. Therefore, it is called or known as tripartite. The idea of the tripartite is based on giving more details for each phrase (Zhou, 2011).

However, this model aims to add formal semantics with specific characteristics to Internet resources.

RDF possesses considerable benefits across XML with the following:

1. Provides a structure for a well-detailed organism trait using natural semantic definitions.
2. Standard RDF can remain applied.

To develop on the RDF capabilities and find alternatives language to existential modelling over the currently available RDF capabilities, a scalable.

It is known that XML lacks a class that allows giving a detailed description of the subject, so XML developers built a level on highest of XML to incorporate and provide the ability to give the elements of an existential primacy.

RDFS allows developers to define RDF data terminology and give a special characteristic to the data that gives meaning to the machine.

RDFS is distinguished as an ontological language because it defines references to classes and can provide resources with properties, constraints, subclass, and sub-relationships. With all of this, the language of RDFs is very limited in its capabilities, which necessitates more research on a language with better expressive power to give a more detailed description of the sources. Moreover, the descriptions must be able to support machine inference.

2.8.1.4 The Web Ontology Language OWL

OWL described in Figure 2-18 is the language approved by the W3C for promoting the use of ontology on the web.
The basic idea of having a semantic web language to represent the ontology on the web is to provide the machine with an understanding of resources, e.g., allowing the computer to automatically process the data and infer the various resources on the web in an intelligent way.

This is certainly done in a way that allows the sources to be given in a more detailed description, thus, making it easier for the machine to create an interaction or link with the

data and then reach the desired from the web resources using the description given to the sources (Zhou, 2011).

Ontology is a term based on philosophy in a sense, which is characterized by giving a more detailed description of the types of web resources and how they relate to each other. The OWL ontology may include descriptions of classes, characteristics, and controls (Sawsana, 2013).

Given the creation of an ontology, for example, the person, the attributes and characteristics given by OWL determine how the results are derived or inferred. For example, if the individual Jack, for example, has a corporate trait and is registered in the classroom as a student, and the student Jack is a sub-class son of Jack, then it can be derived that Jack is also an instance of the person in a manner like what happens to RDFS.

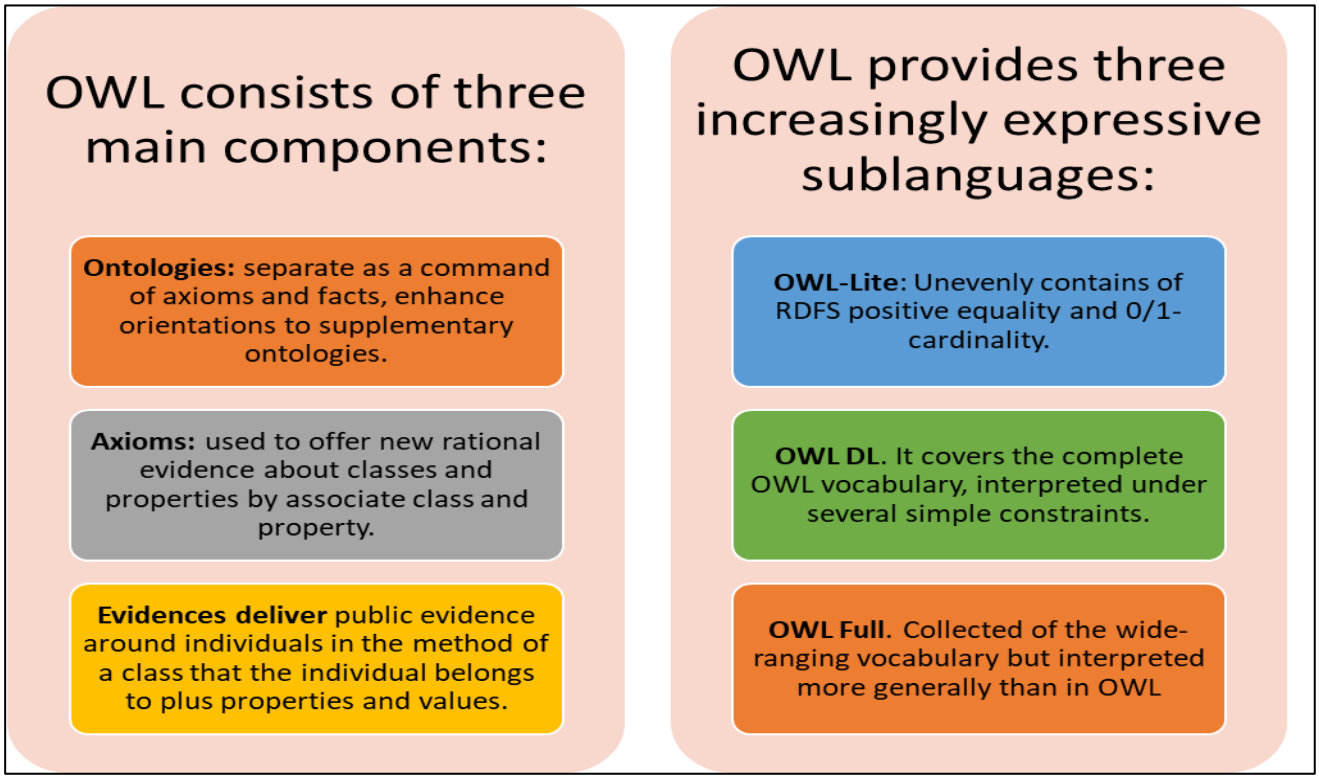


Figure 2-18 OWL Components

Ontology is a phrase reproduced from the viewpoint that describes the art of explaining the types of individuals globally and how they are related.

2.8.1.5 Comparison languages

To get a comparison between various languages more effectively, the comparison was made at two stages as follows:

1. An overall comparison between the different languages is given.
2. Difference between diverse languages, which are thought the extreme common languages giving to W3C.

Sawsana (2013) made the comparisons between ontological languages, primarily overusing some factors such as perceptions, characteristics, instance, axioms, and semantic relation.

According to Sawsana (2013), the ontology of a heavyweight represents the rules of formal axioms and other functions and components, while ontology language represents

lightweight models, i.e., models of categorization and the interactions between them. It can be defined as the unknown classes created by the constraints imposed on class value.

Also, Sawsana (2013) provides an outline of the difference among developing imports, varying shows the emotional superpower of OWL in the equivalent classification.

Ontology can categorise sequences of powerful semantics complex objects and are thus impeccably suitable to define the varied, dispersed, and semi-structured sources of information, for example, the perspectives on the web. Figure 2-19 illustrates the power of ontology OWL language instead of other languages.

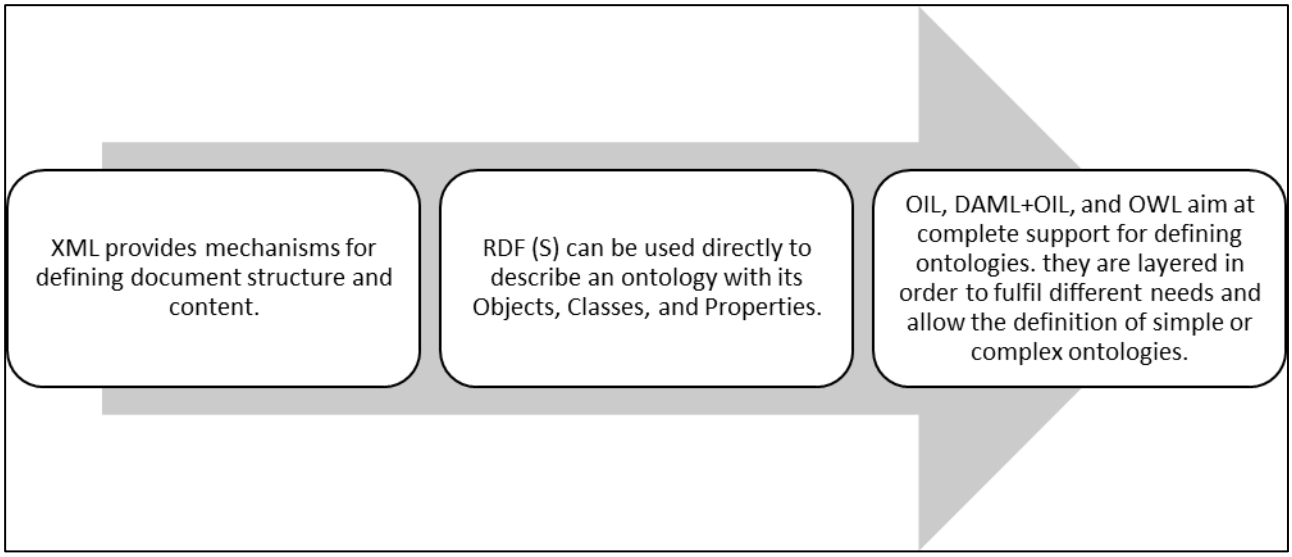


Figure 2-19 OWL Power

Over an in-depth study of the process of comparing different languages and raising all concentrations, OWL was more effective and stronger at all levels.
Therefore, the OWL language was selected to represent the language of the OSE system.

2.8.2 Semantic system development tools

The main concern of many users or even developers of electronic systems is certainly access to retrieving information accurately and easily; specifically, there is an abundance of data from various sources available on the web pages.

To retrieve useful information in an accurate manner, the success of the semantic web needs to develop suitable semantics, here creating a respectable ontology must be established. Accordingly, on the marketplace, many ontology editing tools can be obtainable, many of which have been analysed to arrive at a more suitable tool for use.

Some of the latest available ontology tools are presented in the following section which shows both desktop versions online and compares them with the latest version of the extremely popular Protégé tool. Also, discover the outcome of the study for each field, for example, e-government.

Design ontology has created a leading field within public knowledge management. Each of these tools has its specific characteristics and presentation concentrations based on which we select the most recent edition of six tools and evaluate their working natural background.

2.8.2.1 Onto Studio tool

Onto Studio was created by IBM Planner. It can be downloaded on a trial basis for a period of up to three months to allow the tool to be properly evaluated. However, the tool is an ontology fabrication setup that connects progression and ontology preservation through a graphical user interface (Rastogi, 2017).

Figure 2-20 shows the highlights of the observable of Onto Studio ontology tool. It also provides the contains and describes characteristics, features of the tool.

Figure 2-20 Onto Studio Tool Description

Source: Rastogi (2017)

2.8.2.2 Protégé Ontology editor

Protégé was created by Stanford University School of Medicine, n.d. Protégé is an unrestricted acceptable with free of use. It is also provided via an open-source policy that delivers an increasing public customer used through a set of tools to view area models besides information-cantered requests, including ontology (Zhou, 2011).

Figure 2-21 demonstrates the highlights of the observable of Protégé ontology tool, including the characteristics and features of the tool.

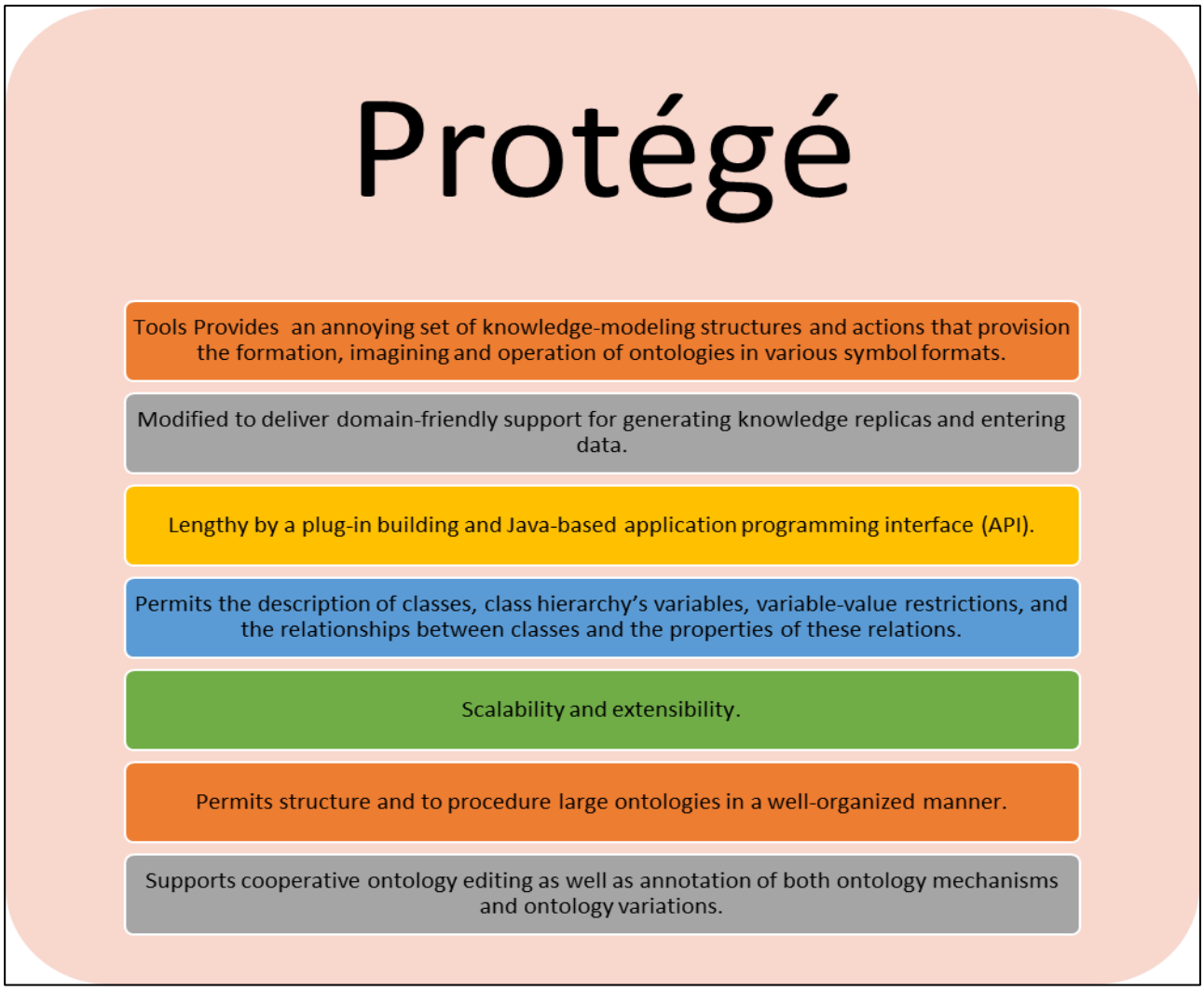


Figure 2-21 Protege Ontology tool Description

Source: Rastogi (2017)

2.8.2.3 Swoop

Swoop (2004) remains a broad editor optimised for use on the web as an editor for OWL management and browsing web pages.

Figure 2-22 illustrates the Swoop ontology tool; however, the figure includes and describes the characteristic features of the tool.

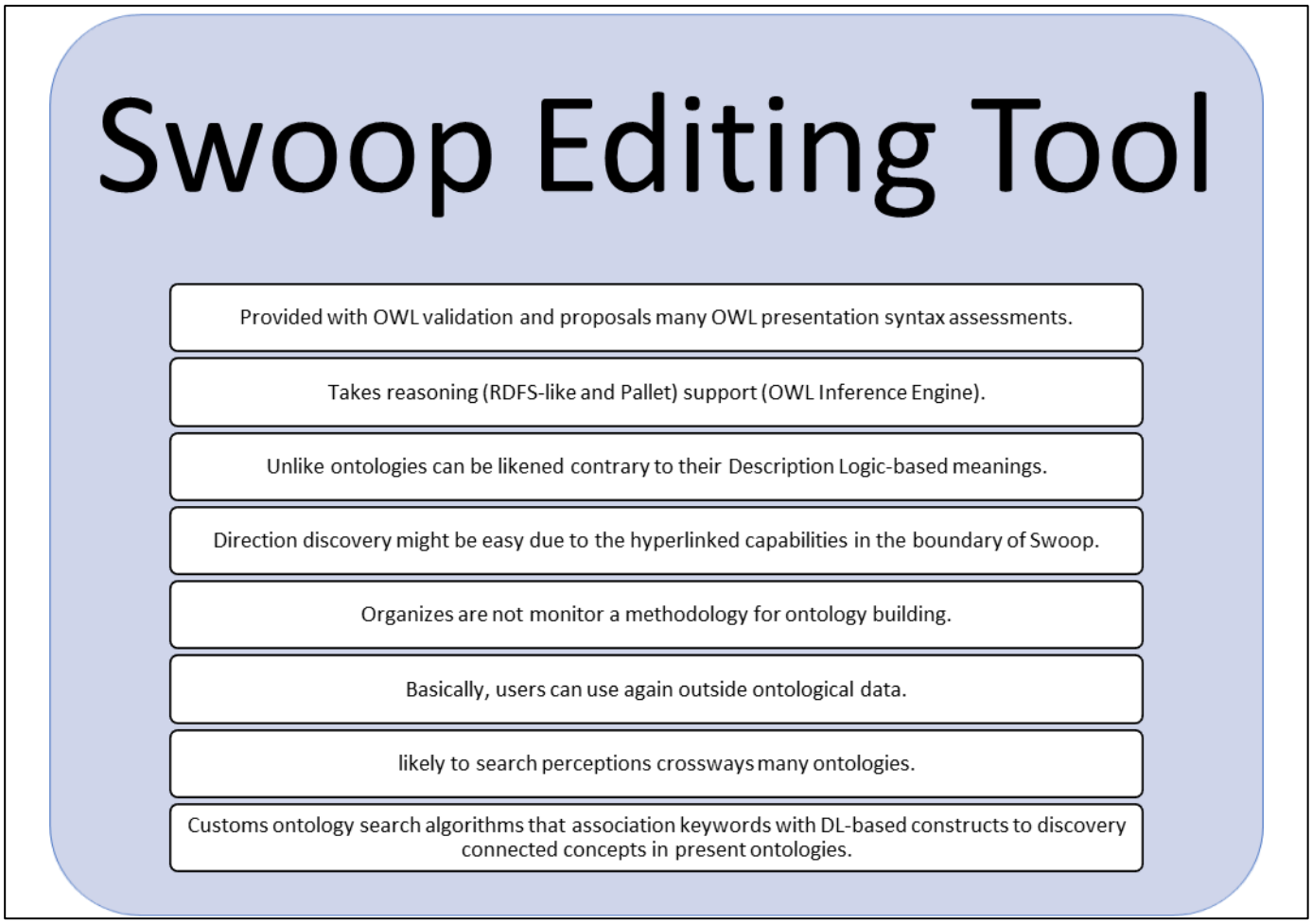


Figure 2-22 Swoop Tool Description

Source: Rastogi (2017)

2.8.2.4 Top Braid Composer

Top Braid Composer (Top Quadrant, n.d.) is a specialised advancement tool for Semantic Models (Assemblies). It is built on the Eclipse stand along with the Jena API.
However, it appears in three editions: Free Trial Edition for a Specific Period of Time (FE): It is considered an initial version only and does not contain all the features (Rastogi, 2017).

Figure 2-23 reveals and highlights the observable taken out Top Braid Composer ontology tool. The figure comprises and describes characteristics elements of the tool.

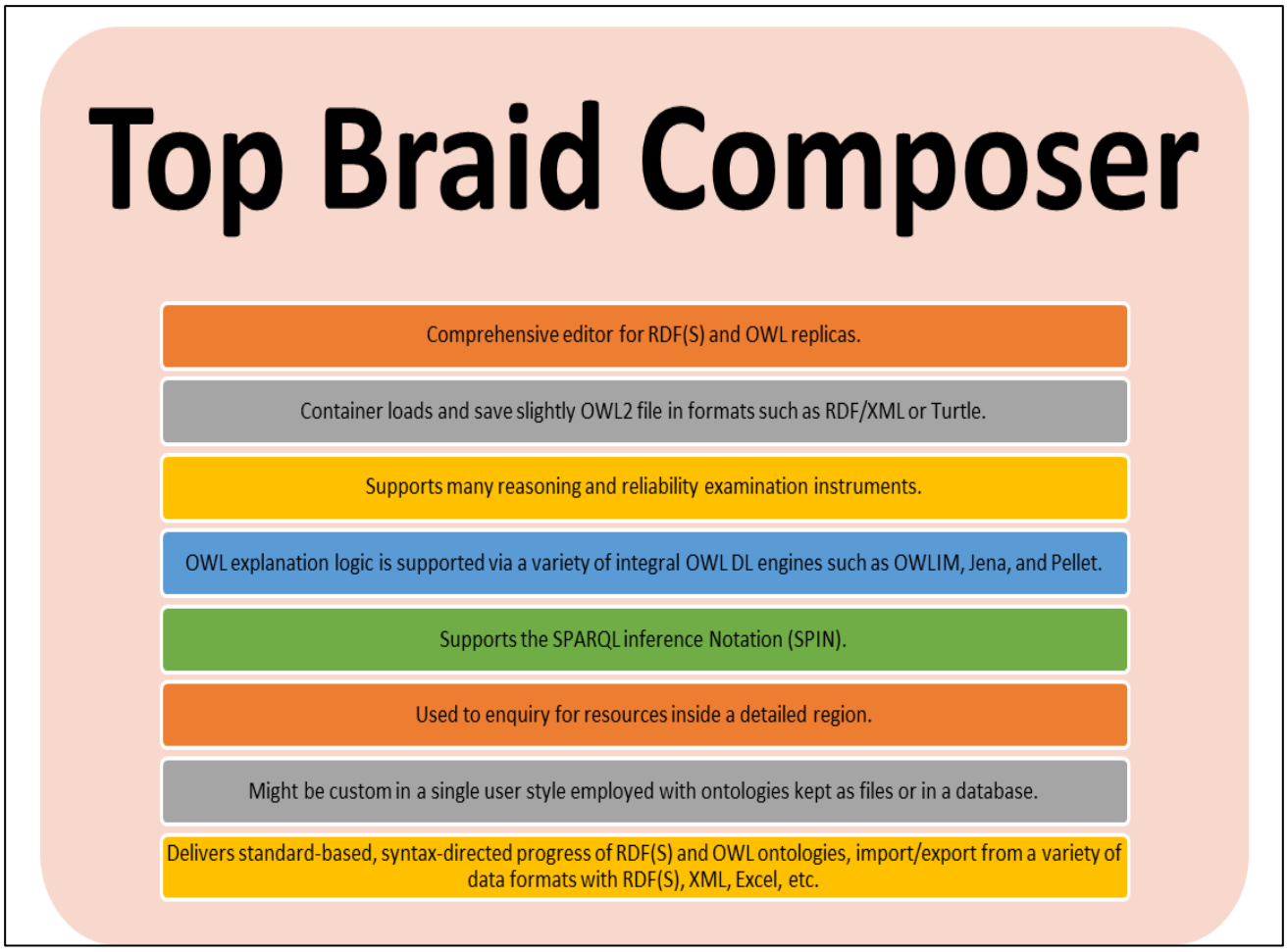


Figure 2-23 Top Braid Ontology Tool

Source: Zhou (2011)

2.8.2.5 TODE

TODE is the first ontological editor developed. The TODE editor is based on the Dot Net framework.
This editor strongly supports the .NET environment and applications. TODE has been greatly developed using numerous technologies such as Telerik Test Studio's controls and JENA Semantic Web tools for translating JENA data toward C #.
Since the editor is based on AJAX, it works more efficiently on low bandwidth users.
TODE has the following salient features:

- Supports web-based AJAX environment.
- Easy-to-use editor, W3C compatible interface is simple to use.
- Facility for OWL Lite.
- Implication, logic checking, and graphical user interfaces.
- Be able to produce other ontology languages, e.g., N-Triple, OWL permitted.

2.8.2.6 OWLGrEd

Figure 2-24 reveals and underlines the perceptible carried out OWLGrEd ontology tool. The figure includes and describes attributes elements of the tool (Rastogi, 2017).

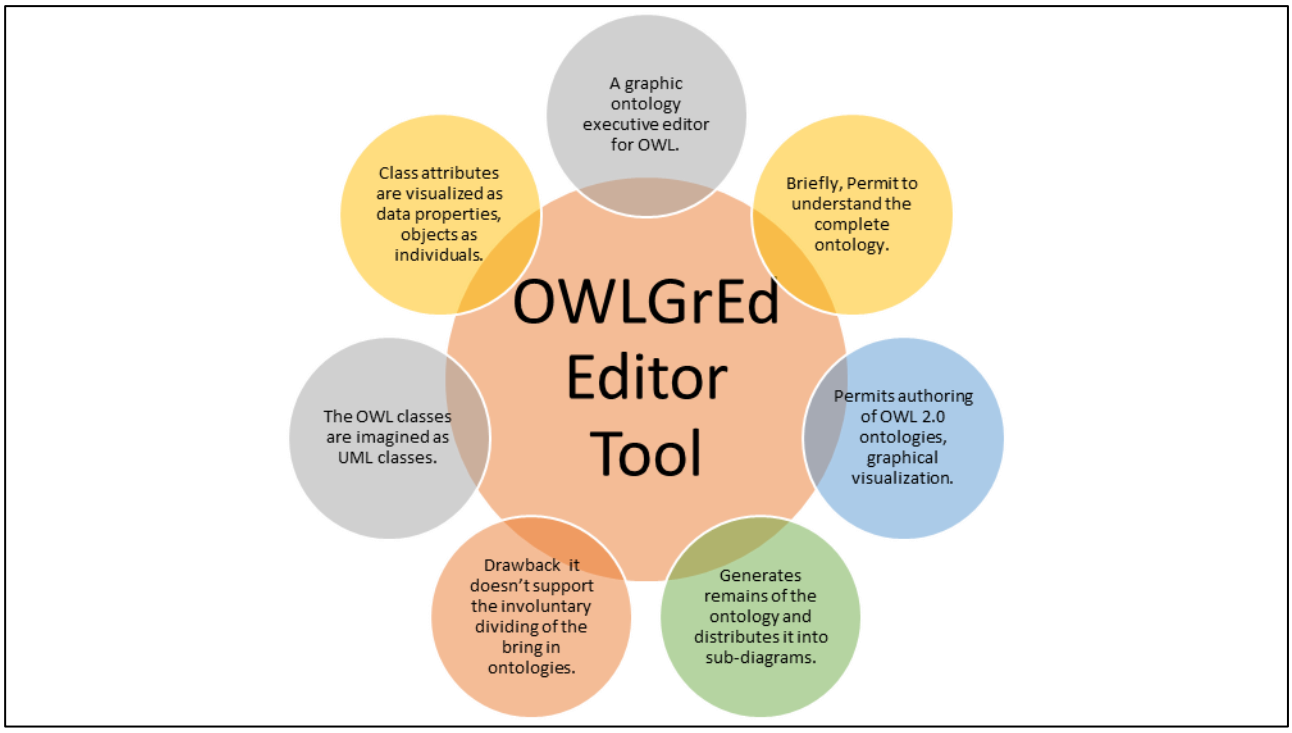


Figure 2-24 OWGrEd Ontology Tool

Buraga (2006)

2.8.2.7 Odase

Odase offers ontology based on a web-centred program known as ODASE. Odase has the following characteristics (Rastogi, 2017):

- Supports adaptable and easy-going results.
- Allows commercial responsiveness.
- Transforms industry-focused approach interested in profitable schemes.
- Decreased expenses.
- Enhanced value of work.

2.8.2.8 Comparison of Ontology editing tools.

Although each ontology editor has a special view and feel, there is still a few degrees of variability in the interpretation of semantics.

Several of the family hierarchy vision and extended concentrations are extremely common types of visualisation ontology.

Later an in-depth study of ontology above and an analytical study of tools based on features, we conclude in the end that each method has a set of advantages over the other, but in general, it can be assured that all of them are characterized by simplicity, in its own way as it is easy to use in general.
This made choosing the correct type subject to other factors such as the size of the ontology, whether large or small, as well as another important factor represented by the nature of the user, whether the user is a beginner or an expert.

We believe, Protégé is the greatest standard and most suitable editor for beginners and has the advantage of allowing Protégé to use a lot whether working on an academic level.

In the compound or work inside the individual house. The following arrangement is SWOOP for largely similar reasons, but it is less common in use by the academic side. When the user wants UML icons, the best option is OWLGrEd or understand his ontology graph as of its better perception. Onto Studio is exceptional and more convenient to develop large assemblies having a complicated nature, as it provides a more professional connection to its users.

Table 2-3 A comparison of Ontology Editing Tools.

Features	Protégé	Swoop	OntoStudio	TODE	OwlGred	Odase
Semantic web Architecture	Web-based, Client/server	Client/server, Web-based	Eclipse based IDE, Client/server & Standalone	Dot Net & web based	Desktop & Web-based	Web-based
Ontology storage	Files, DBMS	HTML models	Files, DBMS	Files, DBMS	Files	Files
Interoperability with other tools	PROMPT, OKBC,FaCT & Jena,	No	No	No	Interoperability with Protégé	No
Import/Export to/from	XML, RDF, Owl, HTML, UML	OWL, XML, RDF, text formats, OIL+DAML	UML 2.0, Database schemas (DB2, MSSQL, Oracle,MySQL),Outlook EMails, Exceltables, file system	RDF, N-Triple, RDBM,OWLLite, N-3,	OWL, OWL2, UML, RDF/XML	OWL, SWRL, RDF
Ontology library	Yes	No	Yes	Yes	Yes	No
Graphical view	Yes	Yes	Yes	Yes	Yes	Yes

In Table 2-3, Protégé overcomes the set of other tools, especially an open free program that is popular, characterized by ease and continuous support, and is also common in academic work.

Over an in-depth study of the process of comparing different languages and raising all concentrations, OWL was more effective and stronger at all levels. Therefore, the OWL language was selected to represent the language of the OSE system.

Some of the latest available ontology tools are presented in the following section which shows both desktop versions online and compares it with the latest version of the extremely popular Protégé tool. Also, discover the outcome of the study for each field, for example, e-government.
Protégé overcomes the set of other tools, especially an open free program that is popular, characterised by ease and continuous support and is also common in academic work.

2.9 Related Work

This section of the thesis will provide a full clarification of the background of the research topic.

Table 2-4 shows the investigated references, study objectives, and the limitations of each study.

Table 2-4 Study Examined Reference

Reference	Approach Purpose	Approach Restrictions
Venkatesh et al (2012)	Gaining /creating services centred on a study (person-services)	Collecting services instead of developing or evaluating the system.
Chan et al (2010)	Offered a theoretical and empirical analysis of an e-government system implementation.	Shows only theoretical and guidelines way which not supported by evaluation or real e-government simulated system.
Jayashree and Marthandan (2010)	Focus on service model to create social services	The only description of how to create services (guidelines). The described method is not including the system structure for e-government.
Layne and Lee (2001)	Describe different stages of e-government development.	Guidelines concept for creating the system.
Tsai et al (2012)	Paper describes ontology design patterns.	Theory steps to create a system not supported by investigational data.
Chan and Pan (2008)	Provides a method of data collection.	The technique based on theory work.
Carter and Weerakkody (2008)	This study provides a method to evaluate e-government using a user engagement survey.	The recommended technique of assessment is centred on single restricting factor (analysis).
Sheng and Lingling (2011)	Use essay ontology OWL to establish just how to generate a reserve ontology on the aspect of the body.	Offer style standards only.
Kayed et al (2010)	progresses a method of ontology in requirements planning method for e-government products	defined in theories and standards.

As shown in Table 2-4, none of the research studies has contained systematic details of developing an e-government environment using ontology technology.
While most of the studies have only briefly described a single activity.

In Table 2-4, the activities addressed in the studies include data collection, e-government development, and evaluation of e-government. Few research studies included more than one activity.
In Table 2-4, when comparing different research studies, reference is made to the following indicators:

- Most investigated studies are distinguished as general guides of a general nature.
- A few studies included evaluation and testing of the applied methodology.

In Table 2-4, the ideas of the studies applied by investigated researchers have focused on building a system using the rules and the basics of software engineering.

However, much of the vision to build an e-government structure ignores the specialized nature of the e-government scheme, which demonstrates private acts.

Based on previous observations, the researcher found it difficult to rely on a research study where the studies are based on a single activity or two brief activities.

Corresponding to the goals of this research, the associated works encountered just one, or at greatest double, goals. Established on that, it develops hard to plan concerning to use ontology in e-government.

However, Sawsaa, Ahlam (2013) and Zhou, J. (2011) have the most relevance and significance to the research thesis. Sawsaa focuses on building an ontology for the library system and information systems, while Zhou builds an ontology for the New Zealand Parliament. Both studies differ significantly from the field of research in terms of application case and evaluation methods.

This research has a significant value concerning offering unified research that involves an assessment and extent methods of the position of ontology in e-government. The research will also help to find efficient public services in e-government.

2.10 Summary

In this chapter, nine main sections are presented to conduct a link that combines the theoretical and the requirements of the practical side. The first three sections presented the area of e-government in terms of benefits, services, and educational services, specifically educational services in Singapore, which illustrates the case study of the domain of e-government.
However, e-government refers to the use of e-government in every possible scope, from government services on the Internet to exchanging information and services electronically with citizens, companies, and other government business environments.
The expected benefits of the e-government include improving the provision of services and making them more efficient through the availability of services to become clearer and more accessible, thus contributing to community service. To monitor, evaluate, and encourage the services provided electronically in various countries, the United Nations issued every two years an international report on e-government. The report senses the effectiveness of e-government measures in providing public services and the designs that countries take in e-government development, besides performance.

The educational services provided electronically are ranked ahead of the rest of the electronic services provided by the Singaporean government, as educational services are characterized by comprehensiveness, diversity, the large number of services, and the many sectors served.

The fourth section is dedicated to the term semantic web. The semantic web indicates an idea based on the transformation and provision of the current global network to include new elements or descriptions, enabling computers to hold meaningful explanations such as information processing, which allow for a person to achieve what he wants access of information.

The ontology concept was discovered in section five; however, the ontology was developed on a large scale in the e-government field intended for benefits to describe the services

provided by the government to citizens. Accordingly, enabling e-government to provide more descriptive expression up to citizens.

Many methodologies were investigated to create and develop an ontology, such as Tove, Sensus, Cyc, and Methonlogy. By comparing methodologies, it was found that some of them have superior strengths and weaknesses in other aspects. However, Methonlogy methodology, with its characteristics method, is largely accepted in the most formed, together with Methonlogy designate a comprehensive ontology development methodology. The methodology is mainly based on developing an ontology using seven steps, starting with specification and ending with documentation.

Approaching evaluation of ontology basically disagrees on how to target many criteria such as consistence, clarity, and completeness, which is the main motivation behind the evaluation of classification.
However, these methods can be classified into six varieties: gold level, corpus-cantered, assignment founded, criteria-built methods, verification and validation of ontology, ontology consistency metrics.
The ontology evaluation of Singapore's education system (OSE) will be based on the ontology assessment process adopted by Gómez-Pérez's approach, which comprises two fundamentals: verification and validation of the OSE system.

In seeking to employ tools and languages, the key outcome of section eight found:

- A web ontology language is appointed as the extremely proper semantic language.
- OWL was applied to implement the ontology technique. OWL is extremely practical for the ontology languages.
- Protégé is a free-resource ontology dealing tool, which delivers a graphic user interface for identifying ontologies. It also includes a concerted ontology development nature for the Web, specifically, Web Protégé.

The last section found that the research has a significant value concerning offering unified research that involves an assessment and extent methods of the position of semantic in e-government

3.Chapter 3 Research Methodology and Strategy

3.1 Plan of Research

The chapter subsequently, passing an explanation of the research environment, converses the theoretical basis of the research concept and expectations. The research approach is mainly recognised on the suggestions carried by Crotty (1998). However, many researchers have broadly supported Crotty's approach, specifically the social science researchers for several years. The Foundations of Social Research is widely cited in the literature, for example, Google Scholar (2019) gets Crotty's book cited 22547 times; Crotty devotes parts of the chapter to distinguish the extremely appropriate research methodology and method for this research (Zhou, 2011).
The chapter completes with the description of the comprehensive research plan enhanced in the thesis with thorough evaluations and explanations of the method used to gather and evaluate the data.

3.2 Study and Goals.

The Organization for Economic Cooperation and Development (OECD) adopted an original definition of the term research, as it launched the concept that denotes organised activity of a creative nature that produces an increase in knowledge, whether it is knowledge useful to humans, culture, and society similarly (OECD Glossary,2007).

In addition to the previous definition of the term research, John W. Creswell (2008) established another definition, which specifies that "research is the process of increasing understanding of a topic using specific steps of data collection and analysis." It has three phases: it begins with asking the question, it is followed by data collection to provide an answer to the question and finally, the response based on the question.

Merriam Webster Online distinguishes the research dictionary in more factor as scholarly review or assessment. In particular: investigations or tests aimed at finding and clarifying facts, reviewing accepted theories or laws contemplating different circumstances, or the useful product of such hypotheses or regulations new or revised (Creswell, 2008).

Based on these definitions used to create the details associated with conducting the research, it was noted from the set of definitions that it focuses on the results of previous efforts and builds on them. There is also an attempt to answer challenges, whether current or expected to occur in the future. Finally, the term introduces the auxiliary data set, or the concepts intended to be achieved (Aken, 2005).

In scientific research design or building research, this type of research is described as descriptive research, with goals of scientific combined with another practical nature. Research into these corrections is important for understanding and refining human science.

Crotty (1998) indicated that in creating research, the necessary to put considerable effort interested in replying to the following four questions:

1. What are the usable methods that we suggest using?
2. Which methodology determines our choice and utilise of methods?
3. What is the underlying theoretical perspective that led to the use of the mentioned methodology?
4. Informs what epistemology from theoretical perspective aspects?

In the four raised questions that constitute the basic elements of the process of creating research, there is a need to carefully explain what each of them means. There are four basic components that represent Methodology, Method, Theory, and Epistemology. All elements are further illustrated in Figure 3-1.

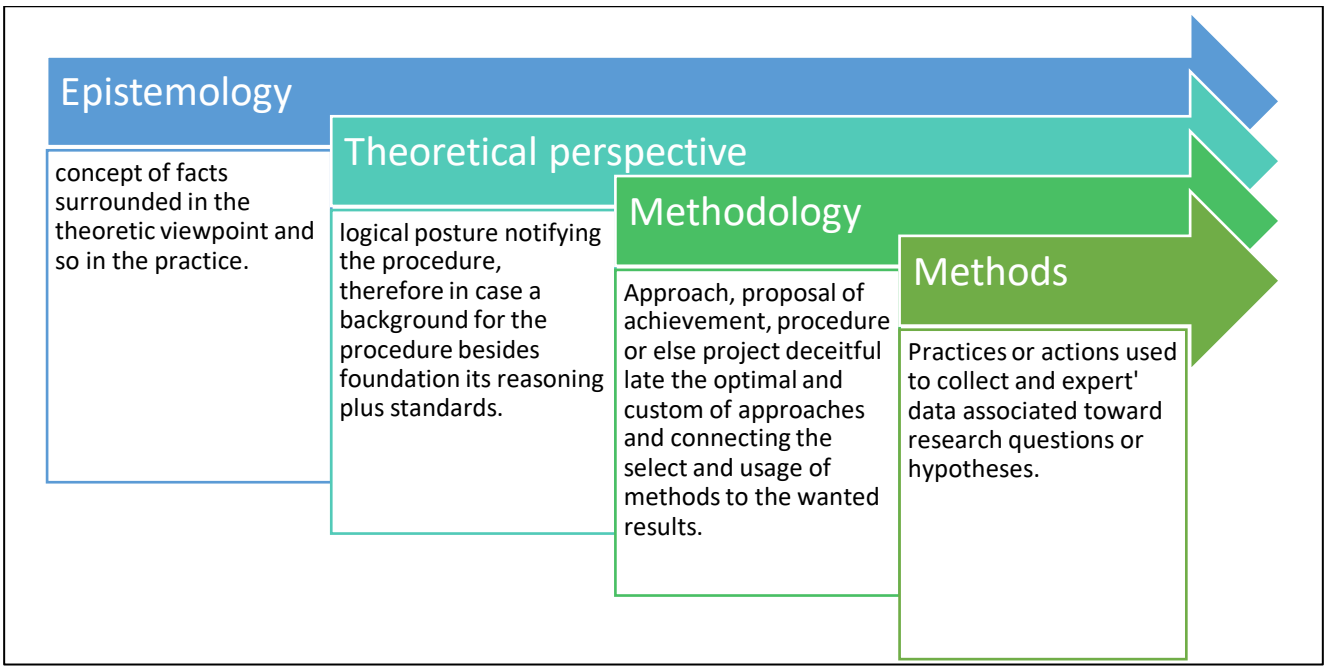


Figure 3-1 The Four Elements of Crotty (1998)

Source Crotty, 1998

In Figure 3-2, a detailed explanation of the four questions raised in Crotty's paper is provided. Saunders et al. (2007) depicted the questions in a graphical representation as an image representing an onion analogy. The research in Saunders' paper was created to indicate the phases followed in the expansion in the progress of the research effort.

Saunders et al. (2007) explain the stages that must be included when creating a search strategy. In other words, every level of onion explains a comprehensive phase requiring further research procedures.

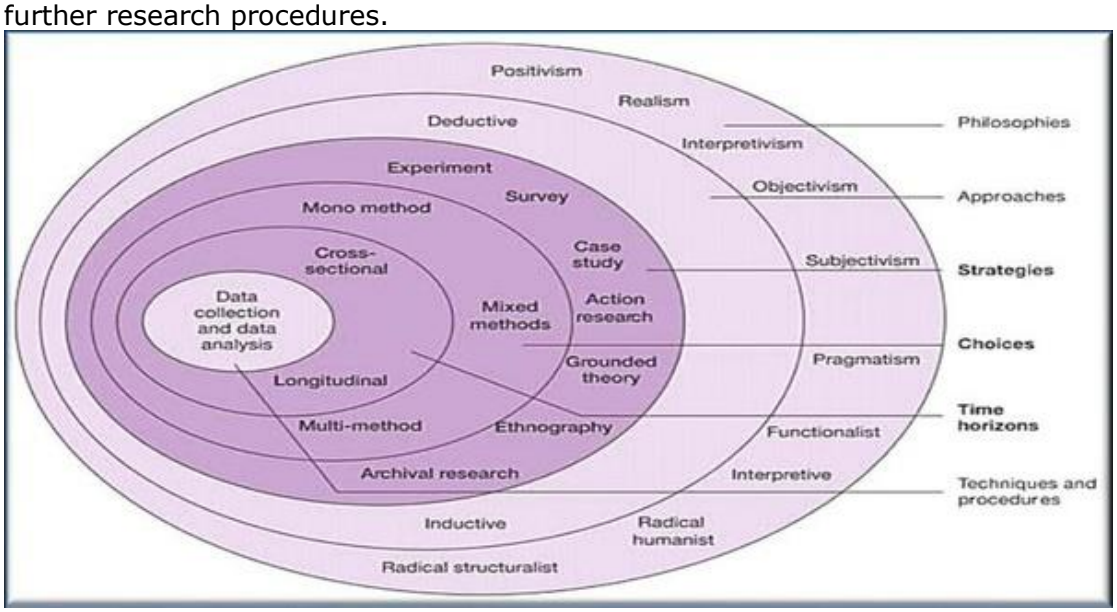


Figure 3-2 The Research Onion Adapted by Saunders Et Al. (2007)

Saunders et al., (2007)

Saunders and his colleagues believe that conducting the research properly is to remove the onion shell, starting with the outer cover until it reaches the inner cover, meaning that to realise the internal level, the external level should be removed initially.

The outside layer characterises the research philosophy that begins with conducting the research, as it is followed in the second step, which determines the method to be implemented as an approach to follow, in the tertiary phase, the search strategy is promoted, while the fourth step controls the period view necessary to complete the research.
The fifth and final layer represents the stage in which the data collection methodology is adopted. Hence, the research advances establish a sequence of phases through which the various data gathering processes can be identified. It also simplifies the steps to describe the systematic study step by step until the research is completed.

The onion research phases at Saunders include the following: beginning with the research philosophy, then the research methodology, research strategies, selection of research and time horizon for research completion.

By supervisory this research, Crotty' s quatern queries are replied to in the succeeding four parts of the chapter. For example, the response to Crotty's starting query involves a response to the element of the binary sub-questions in Chapter 1:

- What is the framework, philosophy, paradigm, and research theory assumed in the research?
- What are the research standards, procedures, and study techniques that should be adopted?

3.3 Research Philosophy

The research philosophy emphasizes a series of beliefs connected to the nature of the reality that has been examined. This definition leads to the conclusion that philosophy revolves around its concept by imparting a nature of knowledge. Also, there is a clear harmony between philosophies and goals, as philosophy is defined to follow the best methods to achieve the desired goals.
Finally, the research philosophy can be chosen according to the type of knowledge to verify the research project.
Two main philosophies are important in the research procedure, as illustrated in Figure 3-3.

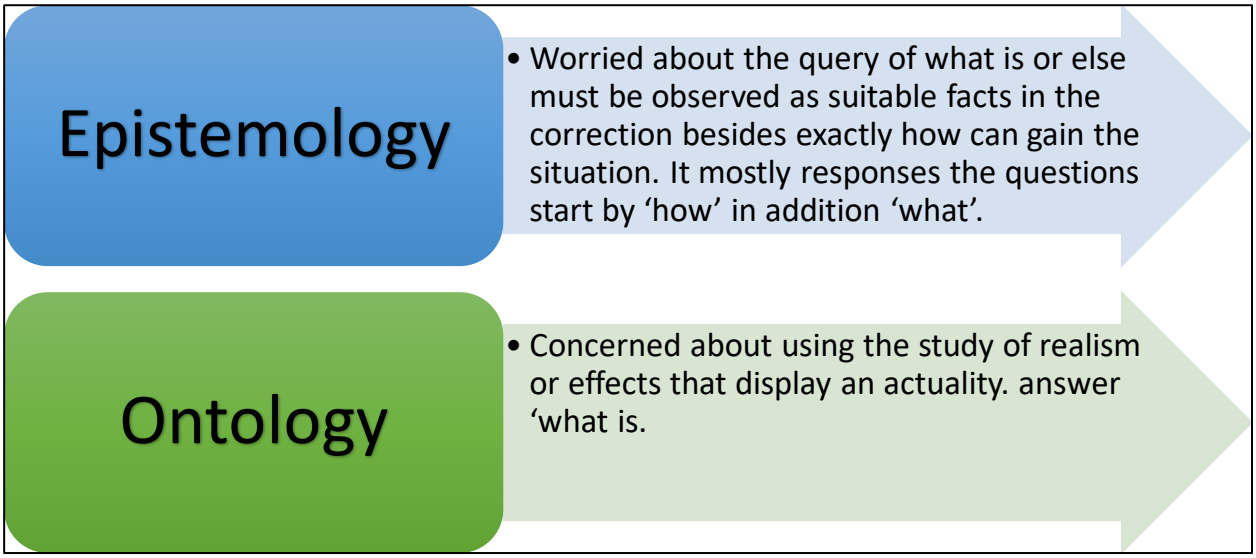


Figure 3-3 Research philosophy

Furthermore, tierce philosophical views associated with Epistemology include logical positivism, essential pragmatism, and explanatory. While vision obsessed by Ontology consists of Objectivism, constructivism, and simplicity. Description of Epistemology and Ontology philosophical beliefs illustrated in Figure 3-4.

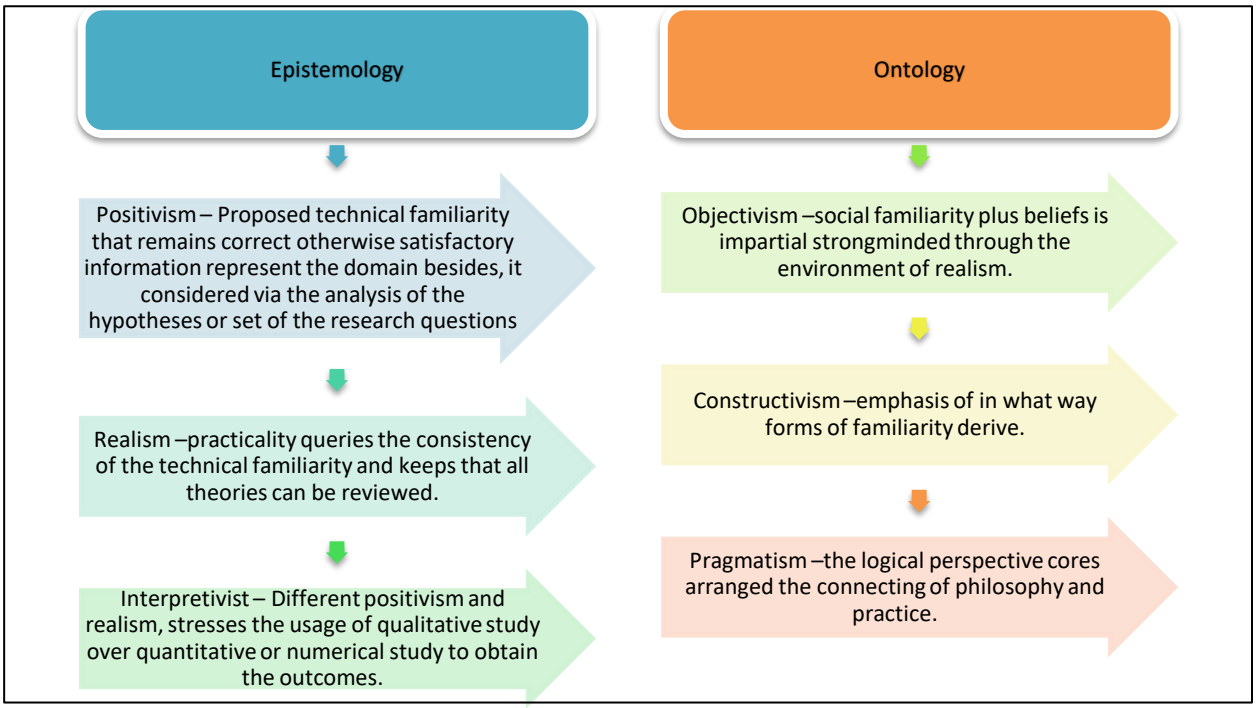


Figure 3-4 Epistemology and Ontology Philosophical View

3.4 Research paradigm

The research model(paradigm) is a research approach or model that is conducted and verified by a group of researchers, then it utilised and assessed the purpose for use in an extended period.

Although there are essentially two types of models, research that belongs to technical or experimental study seems to adapt a quantitative methodology that is a clear model approach and is characterized by being the most preferred to conduct research.

3.4.1 Types of Research Paradigm

3.4.1.1 Positivist Paradigm

Positivism as a theoretical outline considered as highly used in technical or measurable research. In fact, quantifiable research continually supports the positivist method as positivists consider in empirical theory examination.

In studies of a purely scientific nature, the use of positive philosophy is most often due to the nature of research with an experimental tendency to produce facts. In experimental quantitative research, research often derives from the adoption of a probabilistic model drawn from a group of previous research. Here it is believed to be based on the results of a previous study as a model that can be generalized to similar research, regardless of what the model research brings about different circumstances or environment.

3.4.1.2 Interpretivist Paradigm

Greatest of the qualitative research in community disciplines utilises the interpretivism method to the research. The explanatory philosophy relies on the multiple human factors of behaviour, with an emphasis on not relying on a research model that can be relied upon and promoted as a model.
Therefore, the model depends on human behaviour without the experimental or scientific principle.

Differences Between Both Positive and Interpretation Models

The clear difference between both positive and explanatory models is that the positive model focuses on the empirical aspect of constructing the model. The positive model is also subject to established laws, measurement, reliability, and control.
On the other hand, the interpretive model is subject to a set of human behaviour in determining outcomes.
Although both models are opposed to each other, they represent familiarity in two separate ways; nevertheless, both have special value and importance in the development and increase of knowledge.

3.5 Strategy of Knowledge Study

Scientific Research Design is a comparatively innovative method to research to construct a modern existence (i.e., problem-solving).

In both research Horváth (2007) and Baskerville et al. (2015) carry out the following constraints of the DSR:

- Towards develop and increased expertise in the direction of resolve difficulties, generate transformation or enhance present answers.
- Produce innovative expertise, insights, and hypothetical reasons.
- Evaluation, orientation, and assumption of the challenge.
- Model and assessment of the results.
- Validating assumption, support of the research simplifying for other products.

However, design science research DSR enhanced procedures include six stages of activities as follows:

1. Recognition of research difficulty and provide the principles of the possible solution.
2. Establish goals for the research project.
3. Creating and supplying research frameworks such as constructs, models, approaches, etc.
4. Offering the tools needed to find solutions.
5. Evaluating and assessing the proposed solution, as well as conducting a comparison process between the objectives and actual results; And
6. Transferring the research elements from problem, solutions, tools, and evaluation to researchers to generalise benefit.

Given these proposed steps, the research is most likely not going hierarchically, meaning it is not necessary to always start with the first step and follow the second, but it should contain in the end all the steps. However, the produces DSR project is always part of a purposeful, which includes important as the product or process elements; It can be technology, a tool, a methodology, and a technique.

Development of DSR in computer science

Since the inception of computer science, researchers in computer science have conducted without launching the label design science research.

Researchers create solutions to a wide range of problems such as data models and algorithms.
The philosophy of empirical research was based on using the existing research group to present sound and successful prescriptions.
It seems that this theory or the generally accepted research strategy failed in achieving the desired goals in most cases. But this collapse guided the search for useful research techniques.
While DSR seeks to increase the knowledge of its users in a specific field, which enables specialists to develop innovative solutions to a series of problems in their work.

Hevner et al. (2004) established standards used for DRS contained by the restraint of Information Systems. Yet, DRS involves of construction of a modern, resolute object intended for a particularly problematic area.

Seven standards addressed by Hevner et al, (2004), consider for a design science research, explained in Figure 3-5.

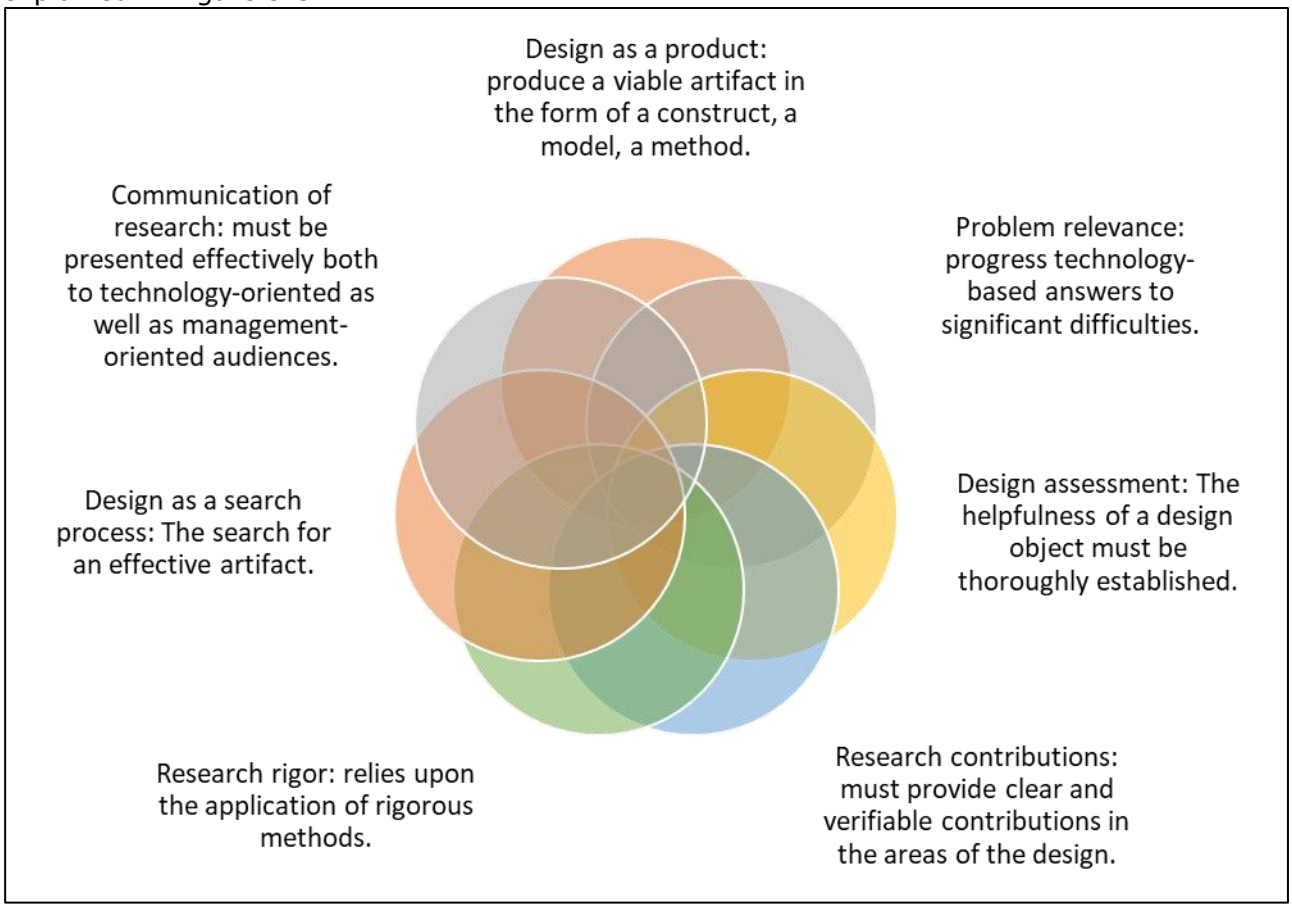


Figure 3-5 Design Science Guideline

Source Hevner et al, (2004)

3.5.1 Theoretical perspectives

To organise our thoughts and make them clear to others, it is important to look at the theoretical perspective, which is very important for research (see Table 3-1).

A hypothetical viewpoint or "Theoretical perspectives" characterized the realisation. It is like a configuration that provides to mutually involve and prohibit; however, theoretical perspectives are encouraging ideas as of the viewpoint. Theoretical perspectives represented the area of sociology that assumes that public structures such as civilization and the people occur, philosophy, community building, types, and responsibilities are true.

Table 3-1 Crotty Elements

Epistemology	Theoretical Perspective	Methodology	Methods
Objectivism Constructionism Subjectivism	Positivism (and post-positivism) Interpretivism • Symbolic Interactionism • Phenomenology • Hermeneutics Critical inquiry Feminism Postmodernism Etc.	Experimental research Survey Research Ethnography Phenomenological research Grounded theory Heuristic inquiry Action research Discourse analysis Feminist standpoint research Etc.	Sampling Measurement and scaling Questionnaire Observation • Participant • Non-participant Interview Focus group Case study Life history Narrative Visual ethnographic methods Statistical analysis Data reduction Theme identification Comparative analysis Cognitive mapping Interpretive methods Document analysis Content analysis Conversation analysis Etc.

The strength of the four elements lies in flexibility and can be used for many purposes; for example, if taking an anthropological approach requires making different decisions on your methods, but the theory of knowledge will greatly influence it. Hence this framework should make the making about the research a slightly simpler and stronger the outcome.

3.5.1 Grounded Theory

The foundations of theory (GT) are a methodical methodology in the field of social sciences that involves building theories through systematic collection and data analysis.

The research methodology uses this inductive logic and contrasts with a deductive hypothetic model of the scientific method.

A survey applying grounded theory is expected to start with a question, or much just with the compilation of qualitative statistics (Figure 3-6).

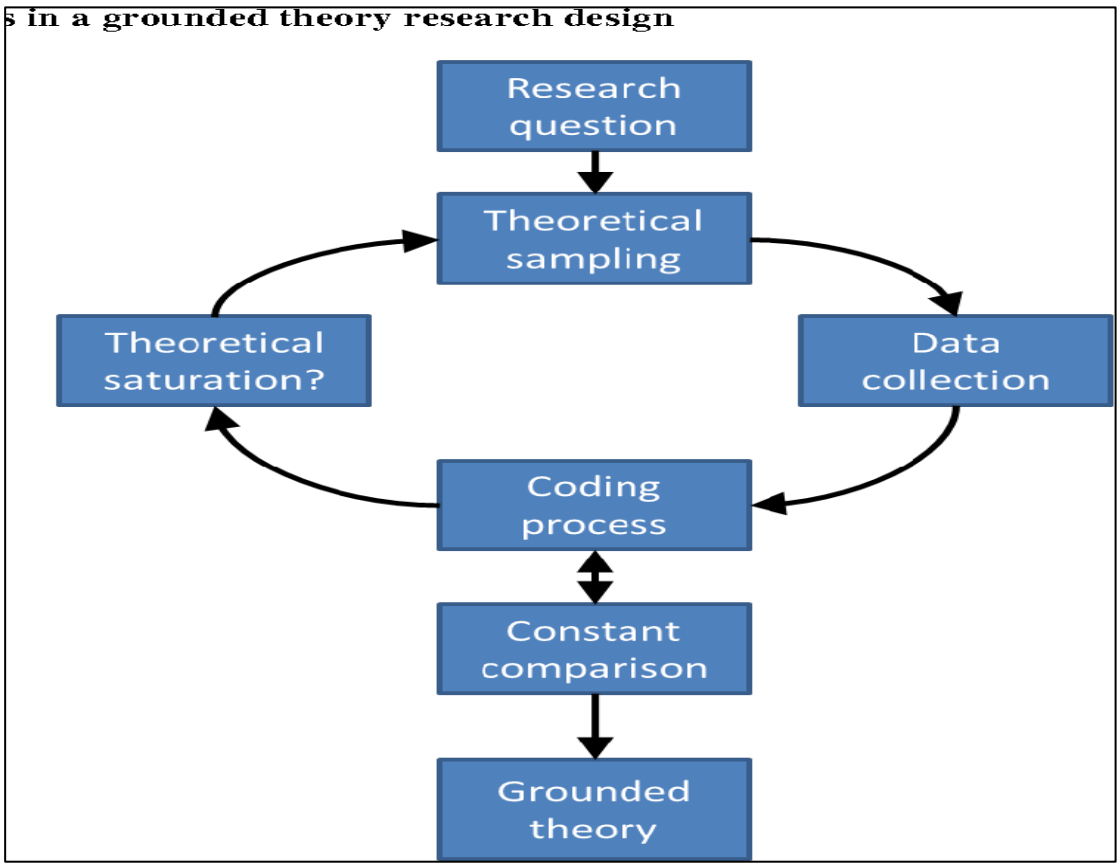


Figure 3-6 Grounded Theory.

Source: G. Allan (2003)

The researchers also review the collected data, and then similar ideas are grouped and classified into concepts or a group of elements that make up the data set. These categories may become the basis for forming a new theory. Thus, in grounded theory, the foundations and work of research differ radically from the traditional method of research; in the method of theory, the researcher chooses the theoretical framework, and only then data is collected to show how the theory may or may not apply to this phenomenon under study.

Furthermore, the grounded theory scheme focuses on an information-gathering approach to construct theory instead of a single test or focus. A researcher utilising a theory-based strategy regularly starts through realise research queries or qualitative data gathering. After that, the data gathered through observation and review via the researcher and frequent insights and then implied / arranged into classifications this, in turn, generates the foundation for a new theory.

Establishing the truth is not one of the purposes of using the foundation theory; However, the most important thing is to focus on the hypothesis whatever the impact of the experimental research.

The advantages of applying grounded theory involve:
(1) Environmental
(2) Creativity
(3) Prudence and theorising their relations.

3.6 Research Methodology

This segment referred to Crotty's second question:" Which methodology determines our choice and utilise of methods?"
Founded on the responses to Crotty's first question, the research procedure is running under the epistemology of the "philosophy of science" and the theoretical perspectives of the "design science paradigm.

3.6.1 Methodology and Method

The methodology indicates the theoretical framework that supports all the available methods from the perspective of finding solutions to research and formulating or approaching the goal to be achieved.
The methodology does not commit to finding solutions; instead, the methodology presents the theoretical basis for an understanding of a topic that can be applied using the method; therefore, what the method does is a set of best practices for finding a solution to a detailed issue.

The methods can refer to the largest procedures followed that remain applicable in specific situations, such as identifying a specific outcome. Methods are the approach to accumulating of utilising data. This might include Discussions, Surveys, Concentration parties, Tests, Case studies, Experimental findings, and electronic information gathering.

Each method differs, so it is important to research the method and study the method before applying it. For example, conducting an interview can be structured or semi-structured. The questionnaire can be multiple choice or else extended answer questions.

3.6.2 Research Methodologies

The interpretivism paradigm (design science) has been selected as the most appropriate paradigm under which this research appropriated. However, research methodologies comprise four elements called in the next sections.

3.6.2.1 Action Research

The extremely commonly utilised belongs to the thinking and approach of applied research generally in the social sciences.
Action Research aims to make a fundamental change in the system for acting and conducting research simultaneously, i.e., at the same time.

This type of research contributes to a great uncertainty at the level of research, which provides an opportunity for society and governments to benefit from improving their strategies and effectively monitoring the business environment.
Although both quantitative and qualitative research methods are used in research and work, qualitative research methods are the dominant feature most of the time.

3.6.2.2 Case Studies

The phrase "case study" has two diverse meanings. It can be used to describe research methodology or explain the social or scientific ground of awareness of groups within the organisation.

However, various definitions described case studies as follows:

- A study method that is frequently applied through social sciences.

- A study plan combined with an experimental investigation that examines a fact in actual-life perspective.
- Case studies remain built on top of intensity review of a specific single unit or else incident.
- An explanatory evaluation of an individual, grouping, or incident.

Case study research is furthermost regularly depicted as qualitative investigation. Qualitative paradigms are wide-ranging besides can include experimental, explanatory, informational, or illustrative seeks.

Cases involve story research, phenomenology, grounded theory, and ethnography. Each methodology is distinctive in method dependent on the ontological and epistemological view; however, all stem from the motivation to explore, seek knowledge, and found the meaning of practices as of the viewpoint of individuals engaged.

3.7 Adapted research methods.

This sector talks about Crotty's primary question "What are the usable methods we suggest using?"
On the foundation of the responses to Crotty's primary three questions, the research procedure is working under the epistemology of the "philosophy of science"," "design science paradigm" is a theoretical perspective, and the research methodology employed the "embedded case study"."

3.7.1 Qualitative research method

There are two ways to collect and study data: qualitative and quantitative research. Covenants quantitative research with numbers and statistics, even as known to qualitative research and rich data including opinions, personal accounts description, words, and meanings. However, all these types of research have various purposes and approaches, and usually, both are important to obtain various types of information.
In qualitative research, the researcher provides further influence on the opinions of the contestants. Yet, the types of qualitative research include case study, grounded theory, descriptive anthropology, chronological and phenomenology.
Qualitative data gathering techniques consists of
Discussions, Focus groups, Case studies, and Literature review.

3.7.2 Quantitative research

Quantitative research is conveyed in statistics and charts. It is used to assess or verify hypotheses and beliefs. This kind of research can be used to create generalizable facts regarding a topic.
Figure 3-7 illustrated quantitative data gathering techniques.

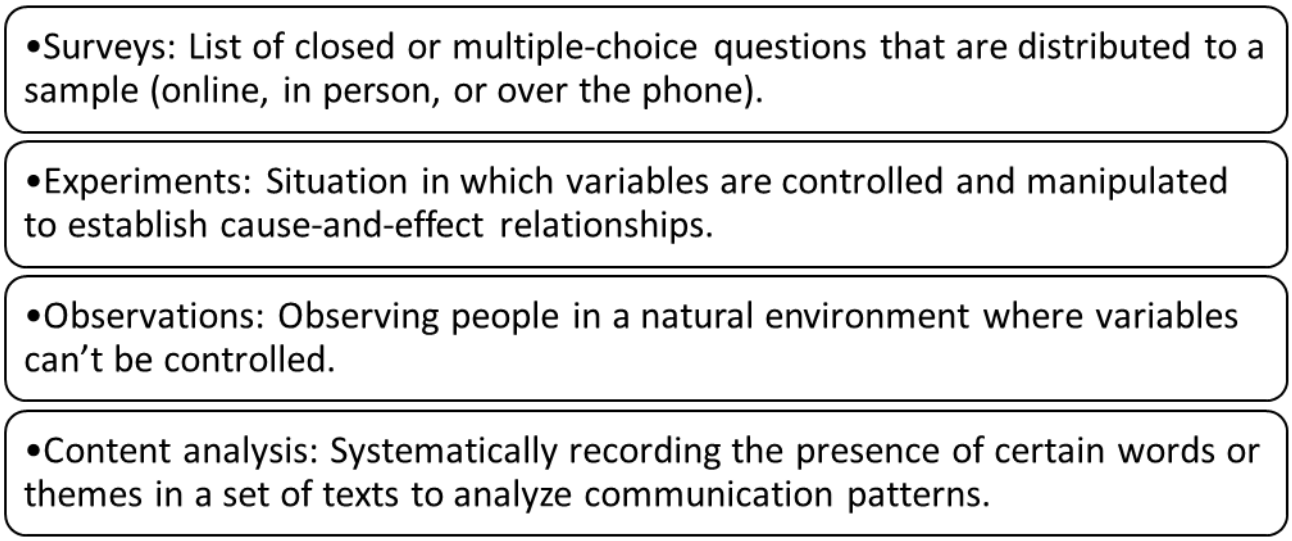


Figure 3-7 Quantitative research

3.8 Research design

Figure 3-8 explains the research design procedure as follows:

Activity1. Define domain and scope.

Activity2. Selecting the e-government system as the use case.

Activity3. Collecting services.

Activity4. Selection services.

Activity5. Developing an OWL-based e-government system

Activity6. Evaluation.

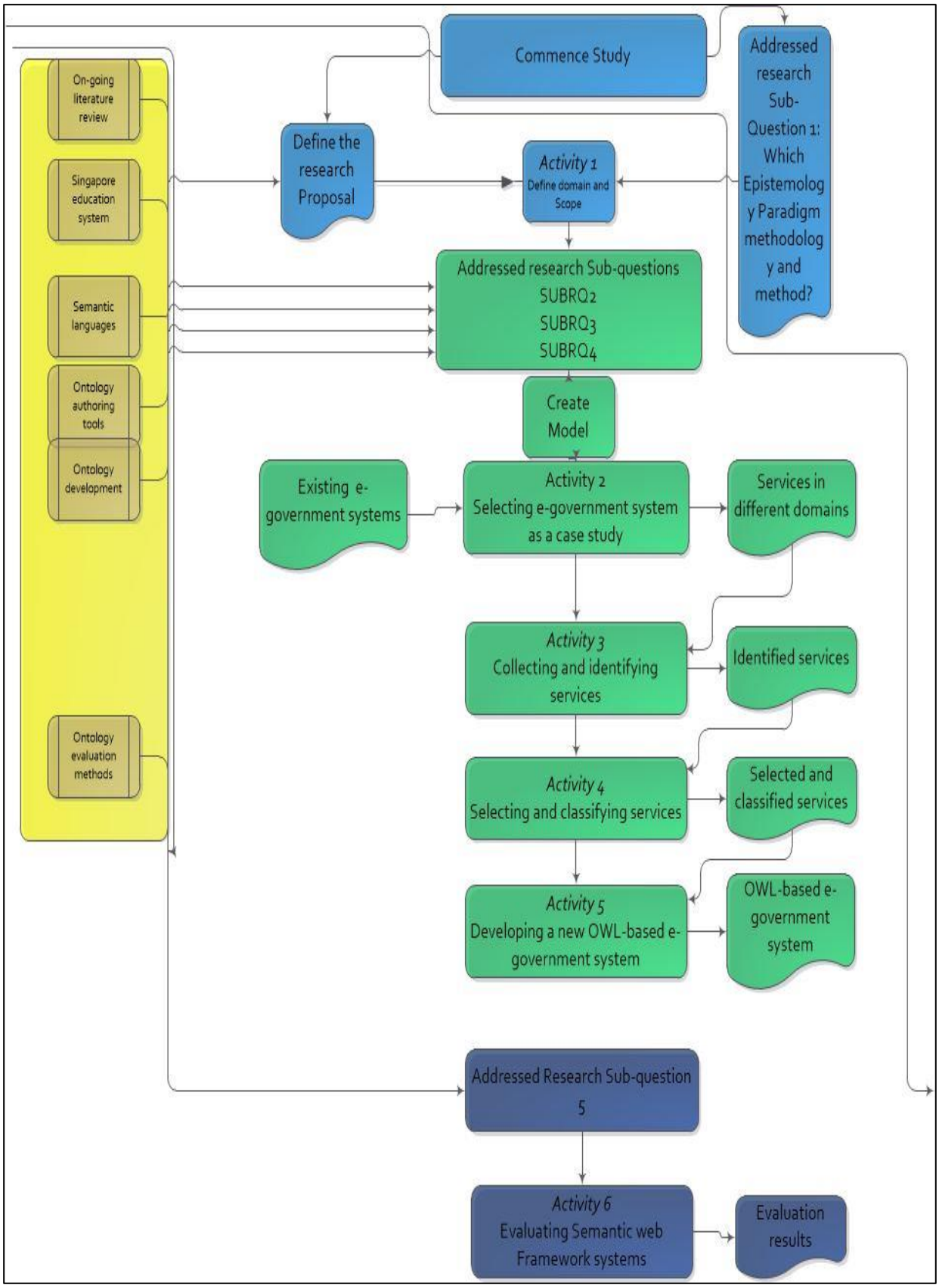


Figure 3-8 Research Design

3.9 Summary

The chapter, consequently, explains the natural nature of research and discusses the theoretical basis of the research concept and expectations. The research approach is mainly recognised by the suggestions carried by Crotty (1998). However, Crotty's approach has been broadly supported by many social science researchers, for several years.

Crotty, 1998 suggested that in establishing research, it is necessary to put considerable effort in replying quatern questions regarding what technique, approach, and theoretical perspectives.

The research philosophy highlights a sequence of beliefs linked to the environment of the realism that has been examined.

Where the research model (paradigm) is a research approach or model that is conducted and verified by a group of researchers; then, it is used and assessed on purpose for an expanded period.

The methodology of DSR is based on the outcomes of information technology, which offers specific rules for assessment and replication in research projects.

Scientific Research Design is a comparatively innovative method to research to construct a modern existence.

The foundation of theory (GT) is a methodical methodology in social sciences that involves building theories through systematic collection and data analysis.
Given that the interpretivism paradigm (design science) has been selected as the most appropriate paradigm under which this research appropriated.

On the foundation of the responses to Crotty's primary questions, the research procedure is working under the epistemology of the "philosophy of science"," "design science paradigm" is a theoretical perspective, and the research methodology employed the "embedded case study. "

For the research procedures to accomplish the study, six research activities were employed, including defining domain and scope, selecting the e-government system as the use case, collecting services, selecting services, developing an OWL-based e-government system and, evaluation.

4. Chapter 5 Service Collection and Identifying Services

There is an urgent need to prioritise the services provided by the e-government to reach the promotion of services in terms of priority to appear and test the services of importance to use them in the system to be developed and adopt the service as a case study.

Currently, in attempting to increase the opportunities of achievement of e-government, by presenting services in a further use, high performance, and easily accessible approach, nearby remains a pressing need to search for new, suitable technology, which serves aspirations of delivering services.

Despite the great technological development, there is an ever-increasing diversity and demand for services provided by e-government.

This part seeks to provide a technology approach based on the selection and promotion of quality services provided by e-government. So, allowing enhancing the distribution of services in the e-government system.
Meanwhile, a qualitative (i.e., survey) and quantitative (i.e., mathematic metric) approach was applied to identify the value of public services in the e-government system.

The approach had arranged and classified the various services according to the importance of their appearance and demand. Identifying the domain and selecting services are the two main activities that describe the process of identifying the quality of the services.
This chapter describes the services providing by e-government to characterise the data entry of the e-government environment. Even so, selecting services from an extensive set of services must involve standards of eligibility.

The main characteristics of this chapter are still distinguished in the attempt to respond, search, and obtain answers to the binary sub-questions:

- What method is used to select e-government, and what services represent the domain?
- What services that consider most requested by e-government users?

4.1 Services collection Background

There are several surveys that get dedicated to the selection of services provided by e-government. A set of research studies used a certain technology; others had focused on a service in a specific country prompt.

Table 4-1 illustrated several methods adapted by various researchers towards collect services. The table represented references, a method adapted to collect services, and the gap in the followed approach.

Table 4-1 Selecting Service Method Review

Research Reference	Method Applied	Missing in Method abstained
Venkatesh et al (2012)	Assessment Essential Services/Survey	Public services/Specify attributes (i.e., serviceability technical assistance) for services collection.
Krishna et al (2009)	Assessment of supplying local services utilizing SOA Method	Public services/reprocess of local services recognition
Mettler et al (2017)	Structure applied in e-health	Finding services/ Public services
Angelopoulos et al (2010)	Influence of gender/stage for arranged the nominated of e-government services through survey.	Finding services/ applied in specific area.
Weerakkody et al (2016)	Issues of achievement deploying innovative service	Public services/discovery services
Yildiz, M (2007)	Effect of knowledge value on service customer fulfillment	Identifying public services
Lee, J (2010)	Position of confidence in realizing the use of public services concerning Africa collected data through interviews and survey.	Public service identification/ priority of displaying services
Zhang et al (2014)	Survey to collect data services built on person-services.	Public service description
Plattfaut et al (2013)	A hypothetical paradigm assessment e-health service through meetings discussions	Offering Public services/theoretic steps.

In Table 4-1, it should be noted that there is a range of research-related work provided frameworks and guidance as well as evaluation of services. However, many types of research focused on citizen satisfying.
Meanwhile, many of the research questionnaires were used in the measurement.
It is also noted that most of the adapted methods used qualitative, a few numbers of research had combined between the qualitative and quantitative approaches in selecting services.
Moreover, none of the offer mention researches had given a detailed description of the content of services provided by e-government or provided full services that any of the e-government systems might include. Also missing the classification and arrangement of services that can provide using a specific principle or property such as the priority of the appearances.
Many types of research were focused on a service such as e-health in specific government, as largely ignored of providing services to the public.
Considerable attention on the assessment of public service was evident in researchers' attitudes, specifically, citizen satisfaction. However, although it is important to satisfy the citizen requirements as an important element in reaching better service quality, there is clear neglect of empirical studies with greater emphasis on frameworks and guidelines description work.
It also noted that the questionnaire to obtain citizen views has been used on a large scale. In fact, another approach can be used to select services, for example, a mathematic metric.
This research is characterized by providing a complete and comprehensive description of the services offered through any e-government. Additionally, it arranges and classification services according to the importance of their appearance.
This presents the opportunity to select and promote a range of services and allowing providing services effectively.

4.2 The Procedures Approach in Selecting of Services

The procedures approach in selecting services enhances the utilization of both survey and mathematical methods to prioritise and select various services. The goal is to focus on citizen satisfaction in addition to reuse and arranges services offered by e-government case studies. Certainly, promote and highlights services according to their importance on appearance.
Moreover, Qualitative shows in a survey, which is meanly designed to display the different views of a group of respondents, express their opinions for the quality of the services. Additionally, it shows the order and the importance of the appearance of the services. Quantitate approach; simply will reuse services found in various e-government case studies. However, the selection or reuse of services is established upon a statistical measure that evaluates the existing services' importance, so arranging the services respectively according to the importance of their appearance.
Figure 4-1 describes the approach that will follow in the research; the procedures activities are described as follows:

- Collecting and identifying the domain of services.
- Classifying the services.
- Applying three selection approaches to services.
- Analysing and evaluating selected services.

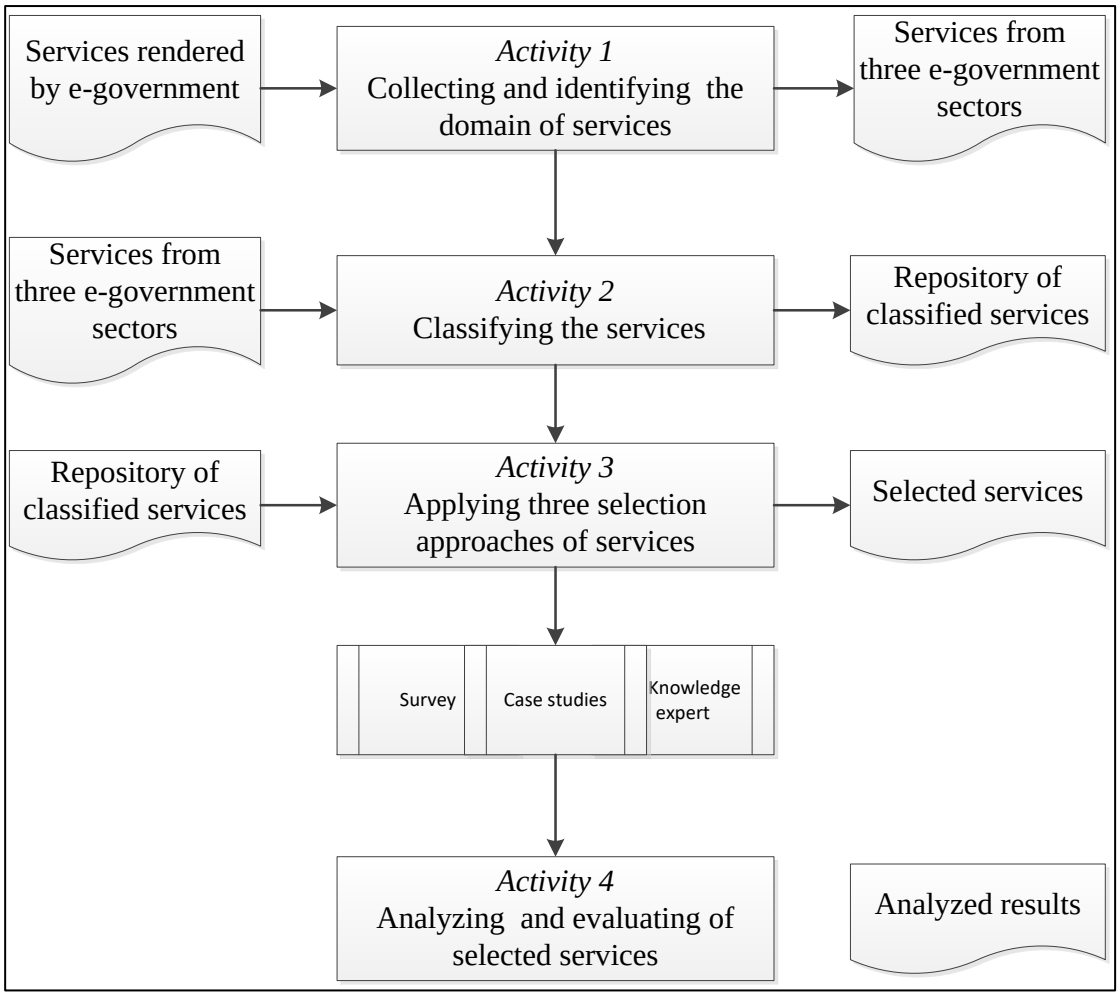


Figure 4-1 Approach in selecting classifies services.

4.3 Service Collection and Identifying Services

Defining public services offered by E-government is represented in the data entry of the e-government environment. Even so, selecting services from an extensive set of services must involve standards of eligibility.
The most important criterion for the selection of services is the compatibility of the delivered services with the aspirations of the user and determine the upcoming public service in the future.
E-government will, therefore, offer a pragmatic study of the most demand services, allowing improvements to the delivering services.
Both defining general services and selection of services are the main activities that are described in the process of nomination of the services.

4.3.1 Defining General Services/Domain Services

There is no restriction of services supplied through e-government (UN survey, 2016). However, public services comprise personal information, traffic, payment of bills, election voting information, education data, taxes, and immigration/resident information.
The gathering and classifying of different services plays a significant role in making the services appear more understandable and clearer.
There are several methods when organising services in e-government. Some of the methods described as:

1. Group-based services; where there are general nature services to serve the common public and the others directed to specific individuals' needs.
2. Single types of service; for example, payment, and query services and so on.
3. Service-oriented; meaning that there are government-oriented services that the government applies to the citizen or business.

In the research study, which will comprise scores of services, the services are classified into three groups as follows:

- Services that are part of the government sector, described in Figure 4-2.
- Services which are characteristic of the private sector, described in Figure 4-3.
- Community services.

On regards the types of services, the description of delivered services shows as follows:

- Documented data such as rules, cost, legitimate and documents.
- Transactional services online which describe services and financial transaction on the web.
- E-Consultation that defines the layout, implementation, and utilization of civilian employment tools. Additionally, conveys the Citizen response regarding the progress of their public services.
- E-decision making, for example, participation online in procurement announcements, Policy available online, and Calendar available online.

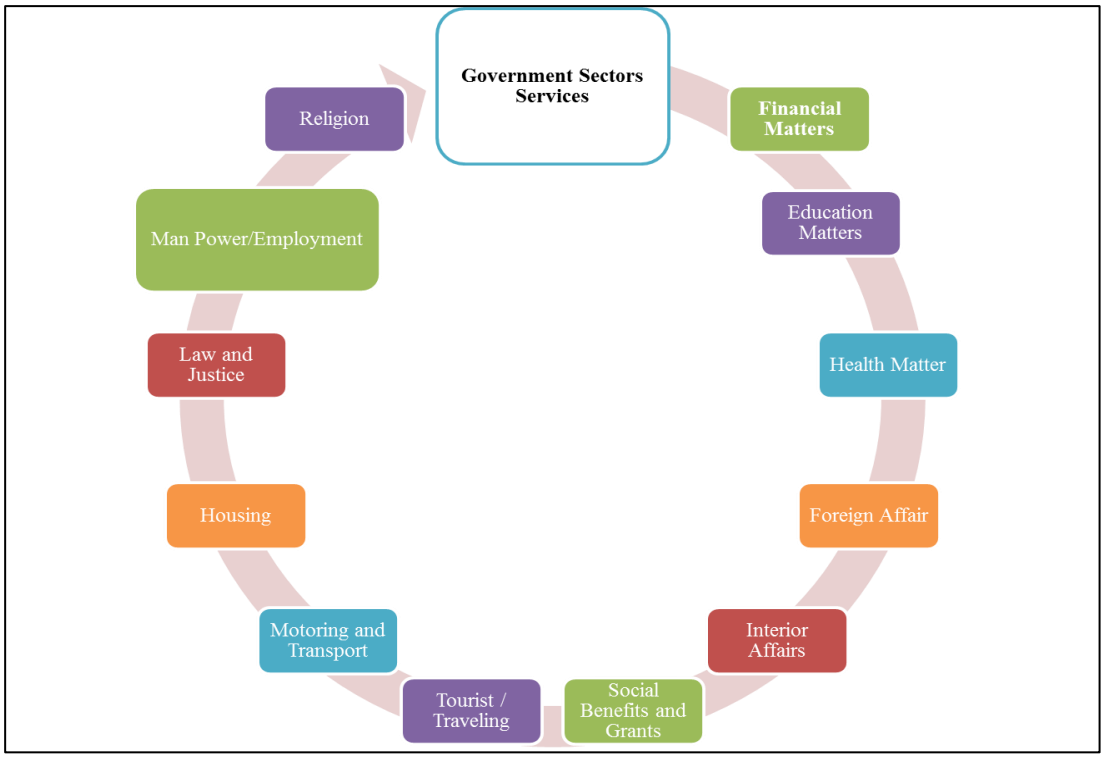


Figure 4-2 Government services Categories

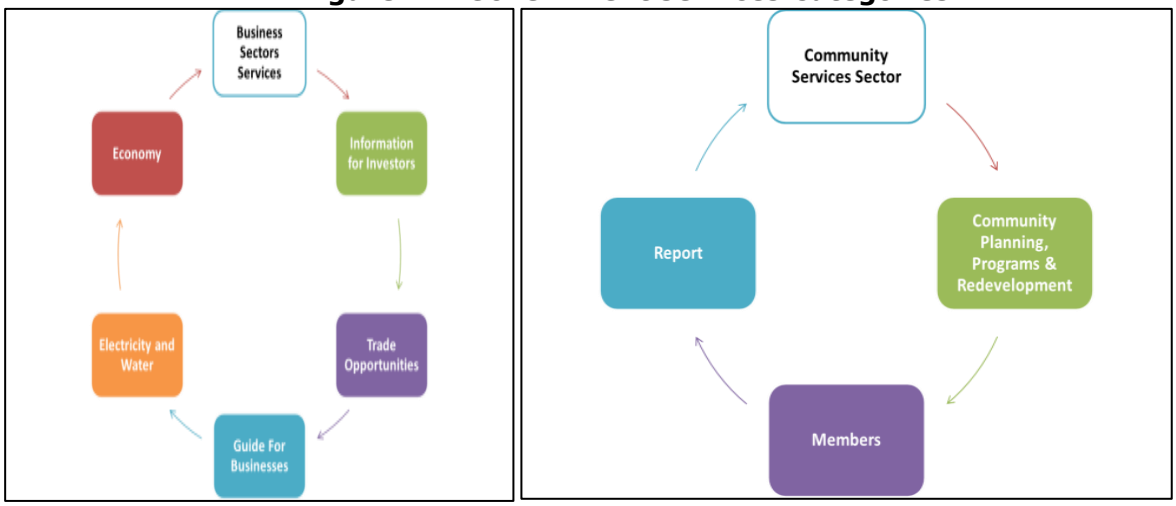


Figure 4-3 Business and Community Services

4.3.2 Selection of Services

The needs for the selection of services occurs due to the reasons are shown below:

1. Many general services can be presented to citizens, making it difficult to include all these services within a single portal.
2. The need to determine the priority of services'; so, utilising services in circumstance assessment to examine the value of the services.
3. Making an informed selection of services, to avoid duplication.

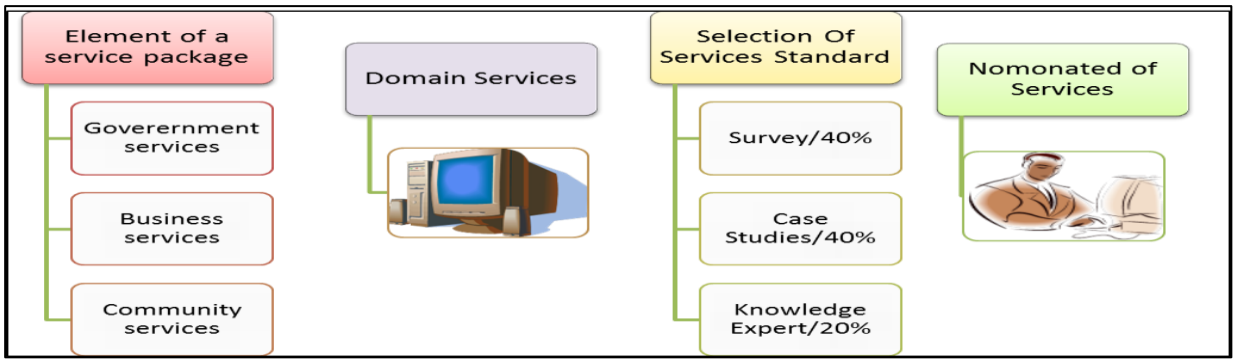


Figure 4-4 Theoretical model

The selection process is aimed at giving priority to the services provided instead of consideration to reducing the number of representatives of services see Figure 4-4. The mechanism clarifies the relevant criterion used in selecting services. However, the suggested method estimates a hypothesized number of candidate services to be placed in the simulated e-government environment. The candidate services have been selected based on the described mechanism. For example, if ten services have specified an estimated number, four data entry services will be selected based on service reusability (case study).

To avoid the selection iteration, the chosen service will be omitted from general e-government services (domain service).

Table 4-2 summarizes the mechanism followed in selecting the service. Both surveys and case studies occupy eighty percent of the selection. The government sector represents the largest number of services. Some points are clarified as follows:

- The number of the domain of services to be selected is 10 of the 20 domains.
- Services are divided into three sectors. Each sector is represented in relative terms according to the type of services that provided the number. For example, the governmental structure/category represents six domains, while business has three domains and community service remains a single domain.
- A frequency service means the emergence of a priority service which moves on to the next service sequence.
- Instead of a description of the item, an item or service is the factor used in the selection process. This facilitates and enables the selection style to be clearer and easier.

Table 4-2 Number of collection services for each category

Framework	Service Category			Total
	Government Sectors Services	Business Private Sectors	Community services	
Survey	3	1	1	4
Case Studies	3	1	1	4
Knowledge Expert/Research		1	1	2
Total	6	3	1	10

4.4 Major accomplishments /Significant Results Obtained

In the next section, finding the candidate services will explain, showing collecting and identifying the domain of services follows, the survey process, case studies and knowledge experts, results and their discussion will be provided.

4.4.1 Collecting and identifying the domain of services

Figure 4-5 shows the domain of services and describes several of the public facilities which be able to deliver to the customers of e-government. Most of the public services belong to the government sectors. For each subdivision of service, more facilities are displayed. For example, the visa service shows the types of visas to their users.

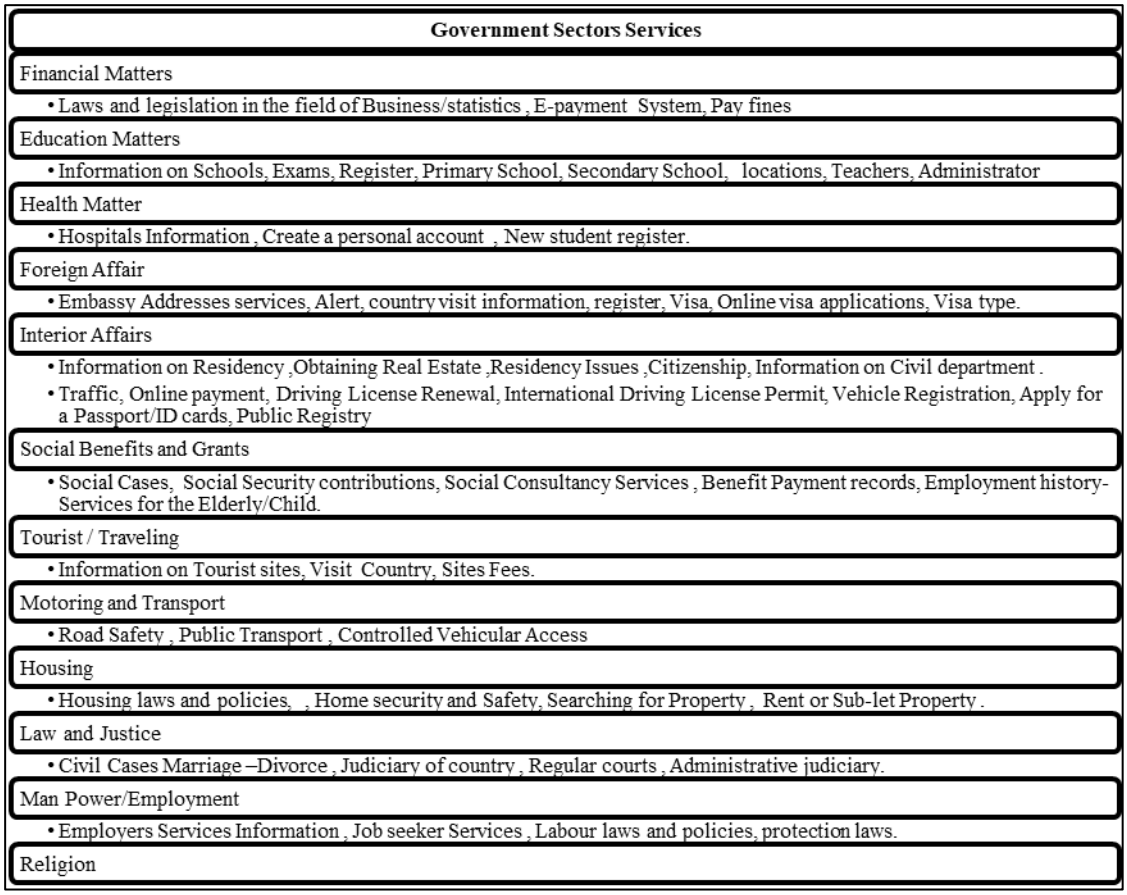


Figure 4-5 Government services

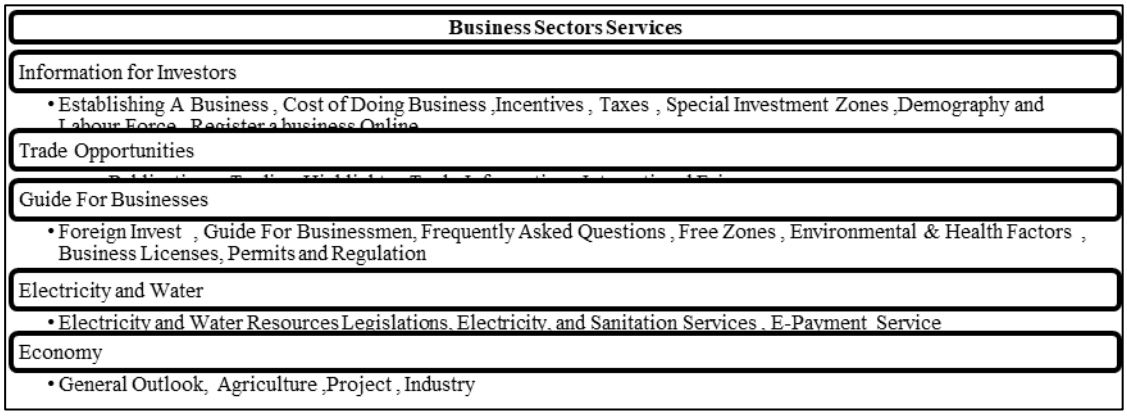
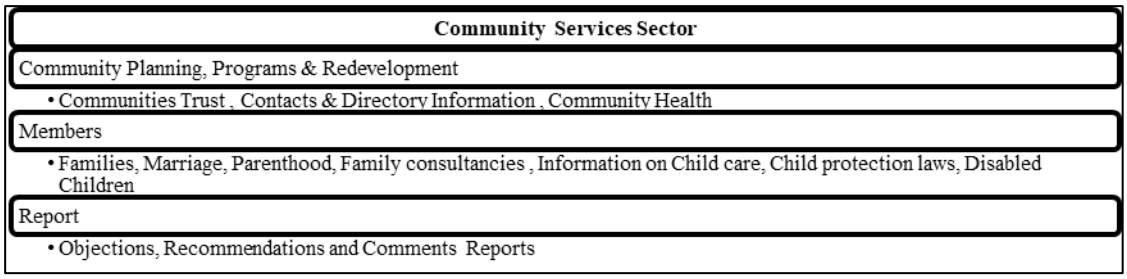


Figure 4-6 Domain and Describes of Services



Some comments and observations are shown as follow:

- The characteristics of the services provided are shown for each item.
- Services described in Figure 4-6 are certainly not final or fixed; a range of different government services can add.
- The largest number of services represents the services that are relevant to the government. However, this represents the logical consequence of authority's responsibility concerning the establishment of different public services.

4.4.2 Survey

The survey is designed to identify the most valuable services according to the target audience and attempt to obtain a range of views on assessment and measurement of the structure of e-government.
The total number of the questions in the survey is ten; the questions are divided into three categories:

1. Some basic information describes the stacker of the survey and the extent of his/her knowledge of services supplied through e-government. There is also, an assessment of the quality of the delivery of the services. This allows the finding and evaluation of the various services offered through e-government.
2. Questions that distinguish the highly valuable/requirement services according to the target audience. The primary axis of the questions will help identify the various services and priorities arising from the perspective of the reply.
3. Assesses the e-government system. This aspect will serve the study in the part of the evaluation system.

The Issue which is significant to mention that the target audience in the questionnaire naturally represents different sectors of society from various countries. Also, it has been communicated in different ways, including social media, smartphones, and e-mail.
An online survey was created together with responsive questionnaires using Smart Survey, which is considered "The UK's Leading Online Survey tool," according to supervisors of the software.

4.4.2.1 Survey Result

Figure 4-7 and Figure 4-8 indicates the major services that have been selected or given priority in the opinion of survey responders. The selections of services belong to government services, business information services, and community service.

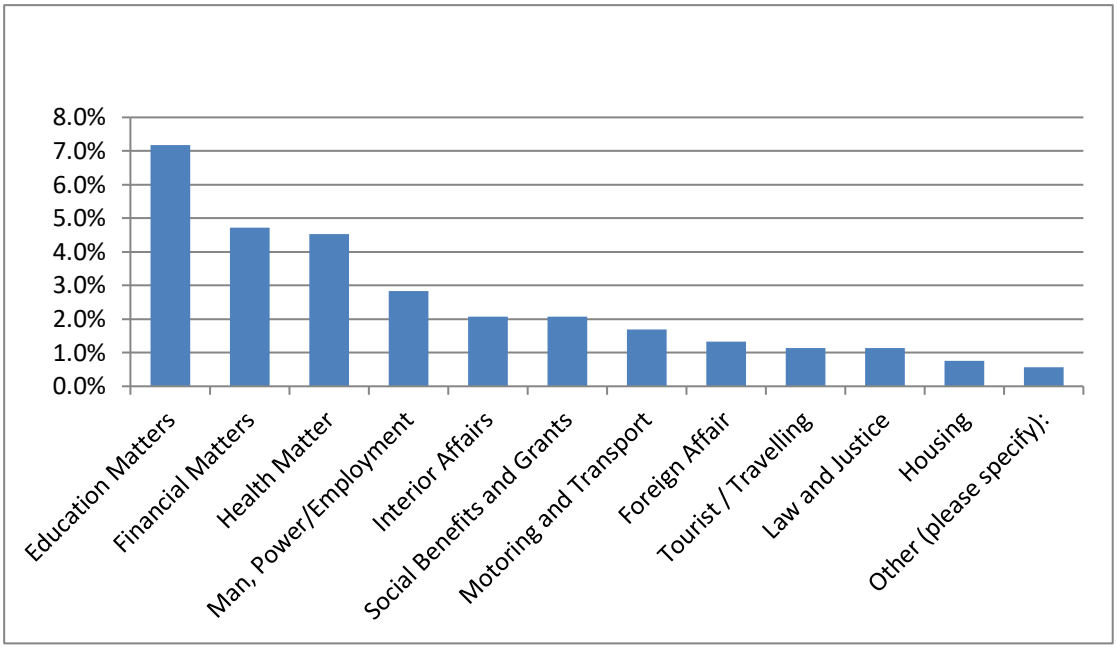


Figure 4-7 Survey Major Services

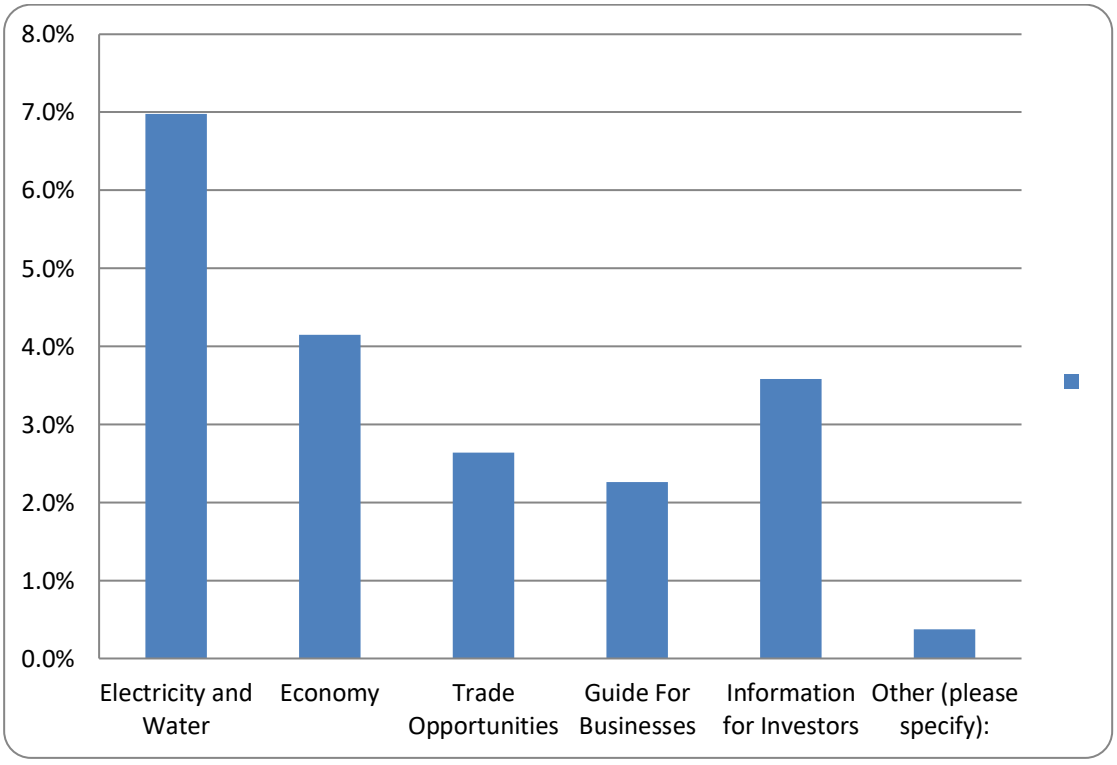


Figure 4-8 Survey Major

Following are the most important services based on the results of the survey:

- Education Matters
- Financial Matters
- Health Matters
- Electricity and Water

- Community Health, Contacts & Directory Information (To be nominated at the end of the process).

4.4.3 Case studies

The case study is the second method designed to provide services using different technologies. This method focuses on reusing some of the public services offered through accessible e-government.
Three of the government/ranking's provisions were selected to represent the experiences of electronic cases to select services. These experiments have been selected based on specific criteria represent the following:

1. Represent the same group/region. The approach provides a service nomenclature and explains it in a way that can compare services with each other.
2. The level of services rendered by the cases. Therefore, services are classified as medium, good, excellent. This reference system is used by United Nations e- governments for offered/ provided services.

Based on the above criteria from governments or situations the three rankings used are

1. Singapore-ranked four in UN report 2016, plus eight in E-Participation Index out for the count of 193
2. Bahrain-very high Ranked in the region located as first in the GCC.
3. Sultanate of Oman-high rated 66 in UN report 2016, out of 193.

In UN Survey 2016 described in chapter two, the survey is prepared specifically to focus on the evaluation of the performance of various electronic governments instead of giving a description of the electronic services. Therefore, it has been used this study as an indicator and classification of countries.
Among other aspects described in the report, online assistance distribution and e-involvement are items in the accredited index as indicators of the evaluation and ranking of countries.

4.4.3.1 Method of measured/selected services

The electronic service sector indicator of the e-government is a guide assessing the usage of a variety of public services through governments towards providing public services at the state stage. It is built on offering public services as of the cyber occurrence of the entire tierce countries.
The index assesses several services instead of the technical features of national websites for the delivery of services.
The following mathematical equation was used to calculate/scale several of the services provided by e-government in the cases of the three states:

Priority Index of the services (PS)= 1/3 (∑ (Indicator of services (IS)+Number of services (NS))/ (Total Number of the category Item of Services))

The indicator (IS) describes the delivered Service in each case study. It includes Archived information, transactional service, discussion, and assessment. The scale specifies the variety of services by the extent that it contains every item in the index.
The index has been calculated by adding a fixed number, either 2 or 1, to give or reflect the service type.
The fixed number represents the average quantity of facilities that have been supplied by the three governments in the division with the sum of objects (services) labelled. For instance, the overall total of government facilities is 12, while the business sector is 5.

The (NS) indicates the number of services offered in each case study for a particular item. The results are recalculated and presented in the form of a series of values ending with the number four and starting with the zero, which represents the least standard of services, while certainly, the numerical index occupies four possessing the highest standard value of services.
In detail, the equation which has been described earlier is an attempt to arrange services concerning their importance for the three countries. So, a measure of the importance of each service was set using the two below indicators:

1. The number of services provided.
2. The nature or type of service.

Reliance on the basis of the importance of the service index is an increase of services available from the e-government and the diversity of services. Both indicators will prove the importance of service.
As described, the index does not give an absolute measure of services. On the contrary, it is a measure of the immediate services provided that are subject to continuous change from one period to another. It also gives the set of services provided by the three countries for services. Index values are intended for absolute measurements. Therefore, the index can be considered a tool for comparison, with a high degree of measurement concerned with finding an indication of current best procedures instead of the accuracy of perfection.

Finally, the method employed represents official case studies of E-governments websites and deals with selected case studies.

4.4.3.2 Result case studies

Table 4-3 shows the order of the priority index of the domain public services offered in the three cases of the government sector. The Education domain has the highest number of services (i.e., 13.6%), while the financial domain has the lowest number of services (i.e., 6.1%). Education forms a priority for the governments of Bahrain and Oman, while the health sector dominated the attention of the Singapore government. The Financial matter had the lowest share of the services between the two governments Bahrain and Oman.

Table 4-3 Priority index of the domain of services in government

Domain of Services	Case study			Priority Index of the domain services (PS)
	Singapore (PID)	Bahrain (PID)	Oman (PID)	
Education Matters	16 (9.7%)	14 (17.3%)	11(13.8%)	13.6%
Health Matter	22 (13.3%)	10 (12.3%)	7 (8.8%)	11.5%
Motoring and Transport	14 (8.5%)	12 (14.8%)	7 (8.8%)	10.7%
Manpower/Employment	18 (10.9%)	8 (9.9%)	8 (10.0%)	10.3%
Interior Affairs	13 (7.9%)	10 (12.3%)	8 (10.0%)	10.1%
Law and Justice	10 (6.1%)	8 (9.9%)	10 (12.5%)	9.5%
Housing	19 (11.5%)	2 (2.5%)	8 (10.0%)	8.0%
Social Benefits and Grants	20 (12.1%)	4 (4.9%)	5 (6.3%)	7.8%
Tourist / Travelling	7 (4.2%)	3 (3.7%)	9 (11.3%)	6.4%
Foreign Affair	10 (6.1%)	6 (7.4%)	4 (5.0%)	6.2%
Financial Matters	16 (9.7%)	4 (4.9%)	3 (3.8%)	6.1%

Total	165 (100%)	81 (100%)	80 (100%)	-100%

The order of Priority Index of the domain services in the Business sector is described in Table 4-4. There is a clear affinity for priority services for both Information for Investors and Trade Opportunities. Information for Investors has a great interest to the Government of Bahrain (i.e., 36%).

Table 4-4 Priority index of the domain of services in the business sector

Domain of Services	Case study			Priority Index of the domain services (PS)
	Singapore (PID)	Bahrain (PID)	Oman (PID)	
Information for Investors	12 (22%)	16 (36%)	7 (23%)	27%
Trade Opportunities	16 (29%)	10 (23%)	8 (26%)	26%
Guide for Businesses	10 (18%)	8 (18%)	7 (23%)	20%
Electricity and Water	10 (18%)	4 (9%)	4 (13%)	13%
Economy	7 (13%)	6 (14%)	5 (16%)	14%
Total	55	44	31	(100%)

Community Planning Programs & Redevelopment Occupies a significant difference by the priority index in the community sector, as shown in Table 4-5.

Table 4-5 Priority index of the domain of services in the community sector

Domain of Services	Case study			Priority Index of the domain services (PS)
	Singapore (PID)	Bahrain (PID)	Oman (PID)	
Community Planning, Programs & Redevelopment	10 (63%)	2 (40%)	6 (75%)	59%
Members / Report	6 (38%)	3 (60%)	2 (25%)	41%
Total	16	5	8	

Table 4-6 reviews the quantity of facilities services to each sector in the three cases. Again, Singapore is clearly superior to the rest of the governments. So, Singapore can be singled out as a comparative case for its diversity and several services provided, along with improving the e-government Index in UN reports, ranking fourth out of 193 governments.

Table 4-6 Number of Services in Case Studies

Sector	Number of domains (Percentage ratio per sector	Case study			Total services per sector
		Singapore (Percentage ratio per sector)	Bahrain (Percentage ratio per sector)	Oman (Percentage ratio per sector)	
Government	11 (61%)	165 (51%)	81 (25%)	80 (25%)	326
Business	5 (28%)	55 (42%)	44 (34%)	31 (24%)	130
Community	2 (11%)	16 (55%)	5 (17%)	8 (28%)	29
Total	18	236	130	119	485

Based on the mechanism followed in selecting the services, the eight domains of services are described in Figure 4-9.

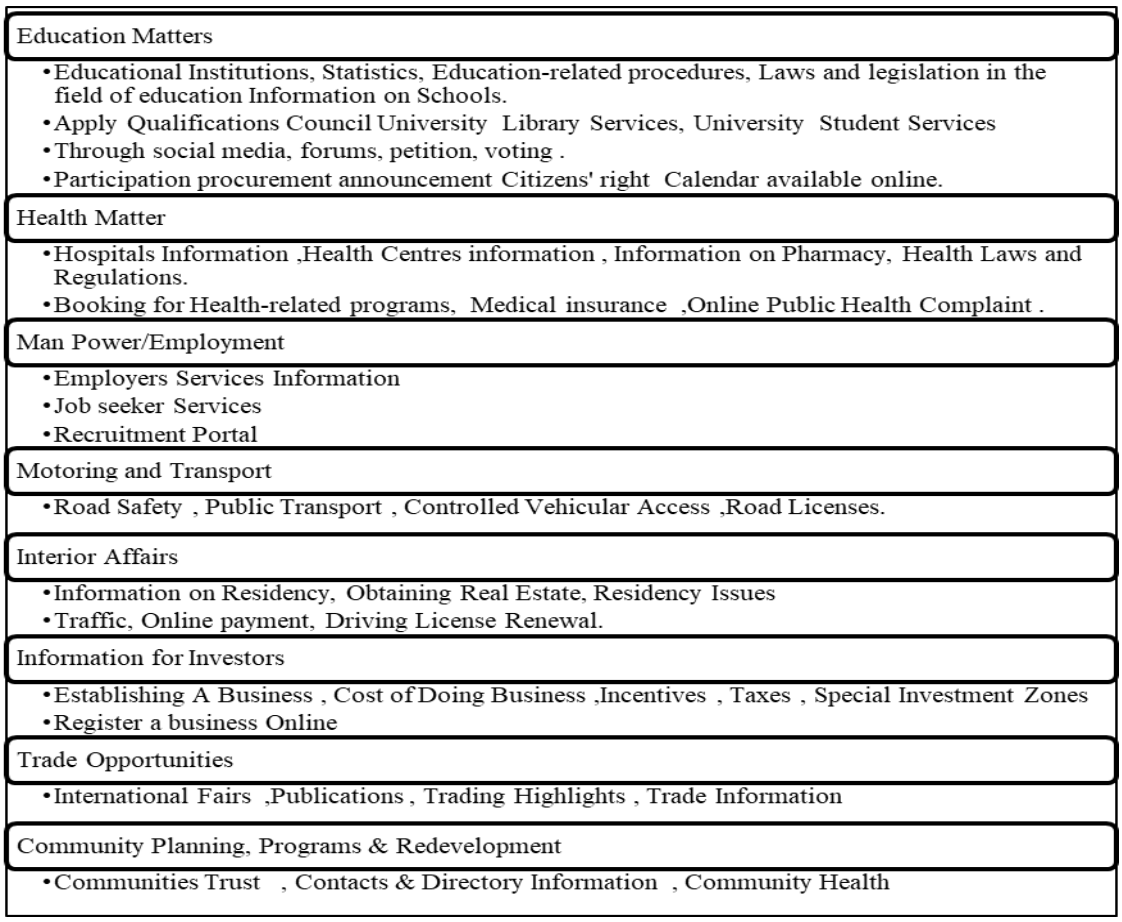


Figure 4-9 Selected domains of services.

Figure 4-10 shows the distribution of the categories along with the overall sum of public services. In the education domain, most of the services (i.e., 23) are information services, while few services (i.e., 2) are consultation services.
Regarding the type of services, the data facilities have the highest number of services compared to other services, while e-decision making has the lowest number of services. Most of the transaction services (i.e., 10) belong to the interior affairs domain, while few services (i.e., 1) belong to the motoring and transport domain.

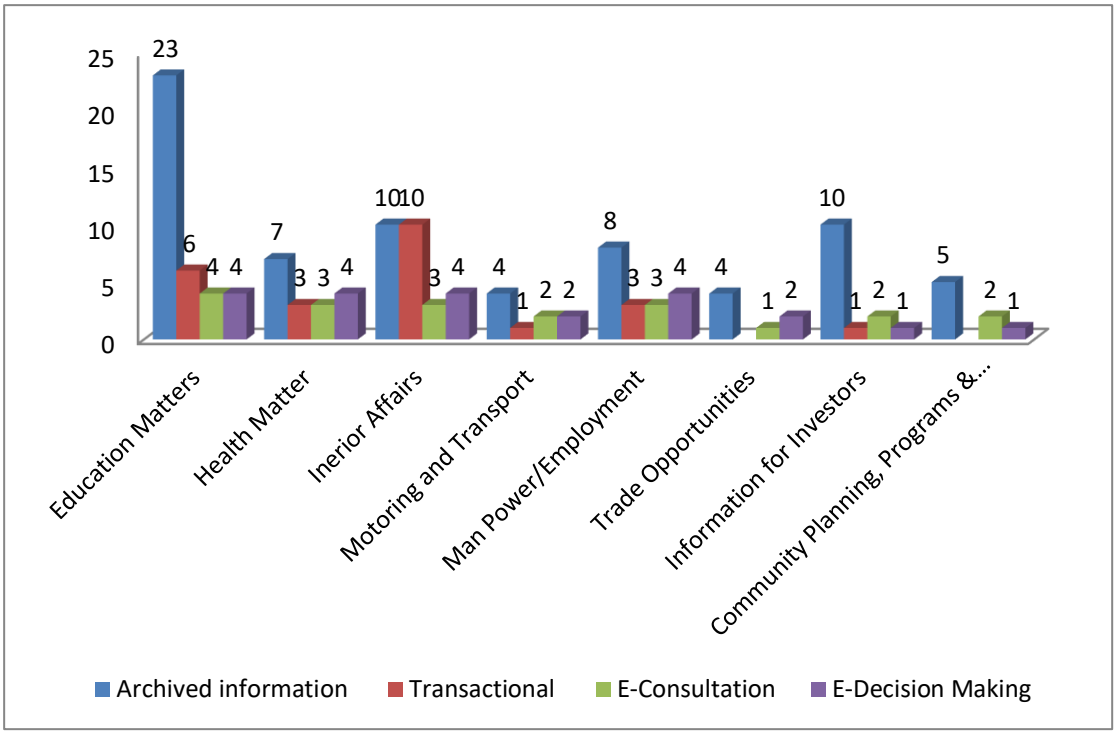


Figure 4-10 Classified Services.

Figure 4-11 shows the primary services which were identified as a priority in the three governments. The services selected belong to government services.

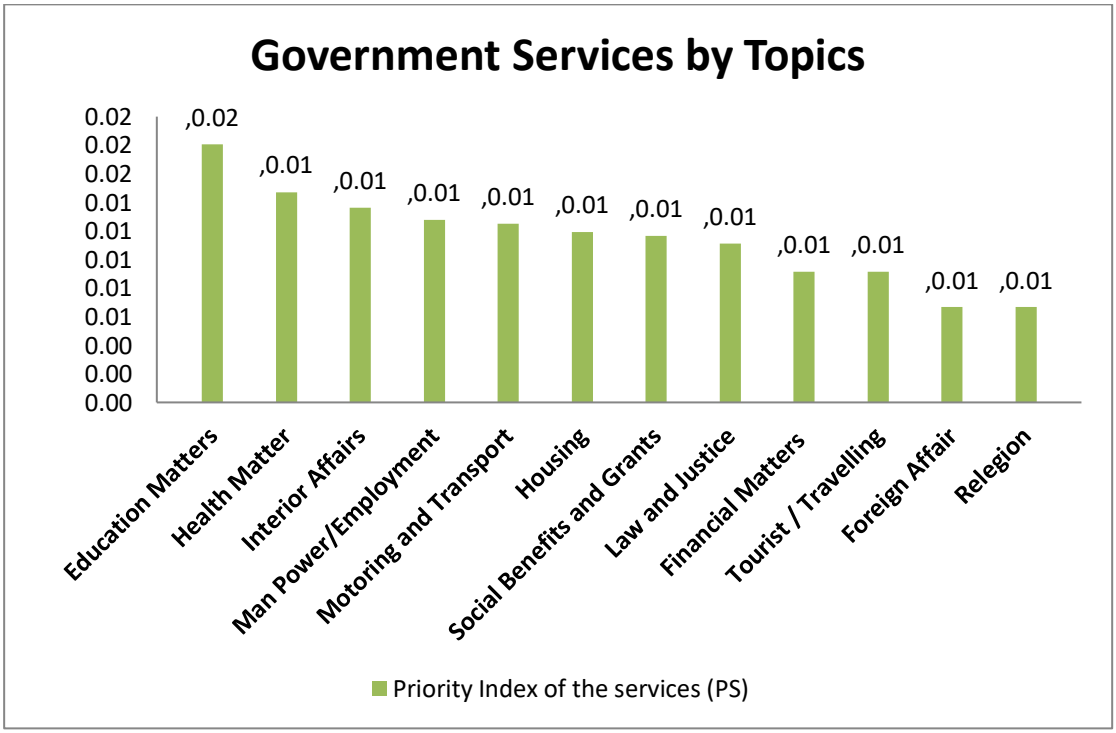


Figure 4-11 Priority of Government

Concentrated on the mechanism used besides to the results of the case study, the candidate services which were selected are listed in order, as follows:

- Education Matters
- Health Matter
- Interior Affairs
- Manpower/Employment
- Motoring and Transport
- Information for Investors
- Community Health, Contacts & Directory Information (To be nominated at the completion of the method).

4.4.4 Knowledge Expert

The familiarity expert or the views of the exporter represent the third method of selection of services. However, the method will be more sophisticated use in the evaluation process rather than the selection of services.

The method employs both the survey and personal interviews to get the expert's views. According to the mechanism used, the services to be examined are two services distributed over the business and community services.

Experts show the order of the Business services, built on the goal of assessment, the Electricity and water sector has the largest space while both investor and business guidance appear on the same interest information.

4.4.5 Putting All Together

Based on the following mechanism, which applied the three methods in selecting services, the ten services were picked are presented in Figure 4-12.

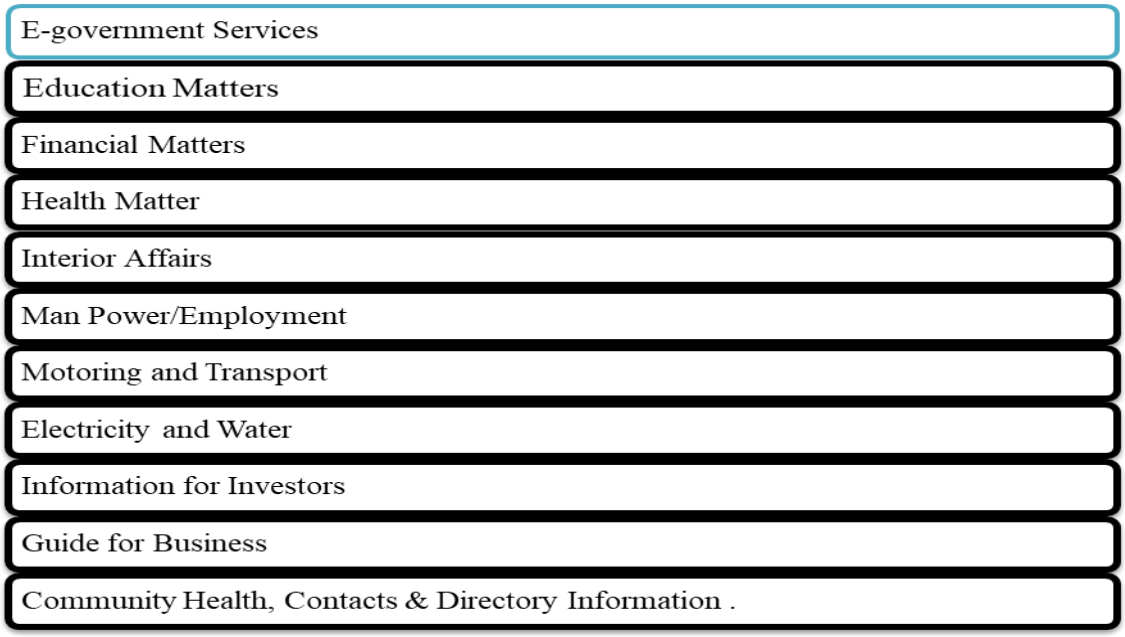


Figure 4-12 The Selected Services

4.4.6 Analysis and Discussion

The following summarizes what has been observed in regard to the survey:

- The number who downloaded /completed the survey was 53, spread over six countries or electronic governments, mostly from Oman.
- The priority was establishing the diversity of the selected services supplied by e-government, as it is considered in place/location.

- The value of the responses was the most important. This factor received more attention and consideration than quantity.
- Access to high-quality information occurred by distributing the survey to those who have some idea about the electronic government and its services. This explains that the percentage of 17 belongs to experts knowledgeable in the field.
- In a question related to the degree of customer approval by the excellence of customer services, half of the number indicated confusion between acceptance and rejection. While 22 percent considered the quality of services was low. This shows a shortage of trust or satisfaction over the value of services.
- Selected services were culled from the view and the orientations of the completed survey, which represent the impressions of the responders. For example, when most of the questionnaires are completed by employees, it is not unlikely that their concerns differ from those of the workforce.
- In the government, the educational services segment received much greater attention than the rest of the services. It occupied about half of the aspirations and concerns of the respondents.
- There are some services far removed from the respondents' concerns, such as Interior Affairs, which contain traffic and immigration services. This might be a surprise, perhaps because those services were not clear or were too distant from the concerns of the responder to identify the service.

On regards to case studies following summarizes what has been observed:

- The results show high compatibility with the services indicator of the "UN E-Government Survey 2016". A correlation between the results or the services index and the most interest in the services or applications to the three governments was also noted.
- In Oman, Web Site is mainly a content of archives documents place along with missing transactions services or e-contribution. Data offered was fixed; however, the portal provided general information about activities. Both the Ministry of Education and the Ministry of Manpower gateway – an excessive gateway, regarded in the highest 10 locally, include e-dealings.
- These observations or drawbacks were greatly improved with the Governments of Bahrain and Singapore, respectively, where more emphasis was placed on the qualitative sense of participation and real services, lesson information or simply on the presentation of a text.

4.5 Summary

Arranging and classifying the various services according to the importance of their appearance and demand is considered one of the methods approaches that can be relied on in the delivery of services.

This research chapter focused on collecting data (services) provided by e-government according to the procedures approach in choosing services.
The approach used is characterized as a complete and comprehensive description of the services provided through any e-government. In addition, it ranks services according to the importance of their appearance.
The goal is to focus on citizen satisfaction as well as reuse and rank services provided by e-government case studies. Promoting and highlighting the services according to their importance in appearance.

According to the approach taken, a qualitative questionnaire, designed to present the different views of a group of respondents, expresses their views on the quality of services. In addition, it shows the order and importance of the appearance of services.

A quantitative approach would reuse the services found in many of the e-government case studies. However, services are identified or reused based on a statistical measure that evaluates the importance of existing services, so the services are ranked respectively according to the importance of their appearance.

It found that services such as education, finance, and employee occupied the first rank by the most demand services. In comparison, services like religion and relations are less demanding.
Priority index has addressed the domain services provided in the three cases of the government sector (Singapore, Bahrain, and Oman).

The Education domain in the Singapore e-government sector was selected to represent e-government as it contained the highest number of services among other domains and government sectors.

5.Chapter 6: Construction of OSE Ontology

Chapter 2 provided a review of numerous ontology development methods. In the last review process and comparisons between different methodologies approaches, an implementation of Methontology is selected as it is considered the most appropriate methodology for applying OSE ontology for the Singapore education system (OSE).
In Methontology, the ontology structure built from scratch is composed of seven actions demonstrated in Figure 5-1: design specification, expertise procurement, conceptualization, combination, execution, assessment, and documents. However, the methodology offers unambiguous support, so the method of bringing out every action is specified.

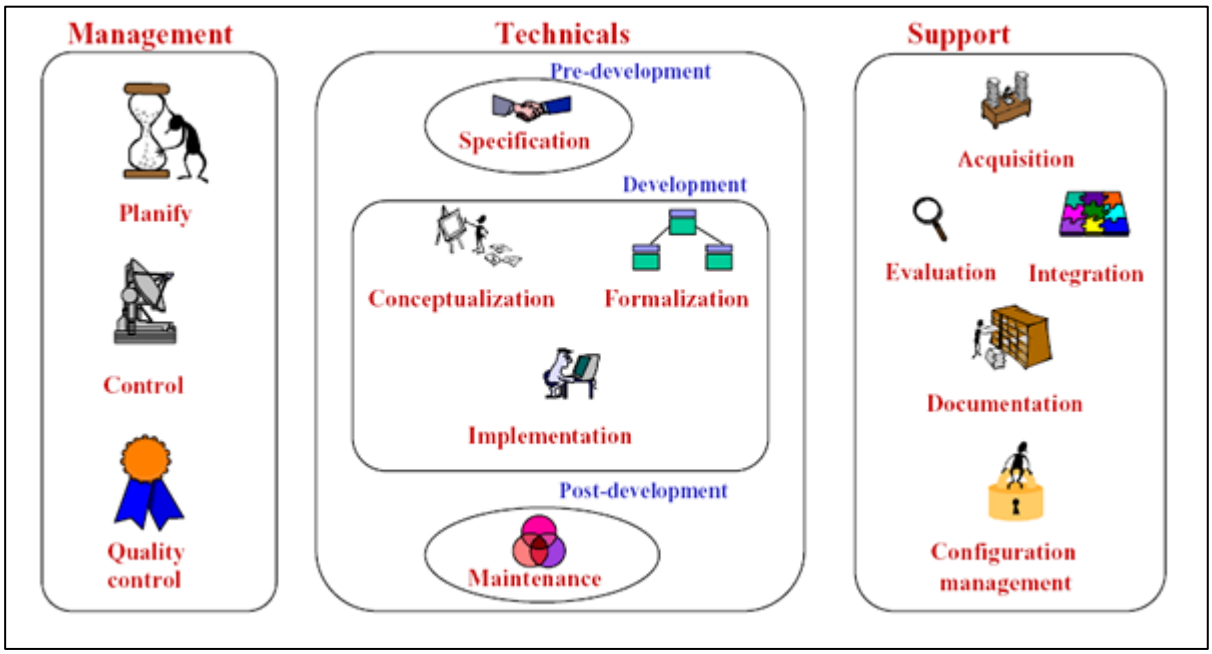


Figure 5-1 METHONTOLOGY building ontology.
Source: Gómez-Pérez A., et al (2005)

The objective of methodologies would give a set of processes to deliver out the endeavours recognised in the build ontology; it also provides the kinds of methods that are considered extremely appropriate and inventions to each production.
Though, the announced scheme it brings into importance the subsequent binary standards.

1. The research question and sub-questions
2. The research essential issue which used the principle of Design Science.

5.1 The Employed Methodology

As previously explained, the Methontology procedure consists of seven activities that can be collected based on the ontology development process into three groups (see Figure 5-2):

1. Actions related to Plan Management.
2. Activities Concerned with Development.

3. Arrangements of Support

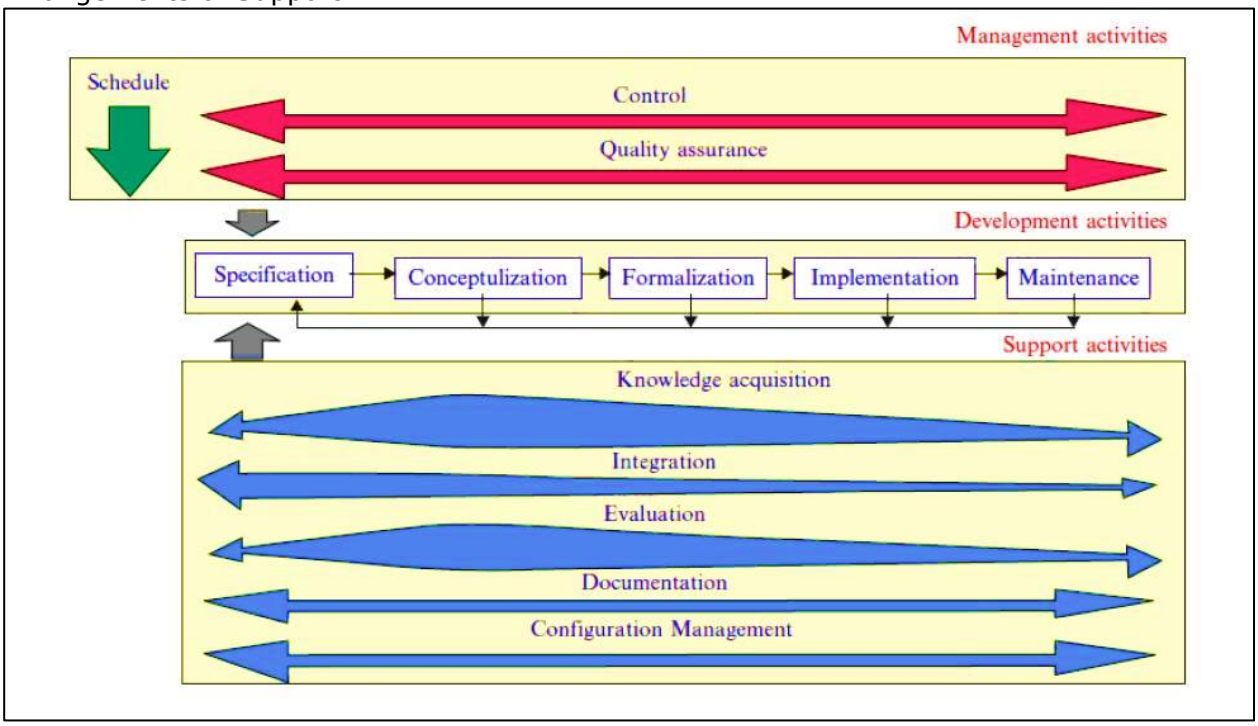


Figure 5-2 Ontology Development Process

Source: Gómez-Pérez et al (2004)

Utilised Tools

Section (2.8) provided the contextual of the tools that provision dissimilar phases of ontology formation. However, the construction of the ontology covers illustrated in Figure 5-3.

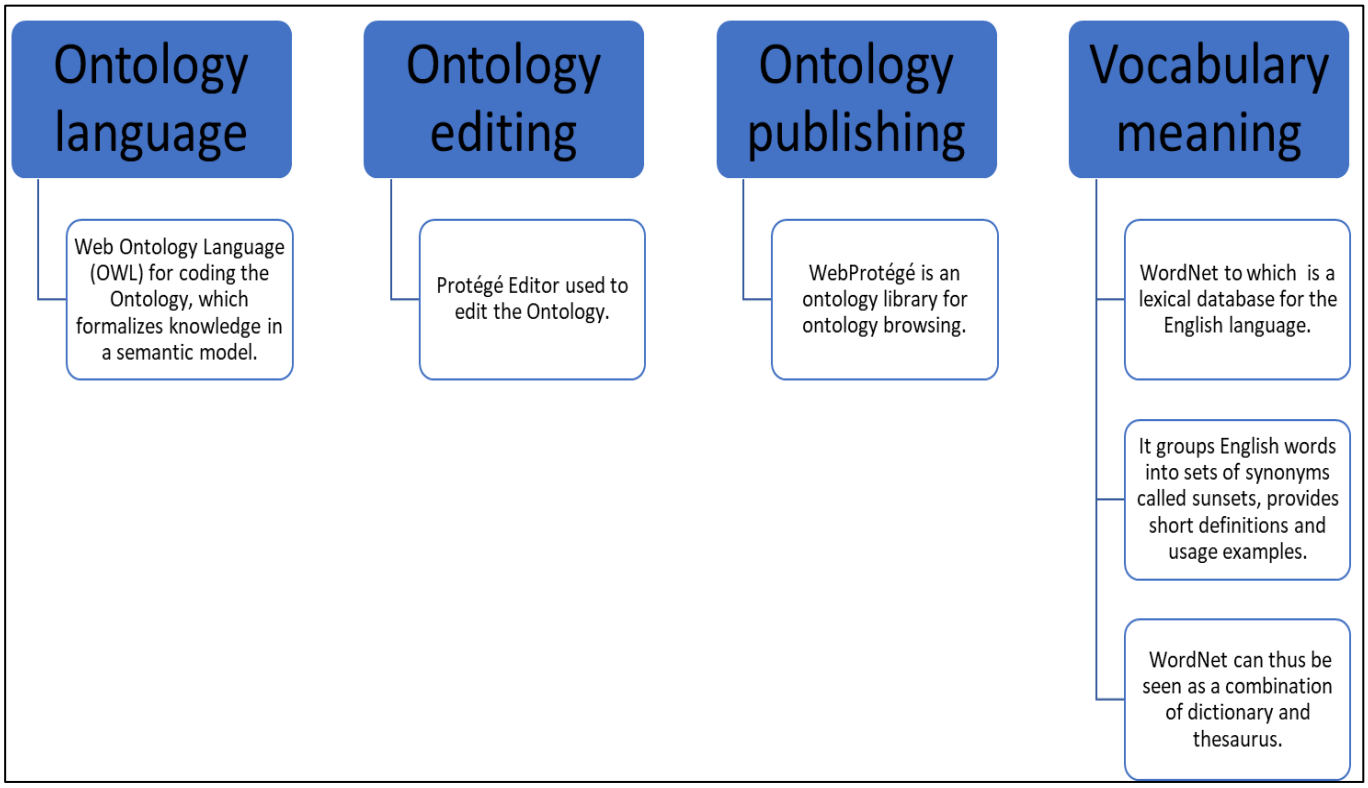


Figure 5-3 Ontology Tools

5.2 Creating the Ontology Model

Generating ontology must involve a good quality of planning coupled with selecting a suitable design to be applied all through in the development procedure. However, both theoretical and mathematical aspects cover the design formation process.

Theoretical component

The assumption aspect in the conceptual is to characterise the obvious domain representative, also has the feature of correctly and to be informal for users to access. However, ontology in the conceptual feature must be formed on:

- **Characterise correctly so feasible:** Considering that it is extremely difficult to represent the entire field accurately. The first requirement is a complete arrangement among specialists concerning the topic ontology combined with familiarity in the field description. Understanding this is critical to capturing knowledge; when there is full agreement, it will lead to avoiding vague or constructive concepts when concepts are equally true to represent in the ontological system.
- **Reprocessing the former of ontological System:** Ontological design should be used by utilising it as a reference for building another ontology. If the whole ontology or some of the elements that require hierarchical classification to cover inheritance scope and use when required. It should not be a deep-rooted hierarchical classification.

Mathematical facet

The mathematical side explains the theoretical prototype with the device and designates a system-reading as feasible. Semantics which are characterized via the device applying OWL toward defining a reasonable approach. However, OWL is communicative enough. But OWL remains not sufficient to signify the entire domain (Sawsana, 2013). however, it is believed that OWL possessed more communicative than other languages as it conveys the complicated interactions in explaining logic.

5.3 Ontological Design of OSE

The OSE ontology Methodology resulted as a common structure of method. While the key outcome will be launched, specifically, the developing structure of the OSE ontological system supports the explanation of the events engaged in creating the OSE ontological system.

However, the suggested method is directed to responding to the goal of the research: Can Ontology of the e-government framework created and described to institute a character reference paradigm for the succeeding distribution of governmental facilities and information?
Consider an application-focused research approach to examine the ability of the ontological semantic web to convey services and information for the e-government domain led to Designing ontology for the Singapore education system (OSE).

5.3.1 Building a Conceptual Model

Figure 5-4 illustrated the domain process of the OSE system. The activities consist namely of specification, Conceptualization, Ontology Formalization, and evaluation

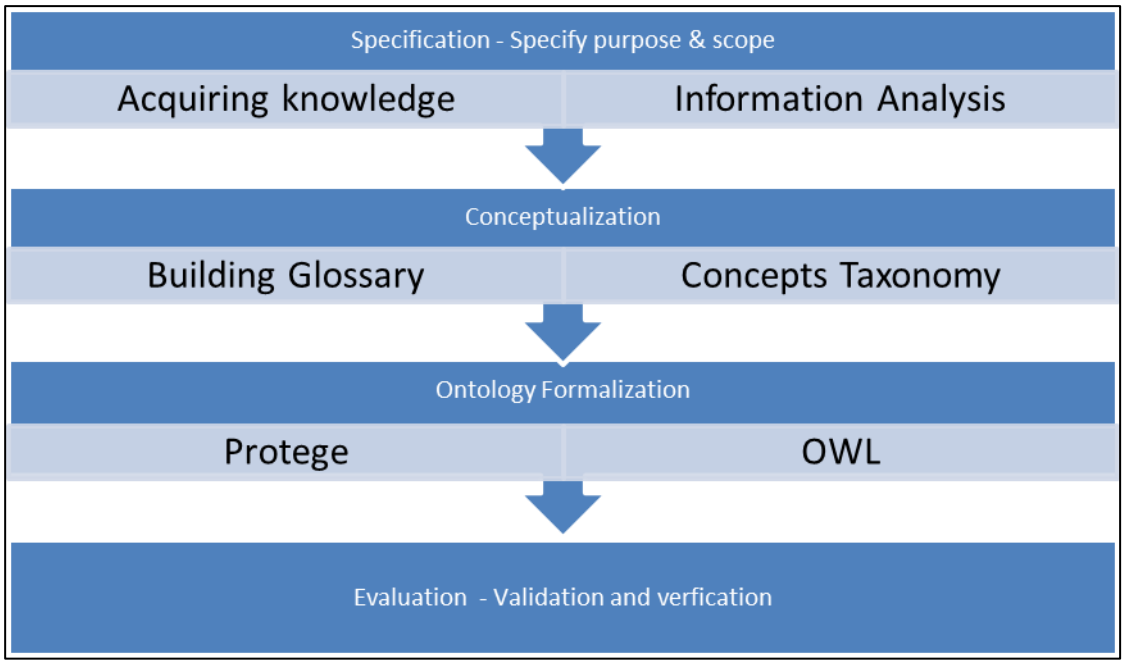


Figure 5-4 Domain ontology of OSE developing process.

5.3.1.1 Specification

The main aspects of specification are producing a written document, either formal or informal, however, the document is written in its own natural language, for creating a facility of the process, capability questions might establish as middle illustrations or expending.

Methontdology planned that at slightest the ensuing data be comprised:

- Ontology determination, comprising its proposed, circumstances, etc.
- Reserve description Level of the applied ontology, contingent on the formality.

Table 5-1 describes the OSE ontology requirements specification document.

Table 5-1 OSE Ontology Requirements Specification Document

Domain	**e-government**
Date	2014-2020
Conceptualization and Implementation	Researcher Mamoun Awad
Purpose	Provide an experimental survey of the impacts along with prospects of applying different methods in the expansion of e-government. Specifically, concentrates on the influence of utilizing ontological method on the achievement of accomplishment of delivering services through e-government.
Scope	The range of the research, which expands to the three layers described as follows: 1. The wide field represented in the outside layer, which represents semantic web product research-motivated utilizing real-world use cases.

	2. The second layer characterized by the domain of research, which merges both e-government and the semantic web. 3. The inside layer covers the Singapore e-government, particularly the education system. The last is the presentation domain of the research.
Level of Formality	Formal
Source of Knowledge	Singapore's portal e-government Singapore's education portal United Nations Survey Reports 2014,1016, and 2018. Worldnet vocabulary Meaning. Articles and research in the education system.

5.3.1.2 Procurement of the Knowledge

The ontology progress requirements a self-determining action called Information gaining. Though, it is coextensive with additional activities. The greatest achievement is concurrent with the supplies the specification stage.

Sources of information are expanded to contain Specialists, books, handbooks, statistics, tables, and other ontologies.
Expanding the sources of knowledge gathered through clarified consuming in combination methods such as thinking, meetings, investigation of texts, and other information gaining tools.
Often text techniques are used to refine the list of terms and their meaning, as both formal and informal assessment can be used in conjunction with structured provisions, and unstructured interviews with experts can be used to comprise or eliminate it in the glossary.

The procedures employed in the information gain phase of the e-government ontology might include were:

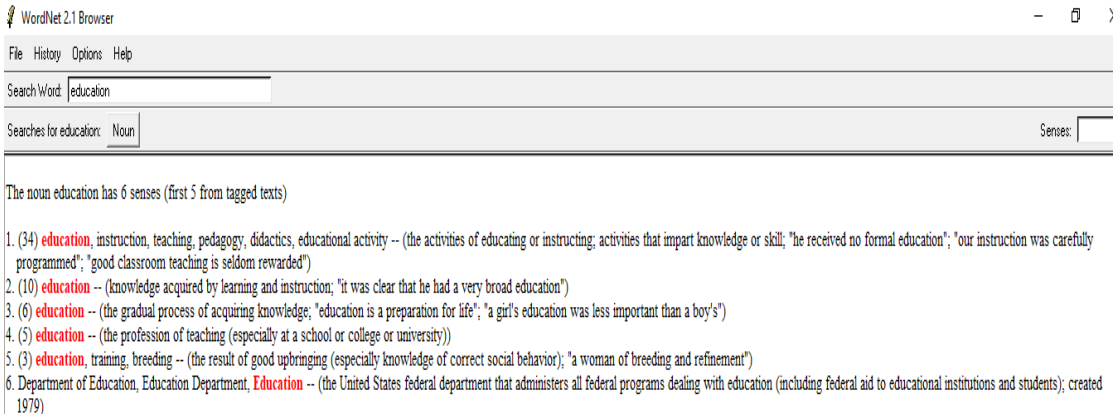
- Non-organized meetings
- Confidential text assessment
- Official text examination.
- Organized discussions with experts.

5.3.1.3 Conceptualization

Generate a comprehensive Glossary of Terms (GT) is the first step toward improving the conceptualization phase. Words consist of theories, cases, verbs, and assets. Therefore, the glossary of terms recognises and collects completely the valuable and possibly functional field information as well as meanings.
The second phase starts with the unit of the terms as concepts and verbs. Later finalized the Grosser term.

5.3.2 Building Glossary of terms

The main phase towered to create the glossary term of OSE, represented in the WordNet dictionary, which clusters English phrases into groups of substitutes known as sunsets, offering short definitions and usage examples.
However, the search for "education" provided different meanings described in Figure 5-5.



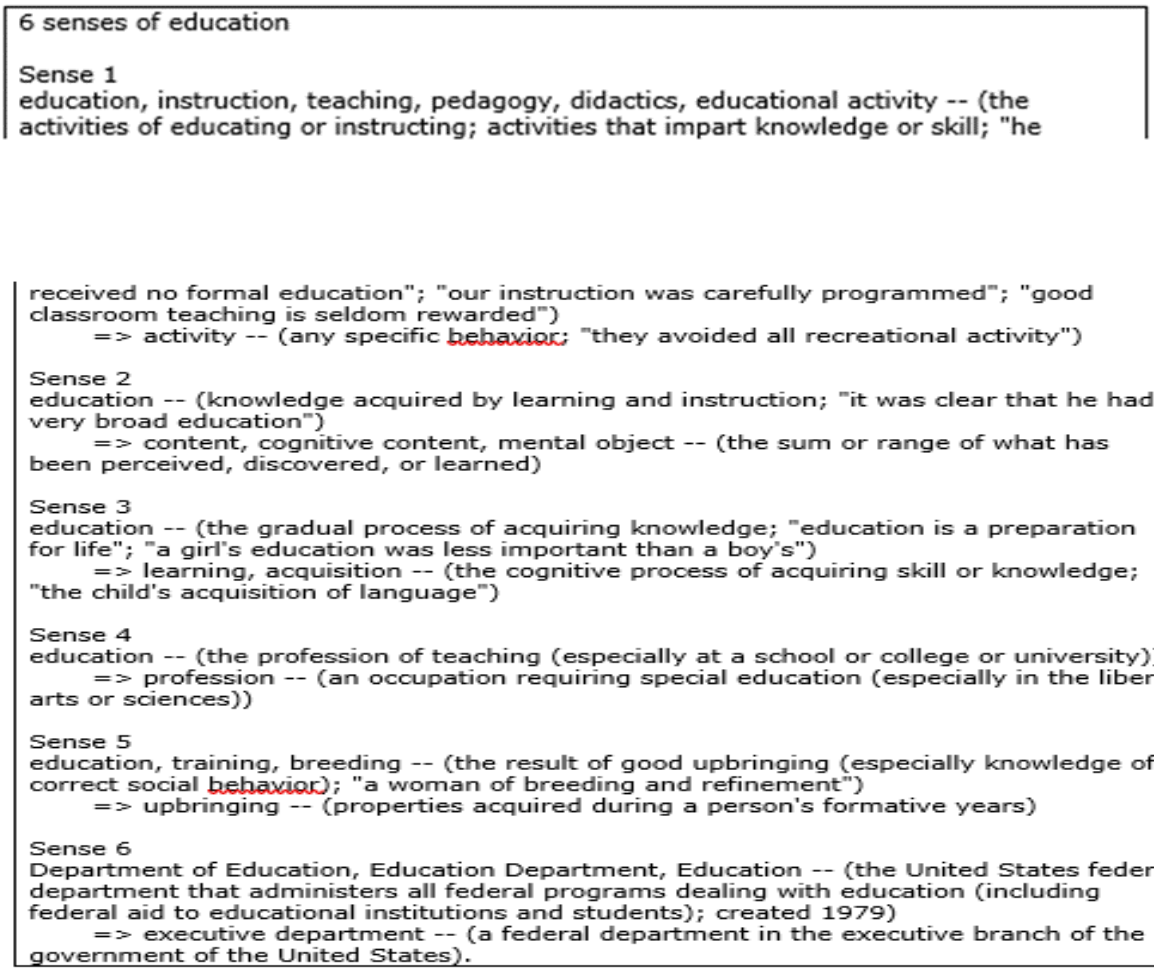


Figure 5-5 WordNet Defining Term Education.

5.3.3 Building second version glossary term

The initial version of the set of concepts for the word education was a strong foundation upon which the complete conception of construct log was built. Various methods have been used to integrate the image in building the meanings of the term education, including:

a) The Singaporean Ministry of Education's official website contains a collection of information related to the educational process.

b) A series of textbooks and researchers' bulletins for a group of authors that talk or create a product for the educational environment to get to know the basic structure of the educational process.
c) A series of interviews with experienced.

Through what was envisioned from the analysis that is present on the official website and the experts' view, the final pictures of the basic concepts are described as follows (see Figure 5-6):

Admissions, Agent, Awards, Careers, Documentation, Registration, Education Division, Education in Singapore, Financial Fees and Funds, Ministry of Education, Singapore, MOE Activities, Person, Position, Programmers and Courses, School, and Student Mater.

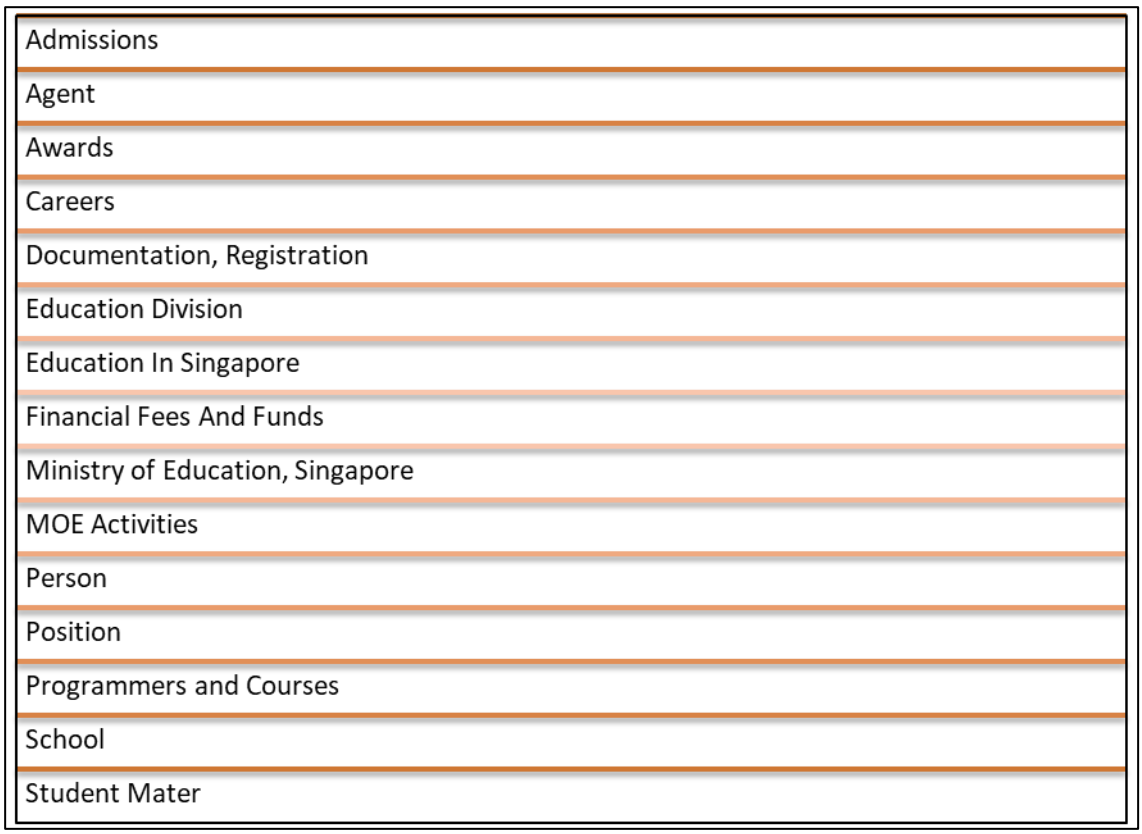


Figure 5-6 OSE Upper Classes

5.4 Building Formalization Computational Model

The endeavour, the transfer process from theoretical paradigm into a proper pattern. However, the theoretical version of the Singapore education e-government system is defined in natural language.
The major production of this stage is conveyed in the OSE ontological system, which is arranged in a suitable ontological executive tool specifically, Protégé.

The ontological system OSE is organized in real tool to be appropriate for information showing and understanding interpretation. It marks the presence of clear and inclusive design of field views and interactions between the instances.
Furthermore, ontology in Protégé can be distributed to various layouts, for instance, RDF and XML; the directory explained below indicates the ontology in OWL language as demonstrated in Figure 5-7.

```
Prefix(:=<http://www.semanticweb.org/mawad/ontologies/2018/10/Egov_Ed
ucation_Singapore-ontology-8#>)
Prefix(owl:=<http://www.w3.org/2002/07/owl#>)
Prefix(rdf:=<http://www.w3.org/1999/02/22-rdf-syntax-ns#>)
Prefix(xml:=<http://www.w3.org/XML/1998/namespace>)
Prefix(xsd:=<http://www.w3.org/2001/XMLSchema#>)
Prefix(rdfs:=<http://www.w3.org/2000/01/rdf-schema#>)


Ontology(<http://www.semanticweb.org/mawad/ontologies/2018/10/Egov_E
ducation_Singapore-ontology-8>
Import(<http://xmlns.com/foaf/0.1/>)

Declaration(Class(:AboutKindergarten))
Declaration(Class(:AboutMOE))
Declaration(Class(:AcadamicStaff))
Declaration(Class(:AcadamicStaffPosition))
Declaration(Class(:Academy_of_Singapore_teachers_Website))
Declaration(Class(:Achievement_Awards_for_Special_Education_Students))
Declaration(Class(:Actitude_Leadership_Camp_Primery))
Declaration(Class(:Activity))
Declaration(Class(:Adjunct_Teachers))
Declaration(Class(:Admission))
Declaration(Class(:AdmissionPost-SecondaryEducationalInstitutions))
Declaration(Class(:AdmissionPrimarySchool))
Declaration(Class(:AdmissionSecondarySchool))
Declaration(Class(:Admission_Secondary_General_School_Placement))
Declaration(Class(:AdmissionsExerciseforInternationalStudents_AEIS))
Declaration(Class(:AdmissionsExercises))
Declaration(Class(:AdmissionsHome))
Declaration(Class(:Admissions_into_Private_Schools))
Declaration(Class(:Advanced_Mathematics_Enrichment_Class_Primery))
Declaration(Class(:AlliedEducatorJobDescription))
Declaration(Class(:AlliedEducators))
Declaration(Class(:AlliedEducatorsPosition))
Declaration(Class(:Allied_Educator_Learning_and_Behavioural_Support))
Declaration(Class(:Allied_Educators))
Declaration(Class(:AllocationPlaces))
Declaration(Class(:ApplicationForms))
Declaration(Class(:Application_Process))
Declaration(Class(:Application_Process_for_Applicants_without_Teaching_Qua
lifications))
Declaration(Class(:Application_Windows))
Declaration(Class(:Application_and_Selection_NUS))
```

Figure 5-7 Ontology in OWL language

5.5 OSE Structural Metrics

The current structure of OSE ontological statistics described in Figure 5-8 is characterized by a massive number of classes, specifically 835, in addition to 193 assertions, with further than 80 regulations and interactions, to handle the strong intelligence articulation capacity.

However, the strength of the OSE was demonstrated in the large number of Axiom numbers exceeding 2600.
While this number of Axioms expresses the formation of common bonds between the classes to form more meaningful connotations of the classes.

Certainly, it contributes to providing the created system with greater interconnectedness between classes and giving intelligent indications to categories, which facilitates access to categories.

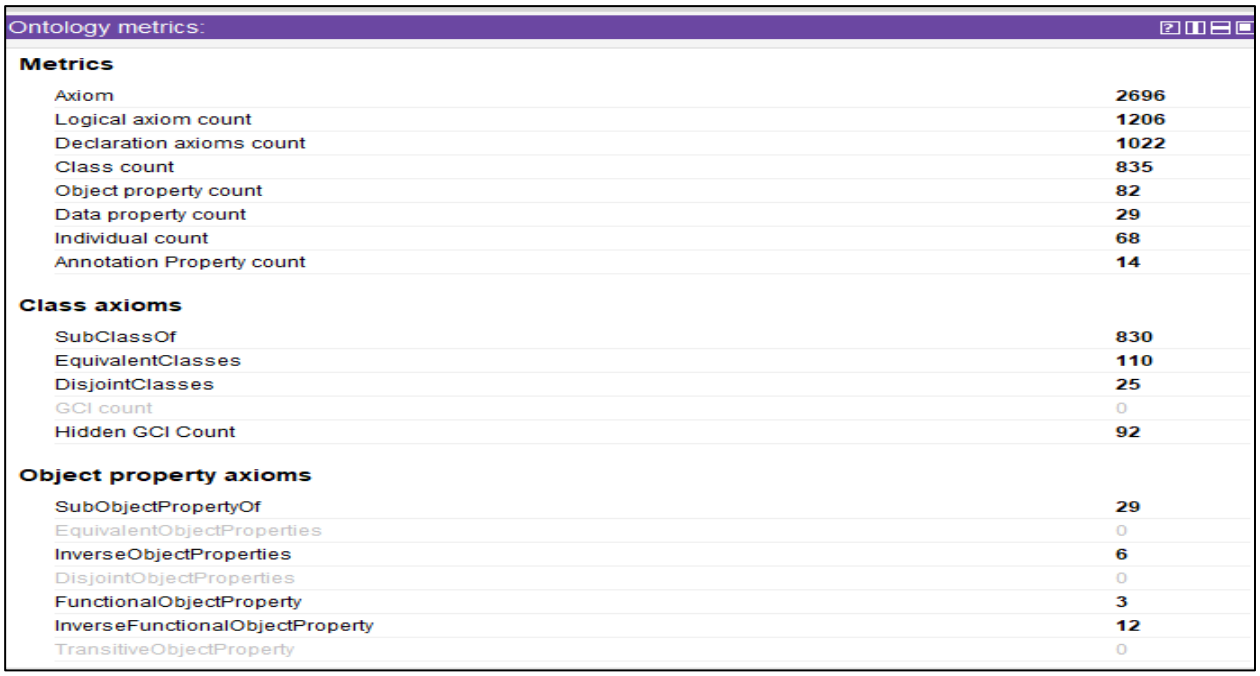


Figure 5-8 OSE Model Statistics

In contrast, Table 5-2 refers to a numeric statistic with the number of classes, characteristics (Properties), and Individuals of both the used ontologies, OSE and the imported ontology, FOAF. Most of the ontology, or 98 percent, is due to the ontology developed by the researcher (OSE).

Table 5-2 Ontologies Statistics

Ontology	Classes	Object Properties	Data Properties	Annotation Properties	Individuals	Datatypes
OSE	835	47	4	6	68	3
FOAF	7	42	29	11	11	2

5.6 Define Classes.

The OSE ontology permits to discover the ontology composition by looking at the higher degree of the tree diagram. However, the higher level gives a common knowledge of the e-government environment. Still, the greater heights can be extended once traversed across various stages of the family tree.

Moreover, The Upper classes covers conceptual objects formed in established the taxonomy of Singapore education and the theoretical methodology as considered in chapter 3.

Accurately, the OSE standard described in Figure 5-9 includes fifteen levels of description, which delivers the establishment of the understanding structure for the OSE ontological System.

Figure 5-9 demonstrates a plain order of the major classes of OSE ontology. However, the OSE ontology root classes are Agent, Awards, Careers, Documentation, Registration, Education Division, Education in Singapore, Financial Fees and Funds, Ministry of Education,

Singapore, MOE Activities, Person, Position, Programmers and Courses, School, and Student Mater.

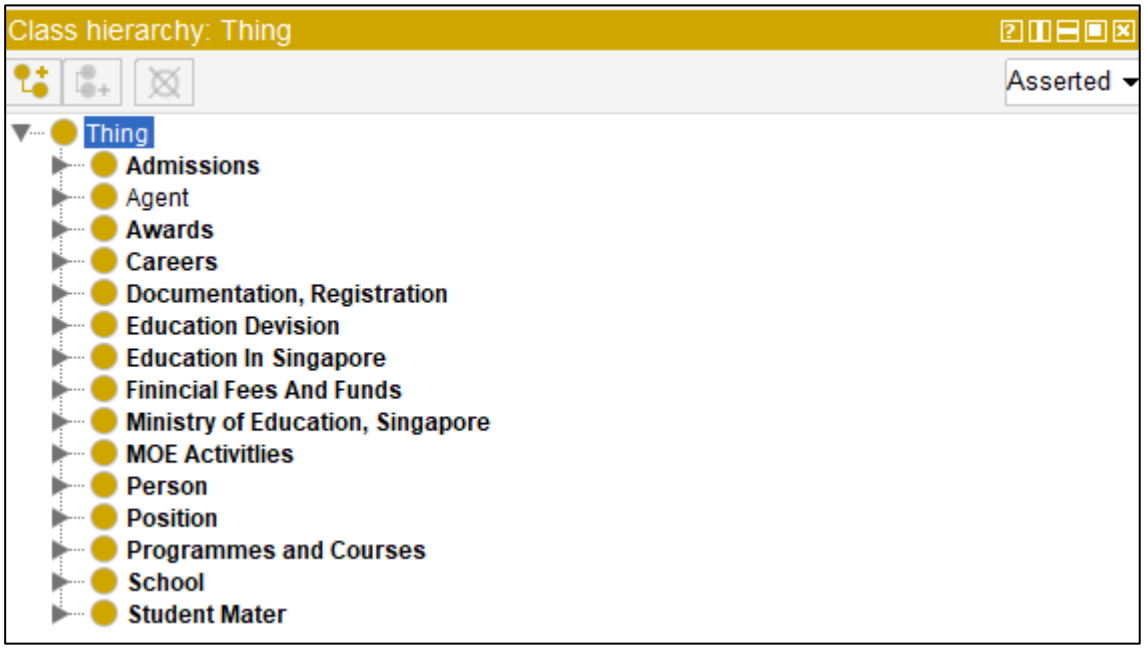


Figure 5-9 OSE Root Classes

5.6.1 Main Class Thing

The core category in OWL represents the source of whole classes. Similarly, Figure 5-10 illustrated the relationship of the main class "Thing."

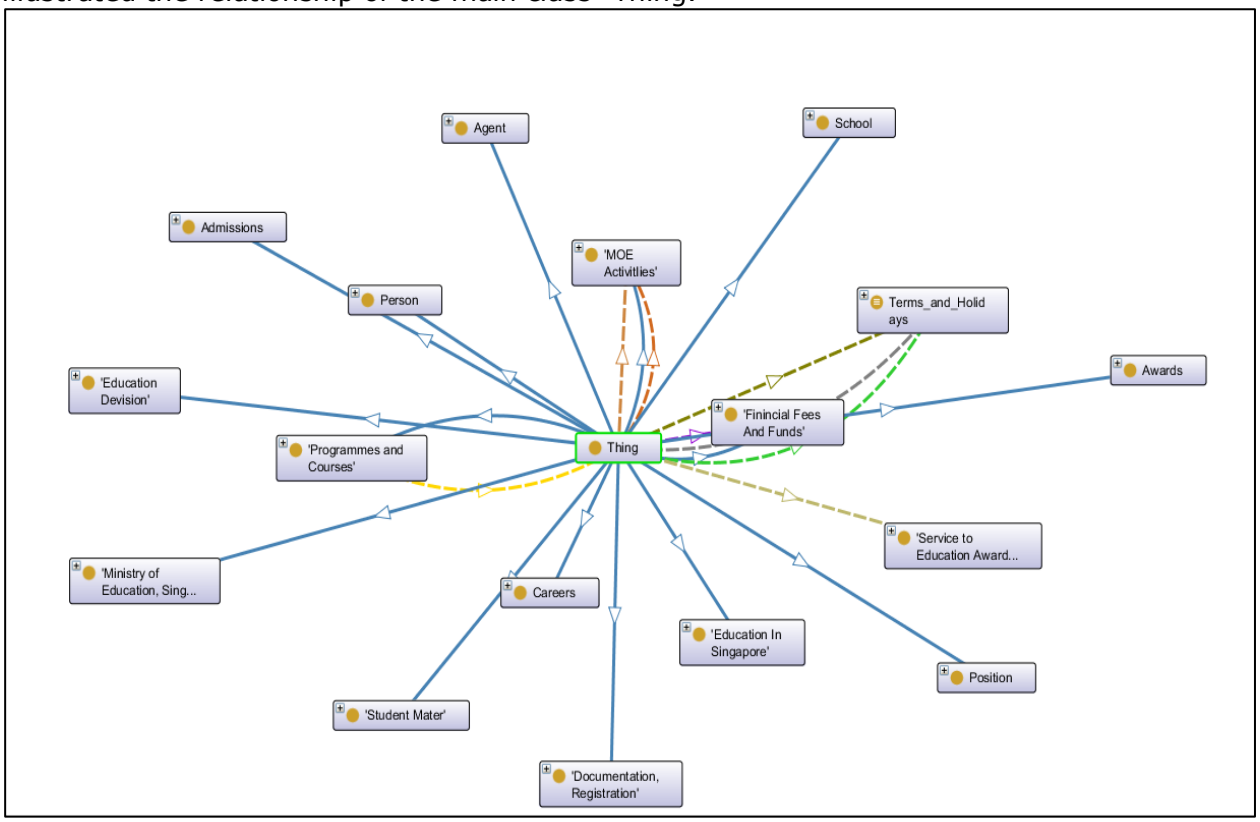


Figure 5-10 Major Classes of OSE Ontology and Relationships

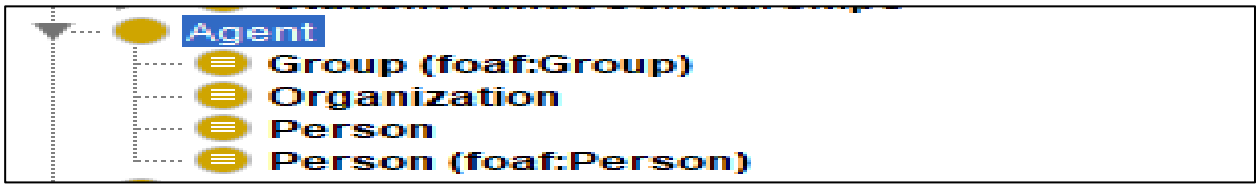
However, the parent class "Thing," as shown in Figure 5-11, indicates three forms of links to form the main pillar of category links: has subclass, is Parent of, and Domain>Range relationships.

```
digraph g {
	"Thing" -> "'Student Mater'" [label="has subclass"]
	"Thing" -> "'MOE ActivitIies'" [label="student (Domain>Range)"]
	"Thing" -> "Person" [label="has subclass"]
	"Thing" -> "'Education In Singapore'" [label="has subclass"]
	"Thing" -> "Terms_and_Holidays" [label="terms (Domain>Range)"]
	"Thing" -> "Admissions" [label="has subclass"]
	"Thing" -> "Careers" [label="has subclass"]
	"Thing" -> "Terms_and_Holidays" [label="schoolTerms
(Domain>Range)"]
	"Thing" -> "Terms_and_Holidays" [label="hasHolidays
(Domain>Range)"]
	"Thing" -> "'MOE ActivitIies'" [label="person (Domain>Range)"]
	"Thing" -> "Position" [label="has subclass"]
	"Thing" -> "School" [label="has subclass"]
	"Thing" -> "'Finincial Fees And Funds'" [label="isPartOf
(Domain>Range)"]
	"Thing" -> "Agent" [label="has subclass"]
	"Thing" -> "'Programmes and Courses'" [label="has subclass"]
	"Thing" -> "'Education Devision'" [label="has subclass"]
	"Thing" -> "'Ministry of Education, Singapore'" [label="has
subclass"]
	"Thing" -> "'Finincial Fees And Funds'" [label="has subclass"]
	"Thing" -> "'Documentation, Registration'" [label="has subclass"]
	"Thing" -> "'MOE ActivitIies'" [label="has subclass"]
	"'Programmes and Courses'" -> "Thing" [label="programs
(Domain>Range)"]
	"Thing" -> "'Service to Education Award'" [label="awarded
(Domain>Range)"]
	"Thing" -> "Awards" [label="has subclass"]
}
```

Figure 5-11 Thing Relationship

5.6.2 Agent Main Class

The category Agent includes information related to persons or organisations affiliated with the Ministry of Education in Singapore. While the whole information, whether persons or organisations, is derived from other classes, the entire description of categories is information related to other categories.
Two subcategories imported from the introductory person from "FOAF" which are the most common ontologies known and used to describe persons. Yet, agents include person, organisation, and group (see figure 5-12).



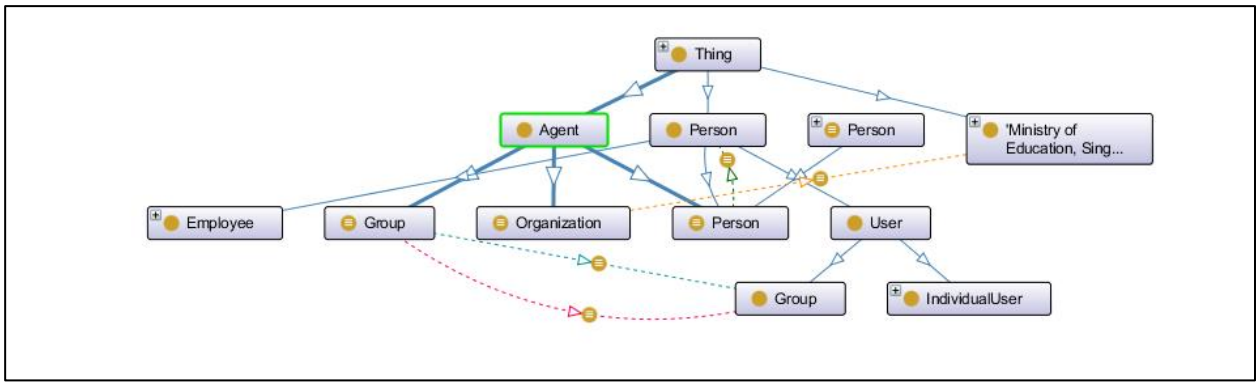


Figure 5-12 Agent Main Class

While the class Agent employs more than 50 uses described in Figure 5-13, which are divided into properties, controls, classes, and subcategories, to give a detailed, intelligent meaning, in which the user can infer the information with greater power and effectiveness.

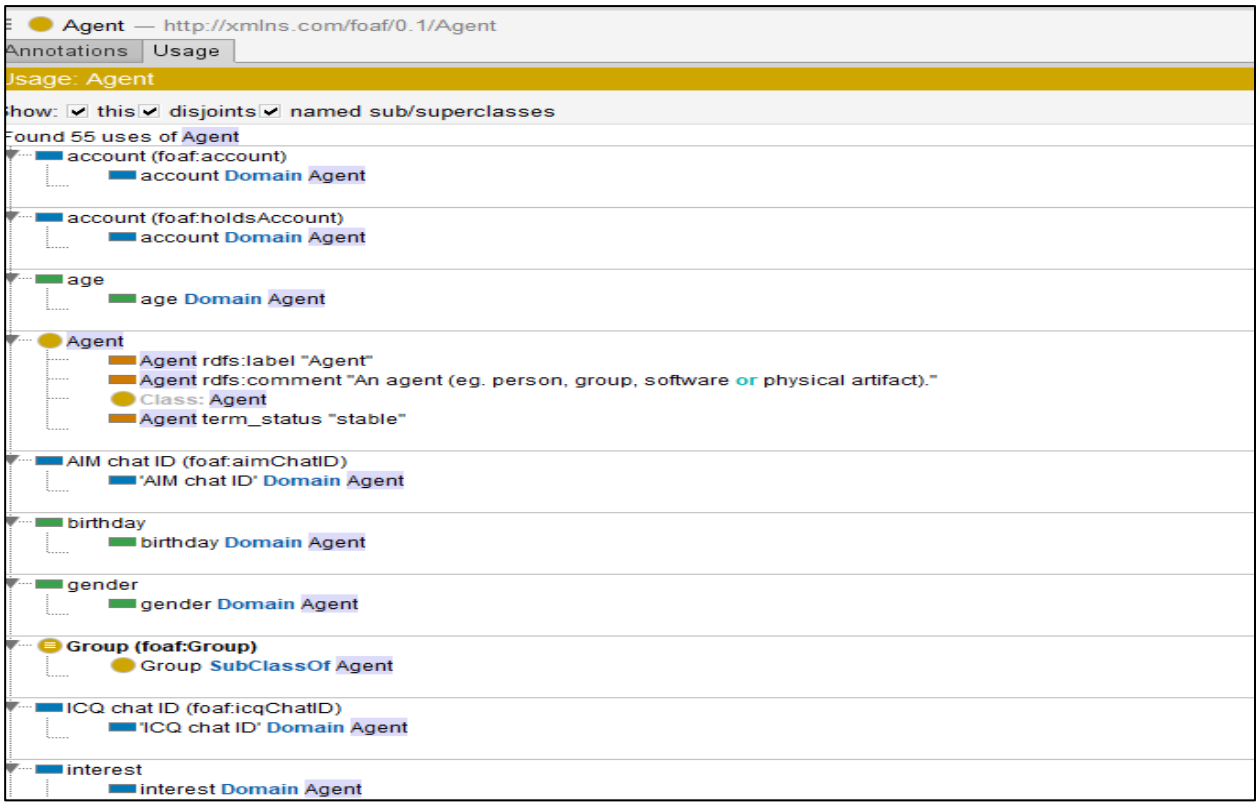


Figure 5-13 Agent Usage in OSE

The class agent also uses more than ten subcategories shown in Figure 5-14 to form a strong link between classes.

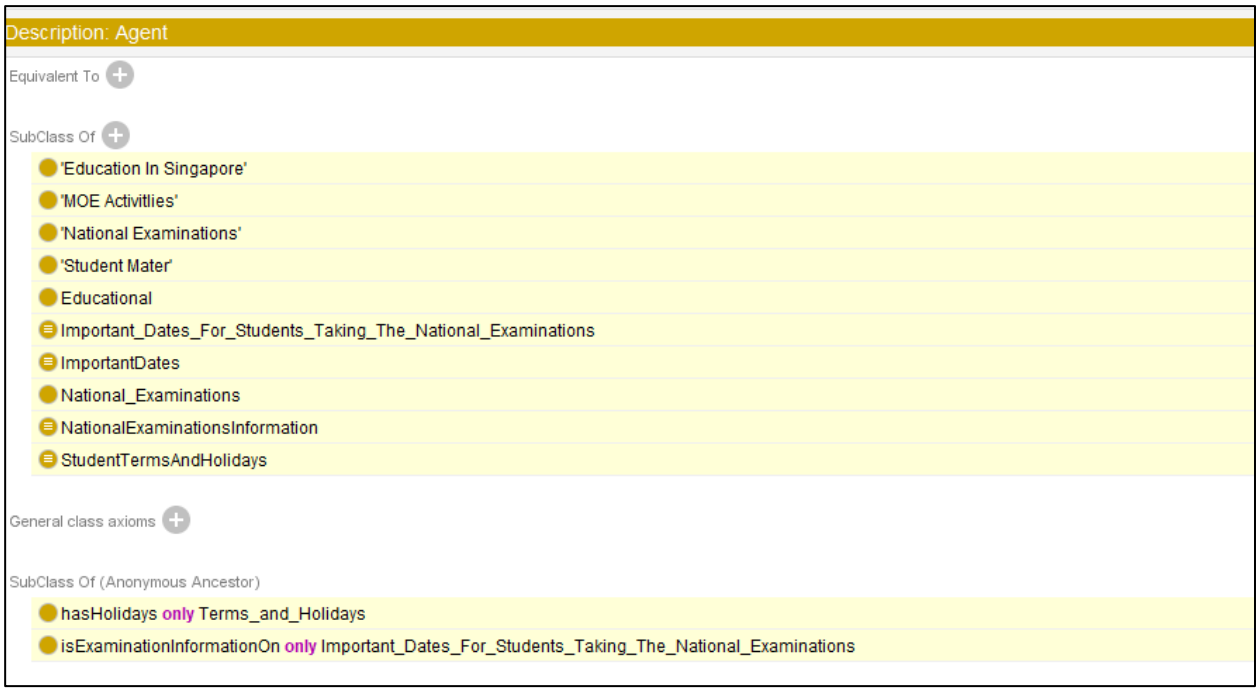


Figure 5-14 Agent Description

5.6.3 Admissions Core Class

The class admission described in Figure 5-15 contains information about the student such as acceptance, admission, approval, consent, admittance, agreement recognition, confession, admission, avowal, shrift, acknowledgment insertion, injection, admission, and intromission. Include information about:

- Returning Singaporeans
- International Student Admissions
- Admissions Exercises
- Transfer Exercise
- Funds

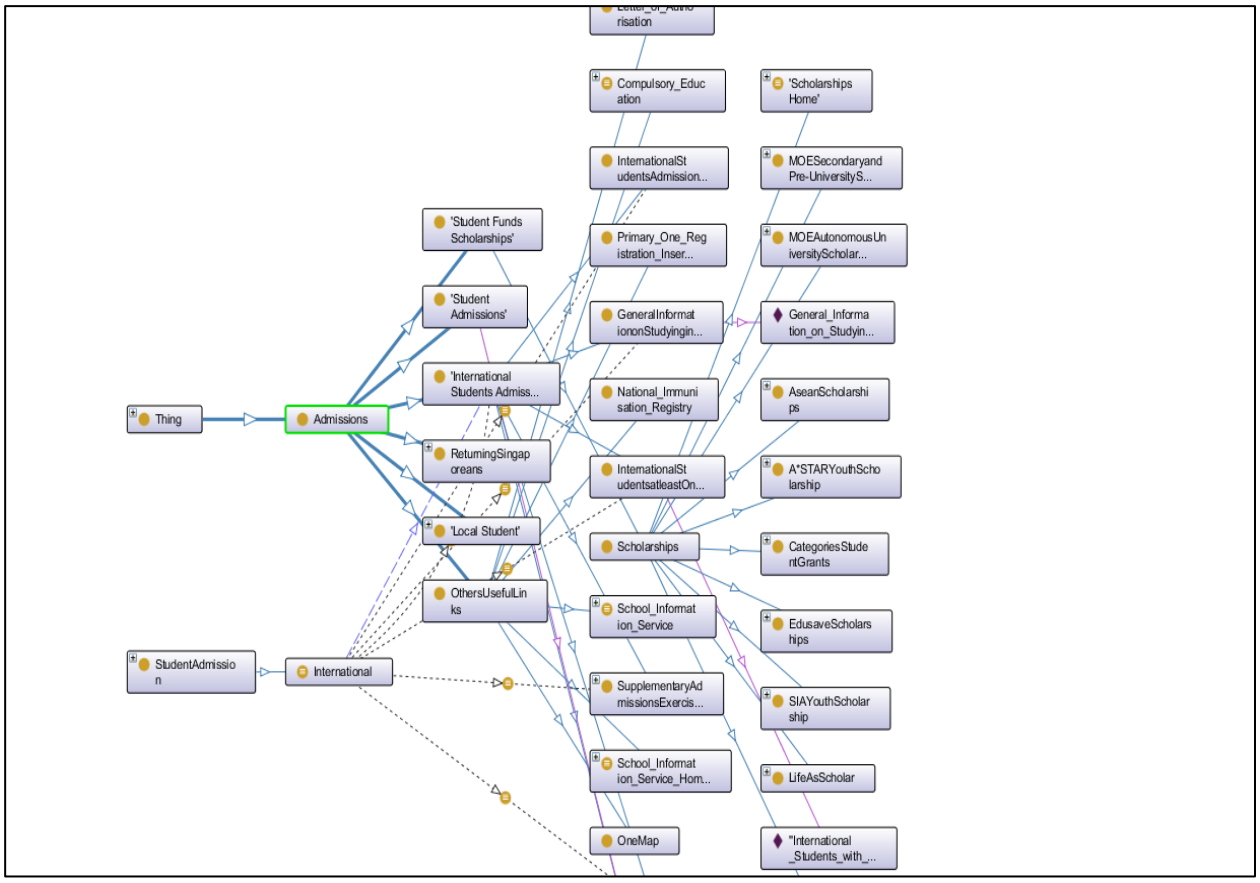


Figure 5-15 Admission Main Class

Though the class Admission engages further than 16 uses defined in Figure 5-16, which are divided into properties, restrictions, classes, and subcategories, to give a detailed, intelligent meaning, in which the user can infer the information with better control and efficiency.

Usage: Admissions

Show: this disjoints named sub/superclasses

Found 16 uses of Admissions

Admissions
- Admissions rdfs:label "Admissions"
- Class: Admissions
- Admissions dc:description "Student : acceptance, admission, approval, consent, admittance, agreement recognition, confession, admission, avowal, shrift, include information about:
  Returning Singaporeans
  International Student Admissions
  Admissions Exercises
  Transfer Exercise
  Funds"

International Students Admissions
- 'International Students Admissions' SubClassOf Admissions

Local Student
- 'Local Student' SubClassOf Admissions

OthersUsefulLinks
- OthersUsefulLinks SubClassOf Admissions

ReturningSingaporeans
- ReturningSingaporeans SubClassOf Admissions

Student Admissions
- 'Student Admissions' SubClassOf Admissions

Student Funds Scholarships
- 'Student Funds Scholarships' SubClassOf Admissions

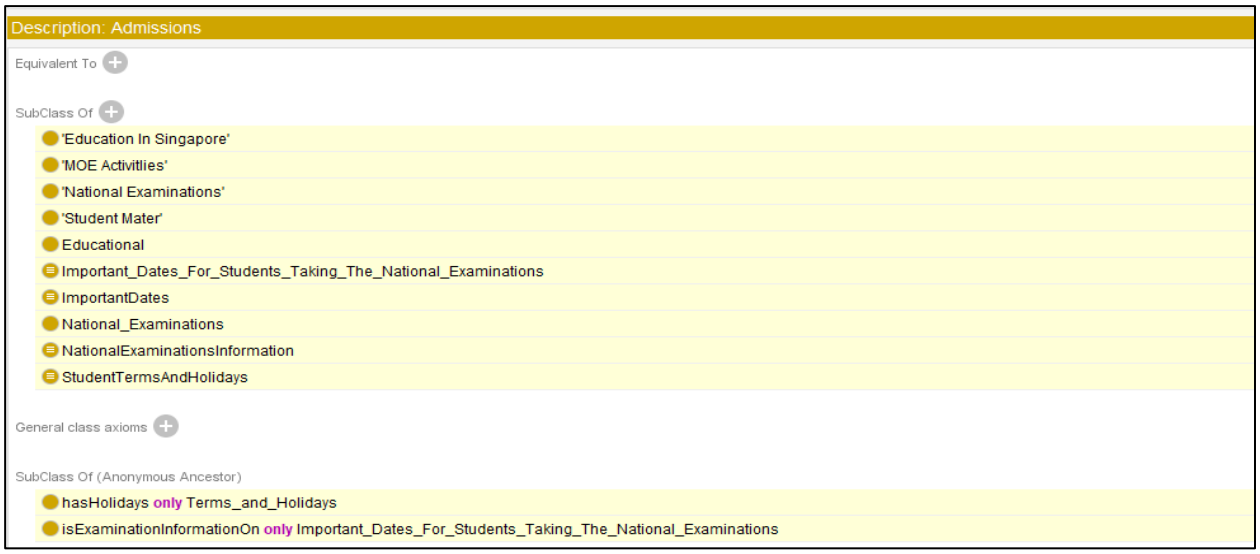


Figure 5-16 Admission Class Usage and Description

5.6.4 Awards Main Class

Award main class illustrated in Figure 5-17 includes information about service education award type, reward, premium, recompense solution, decision, ruling, decree.
Include information about:

- Service to education award and
- Compass partners the general advice-giving board.

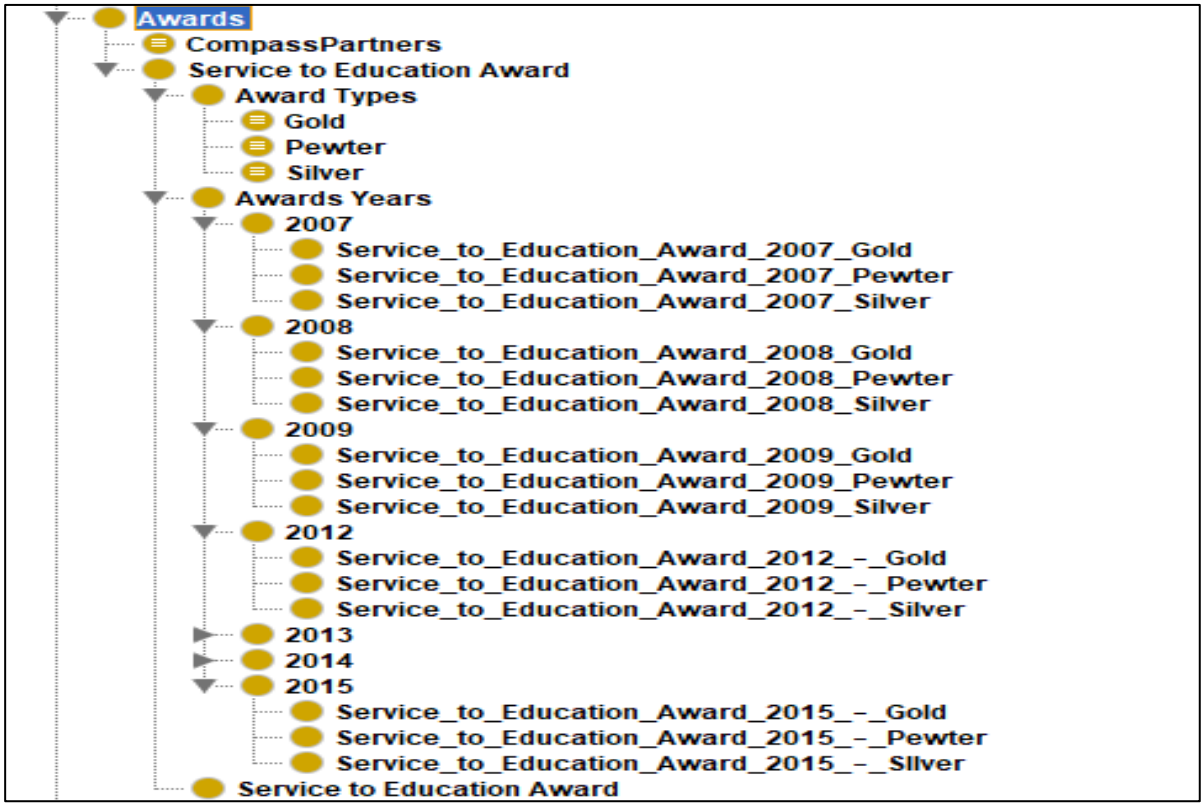


Figure 5-17 Hierarchy of Award Main Class

5.6.5 Careers Core Class

Career main class defined in Figure 5-18 deliver information about the Job opportunity in MOE, information includes Profession, career, occupation, job, vocation, trade. Furthermore, information consists of:

- Teach how to be a teacher.
- Allied Educators
- MOE Kindergarten Educators
- Special Education Teachers
- Executive & Administrative Positions
- An employment.

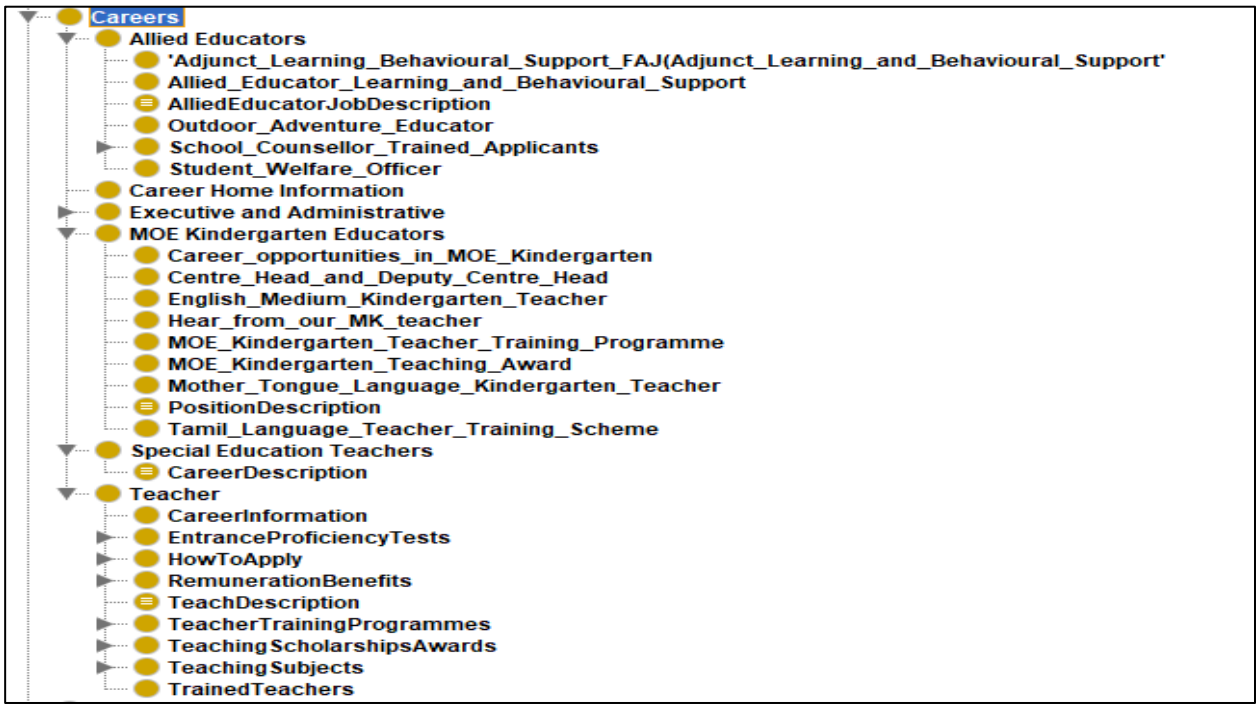


Figure 5-18 Career Main Class

Although the Career class participates in more than 18 usages specified in Figure 5-19, which are split into classes, properties, restrictions, and subcategories, to provide a comprehensive intelligent implication, in which the client can infer the information with better ability and proficiency.

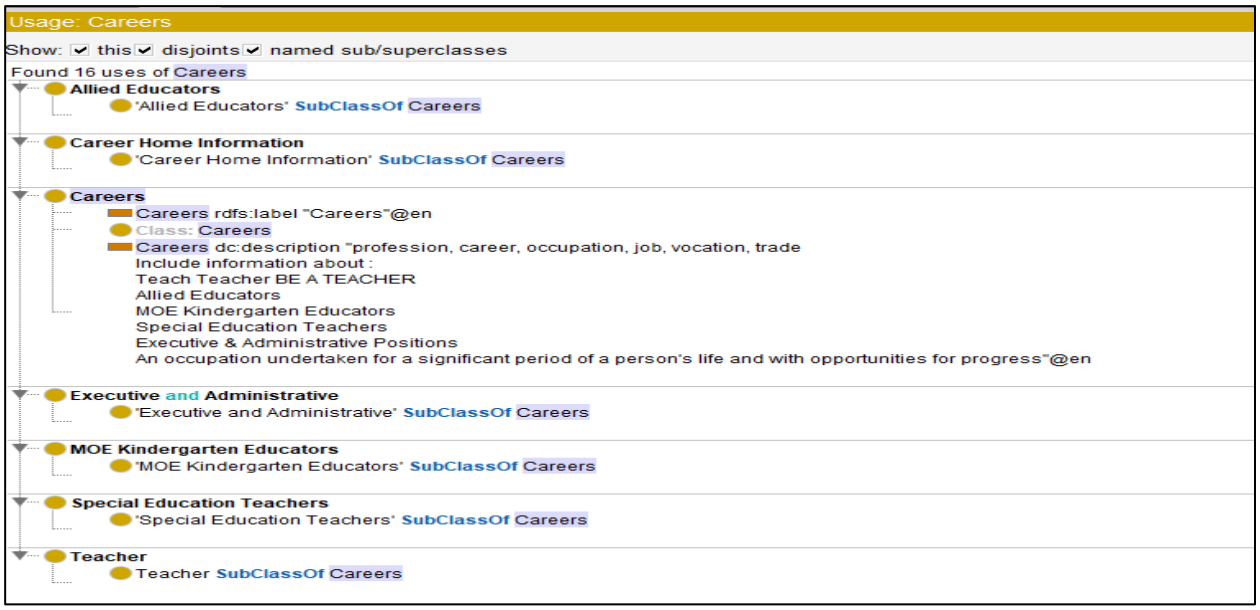


Figure 5-19 career Usage

5.6.6 Documentation, Registration Main Class

Documentation, Registration information illustrated in Figure 5-20 signify the MOE material that provides official information or evidence or that serves as a record.
Incorporate information about:

- Event
- Granted Awards
- News
- Publication

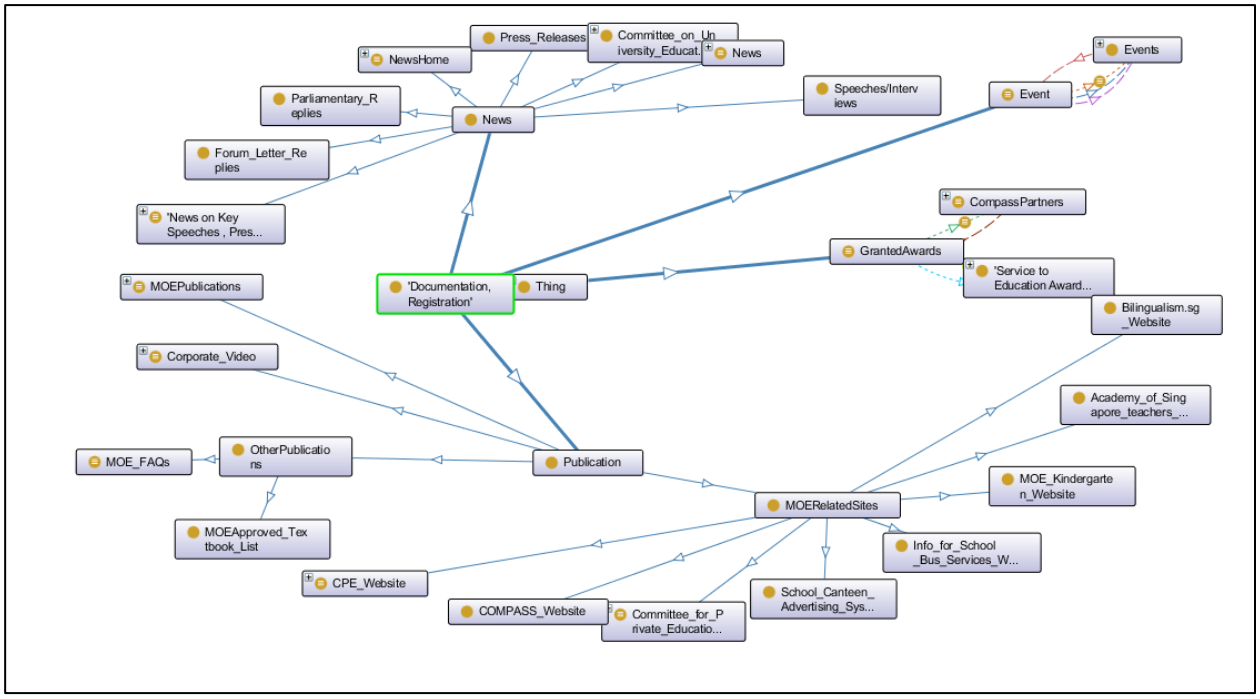


Figure 5-20 Documentation Main Class

5.6.7 Education Division Core Class

Education in Singapore contains division, section, branch, department, ramification split, partition, segmentation, apportionment, allotment section, department, division, part, portion, segment split, division, divide, schism, cleavage, fission distribution, allocation, division, delivery, apportionment, divide.
However, Education Division main class contains four subclasses that described in Figure 5-21 as follows:

- Higher Education
- Private Education Division
- School Grade
- Special Educational Needs

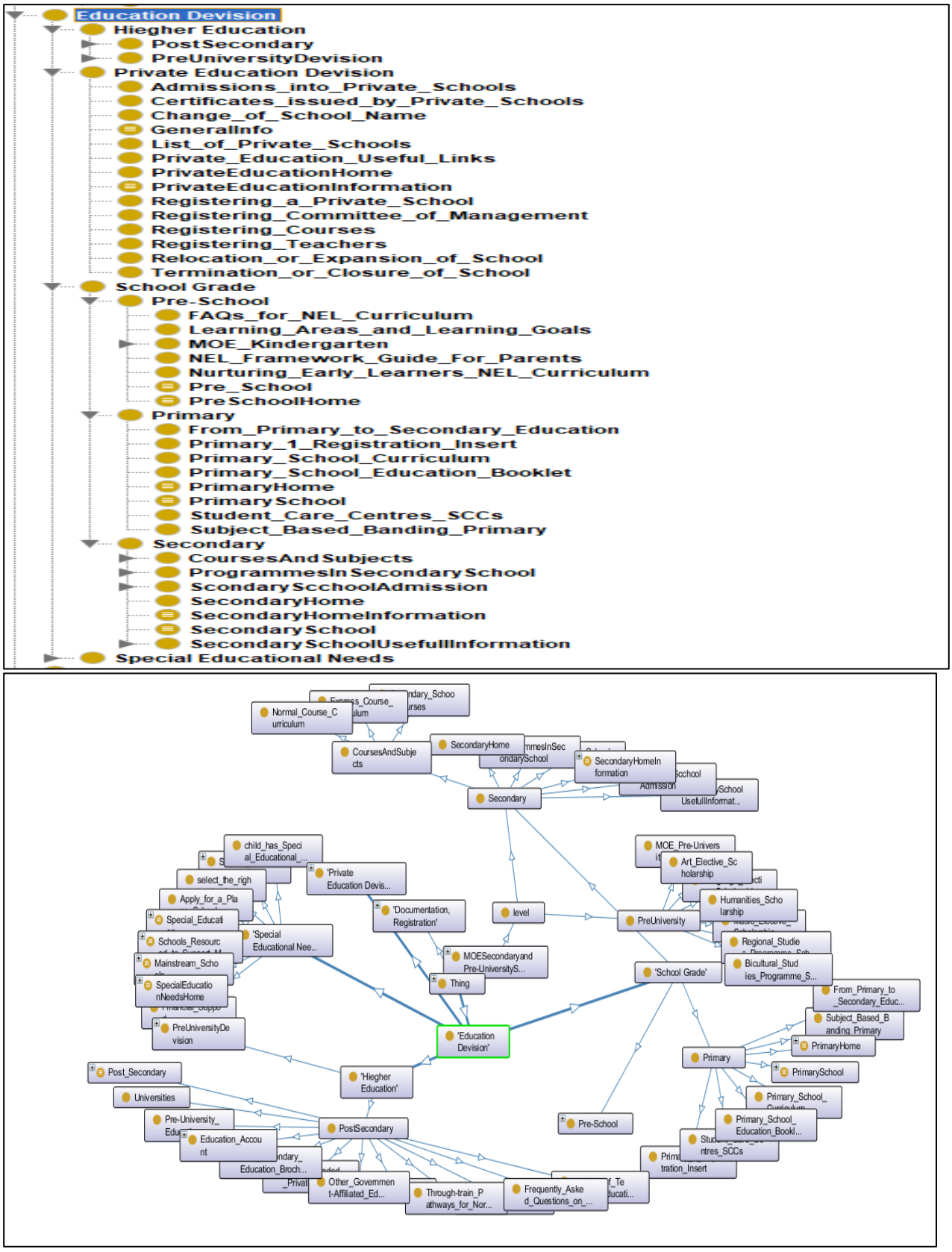


Figure 5-21 Education Division Main Class

While the Education Division main class contributes further than 12 procedures stated in Figure 5-22, which are fragmented into classes, properties, restrictions, and subcategories,

toward deliver an inclusive intelligent inference, in which the customer can conclude the information with well facility and proficiency.

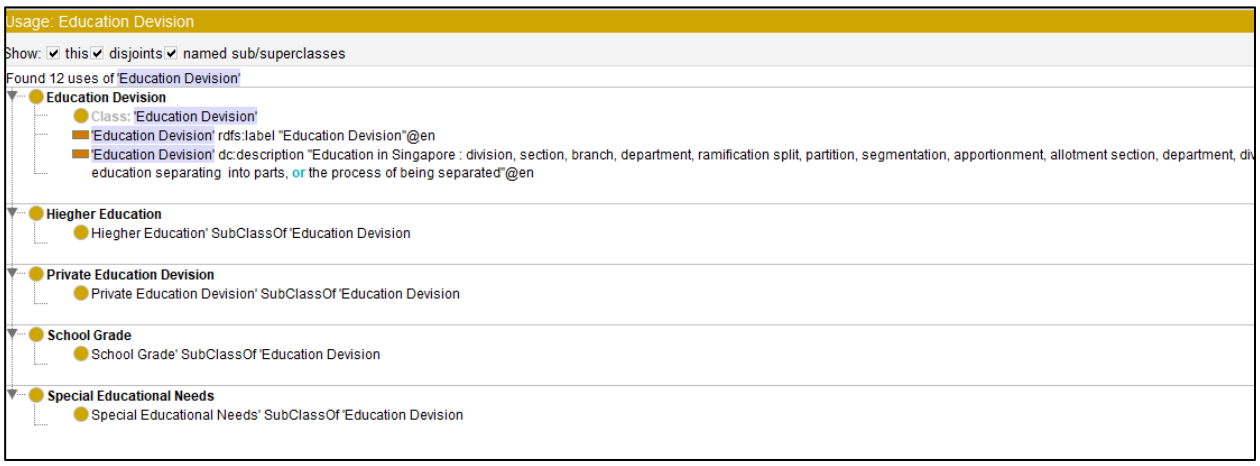


Figure 5-22 Education Division Usage

5.6.8 Education in Singapore Main Class

Education in Singapore core class supply information such as education, teaching, instruction, schooling, marking, precept learning, study knowledge, knowing, learning, awareness, information.
However, in Education in Singapore main class consists of six subclasses illustrated in Figure 5-23 as follows:

- Education System
- Edusave
- National Examinations
- Private Education
- School Syllabuses
- Stages

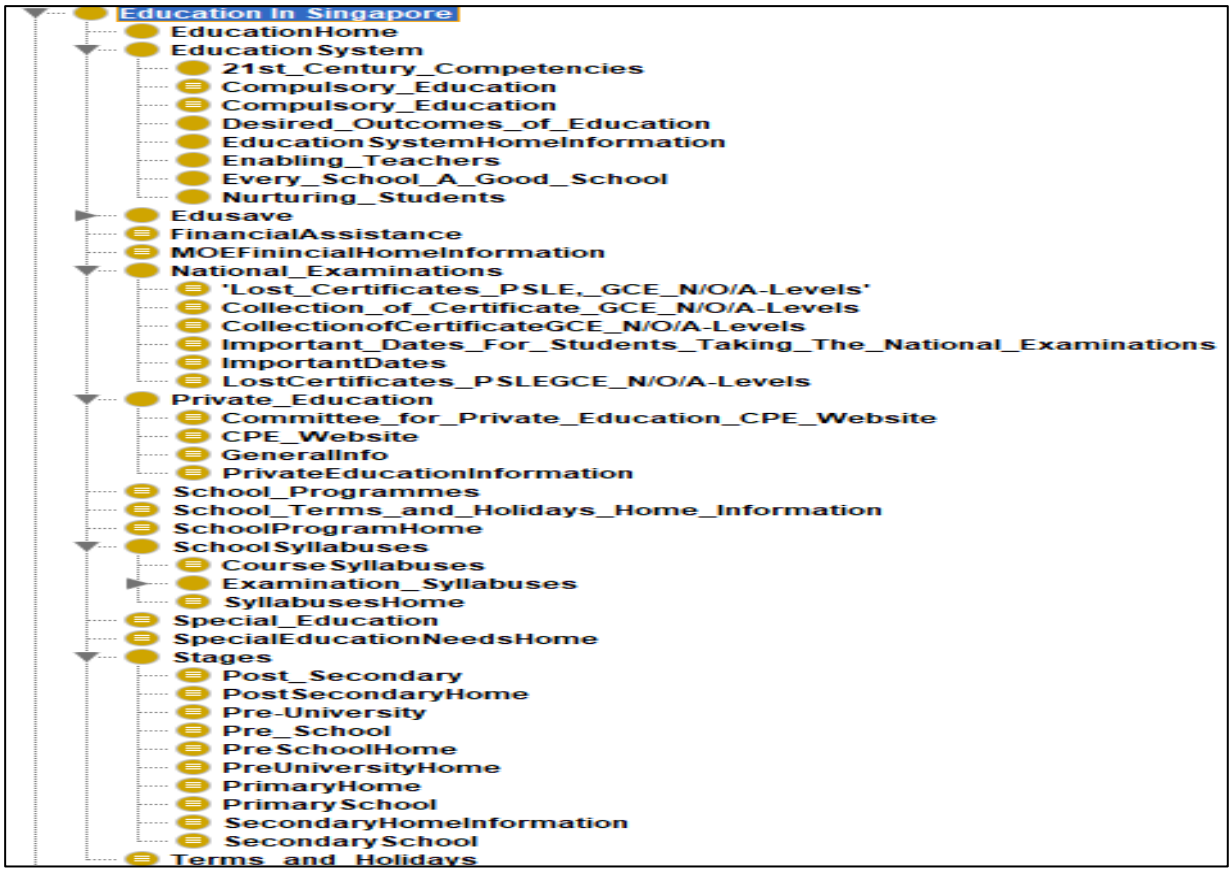


Figure 5-23 Education in Singapore Core Class

Nevertheless, education usage in the Singapore main class participates in more than 26 usages specified in Figure 5-24.

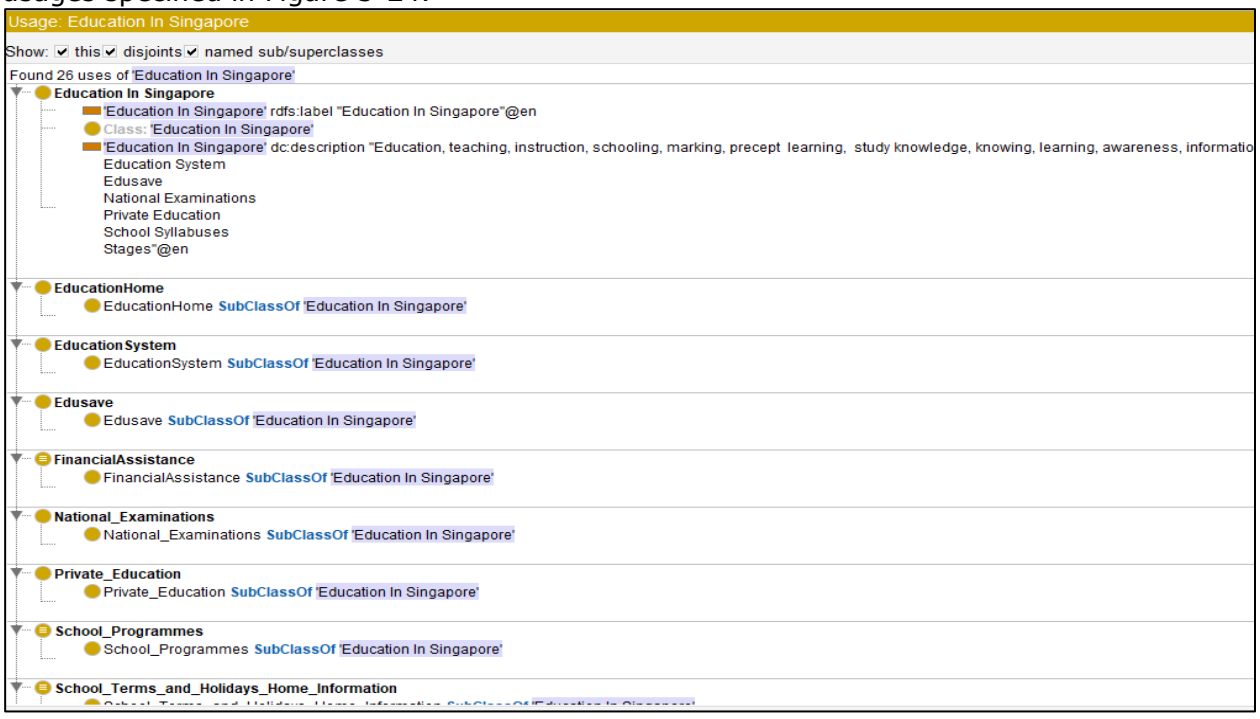


Figure 5-24 Education in Singapore Usage

5.6.9 Financial Fees and Funds Core Class

Financial Fees and Funds Core Class supply information about financial, fiscal, monetary, cash, pecuniary, the pocket of or relating to finance (see Figure 5-25).

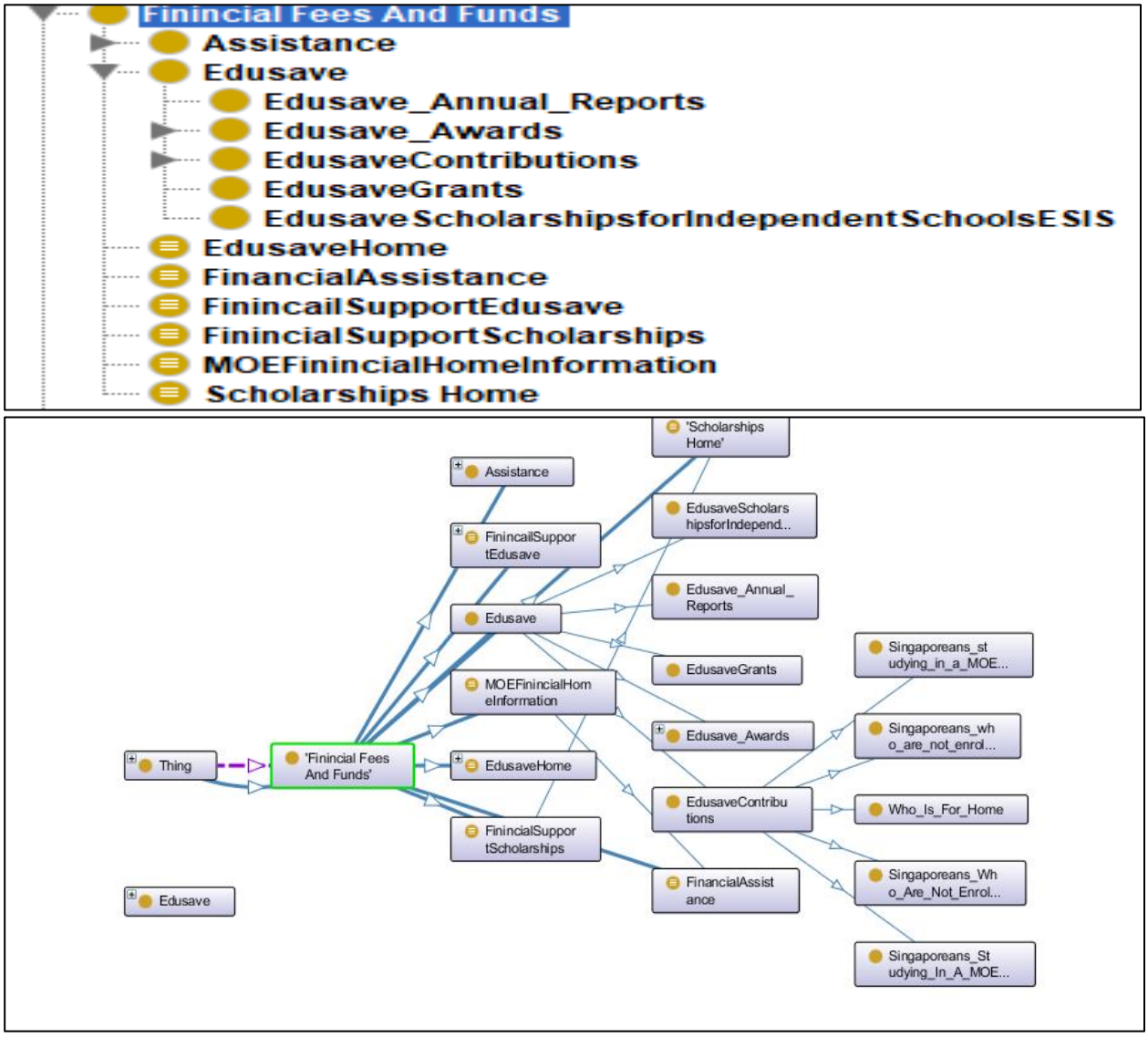


Figure 5-25 Financial Fees Main Class

5.6.10 Ministry of Education, Singapore

Ministry of Education, Singapore main class, split into three subclasses described in Figure 5-26 as follows:

- About MOE
- Contact information.
- FREQUENTLY_ASKED_QUESTIONSFAQs

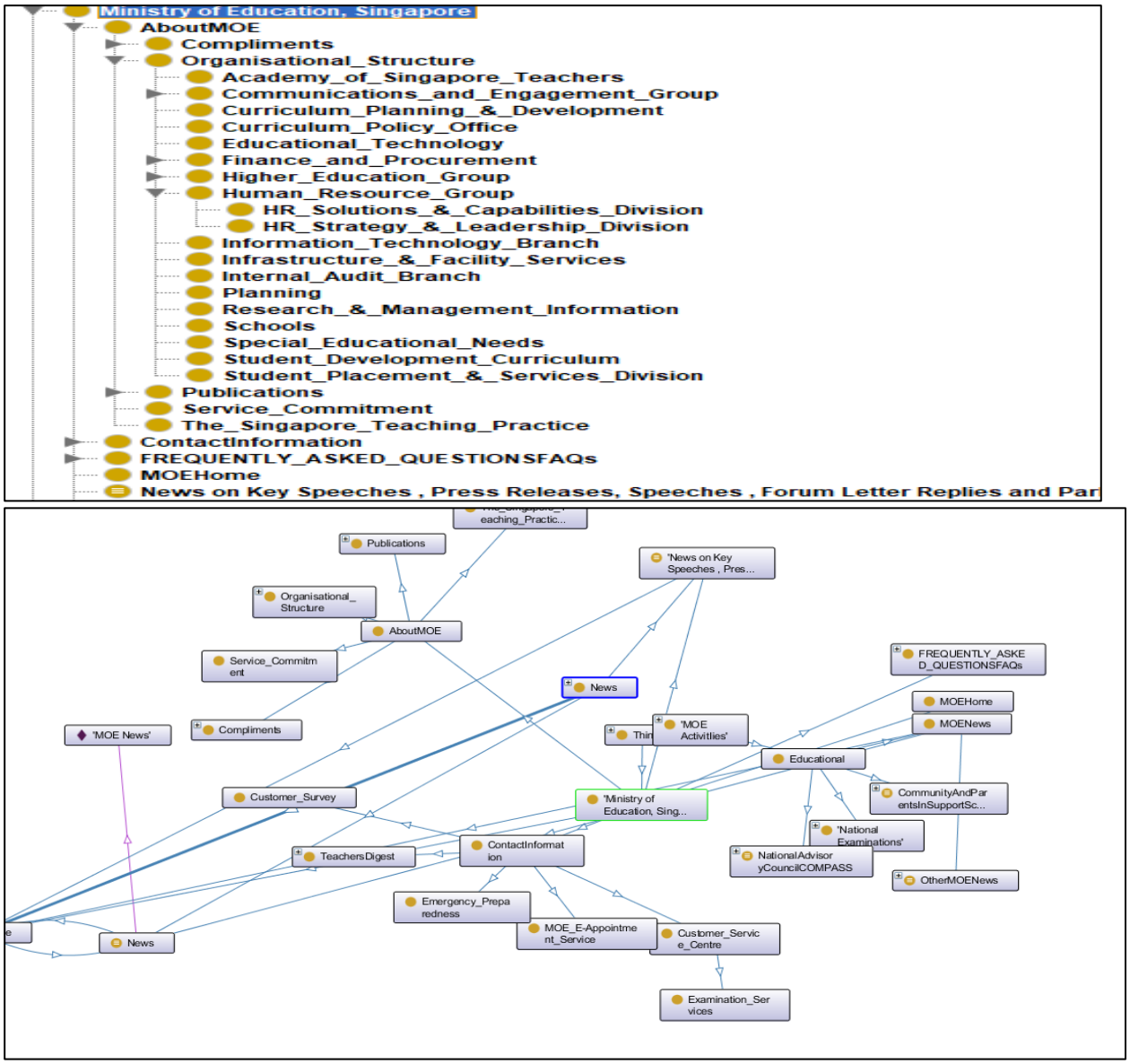


Figure 5-26 MOE, Singapore Main Class

5.6.11 Person Core Class

A human being is regarded as an individual. However, the Person class supplies information of a person, individual, man, guy, body, bloke either employee or User. The person main class is described in Figure 5-27.

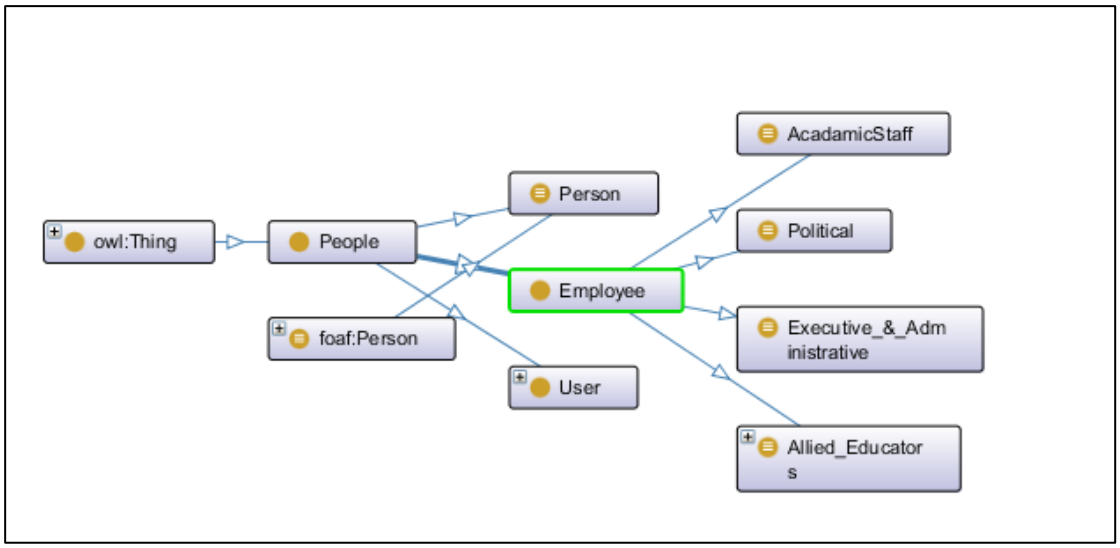


Figure 5-27 Person Core Class

5.6.12 Position Main Class

Position Main Class provides information on position, office, job, appointment, tenure, status, situation, placement. Yet it includes subclasses described in Figure 5-28 as follows:

- Academic Staff Position
- Allied Educators Position
- Executive &Administrative Positions
- Political Position

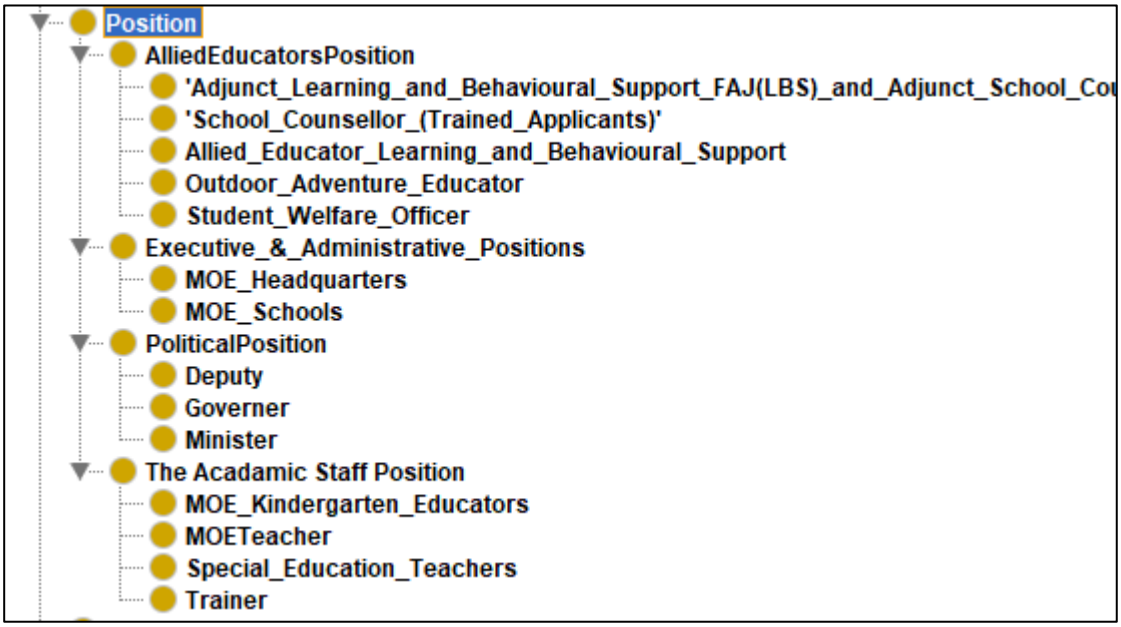


Figure 5-28 Position Core Class

5.6.13 Programmed and Courses Main Class.

Programmed and Courses Main Class provided information about approach, program, program, agenda, platform, scheme, plan, and schedule.
Comprise information illustrated in Figure 5-29 as follows:

- Programs Special
- School programs

- Syllabuses

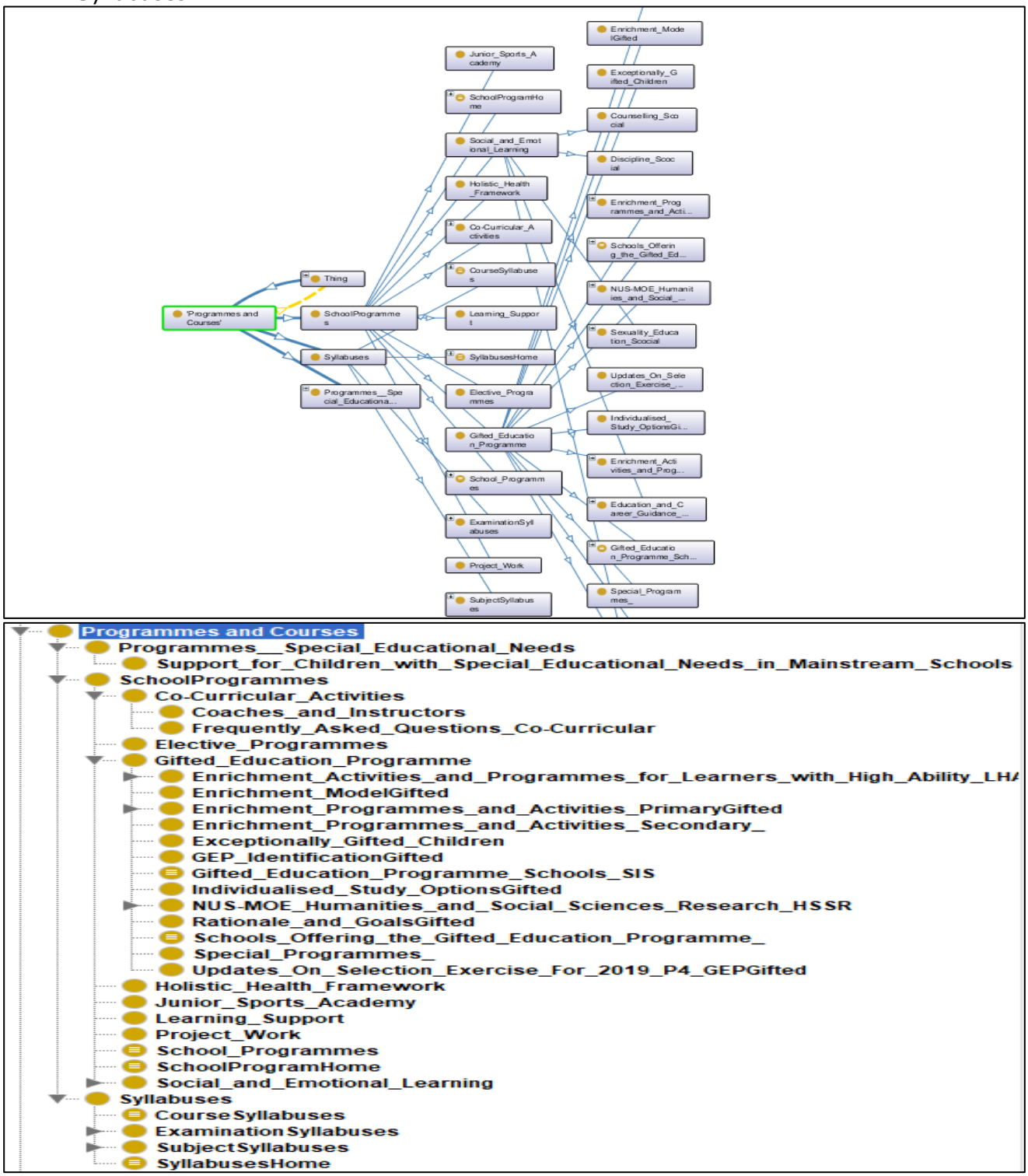


Figure 5-29 Program and Courses Main Class

5.6.14 School Core Class

School Core Class described in Figure 5-30 provide information about educational institution academy, college, university, seminary, an institution for educating children.
Completely subclasses comprised as:

- School Information Service SIS
- School Terms and Holidays Home Information
- Terms and Holidays

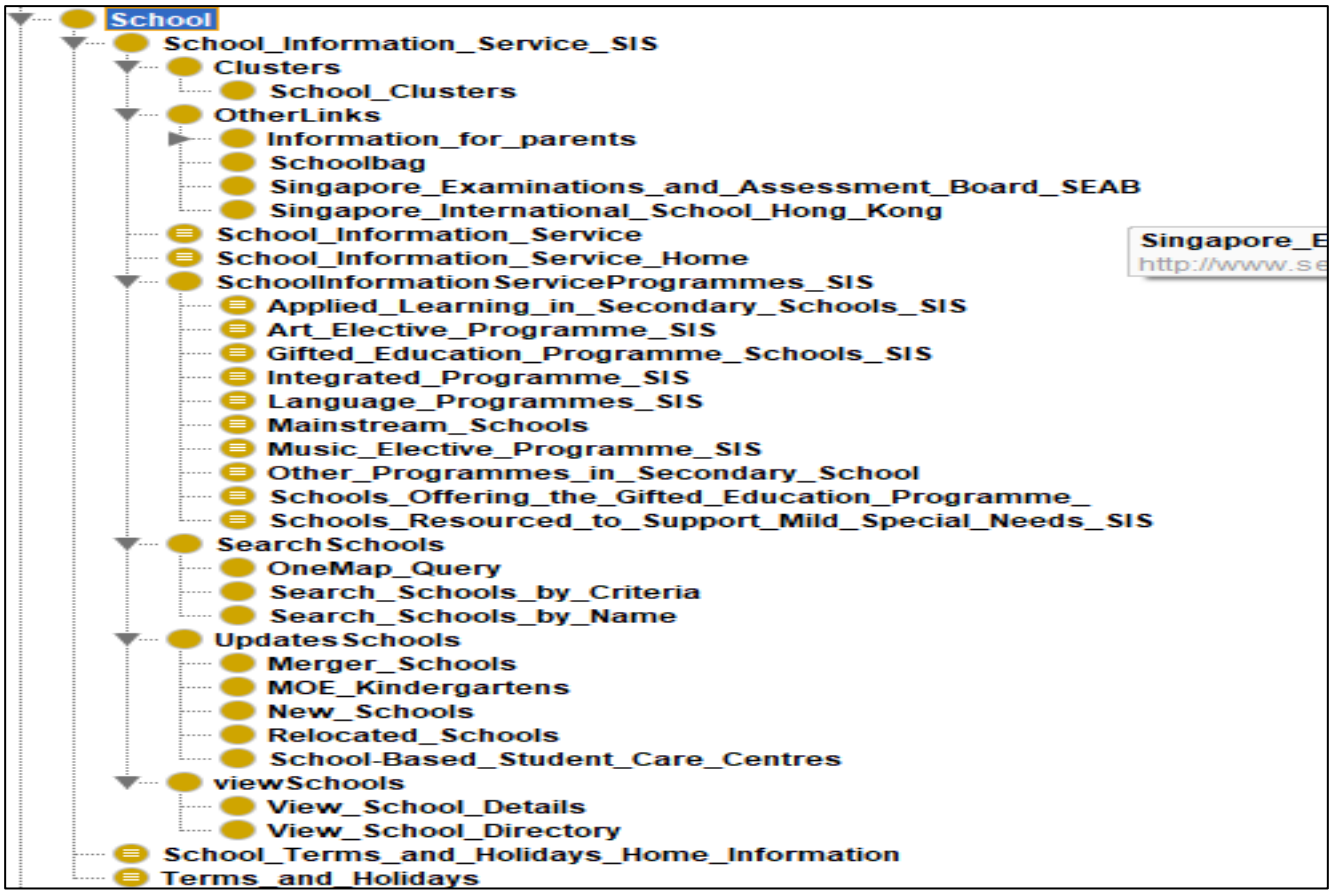
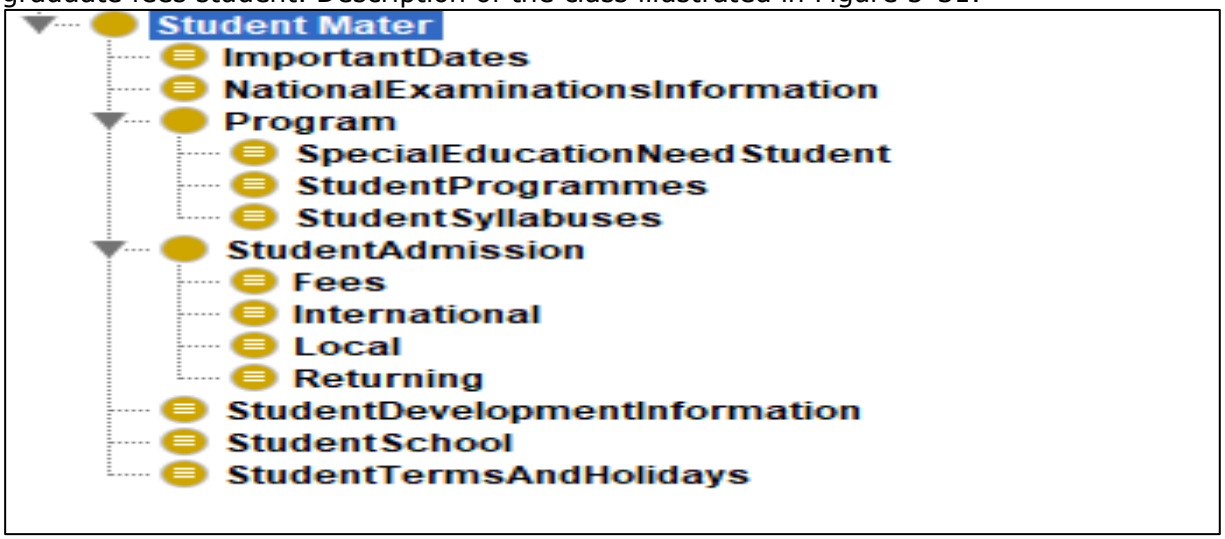


Figure 5-30 School Main Class

5.6.15 Student Mater Core Class

Student Mater Core Class contains information such as local student, international admission, program, applicant, request, scholar, dates, learner, scholar undergraduate graduate fees student. Description of the class illustrated in Figure 5-31.



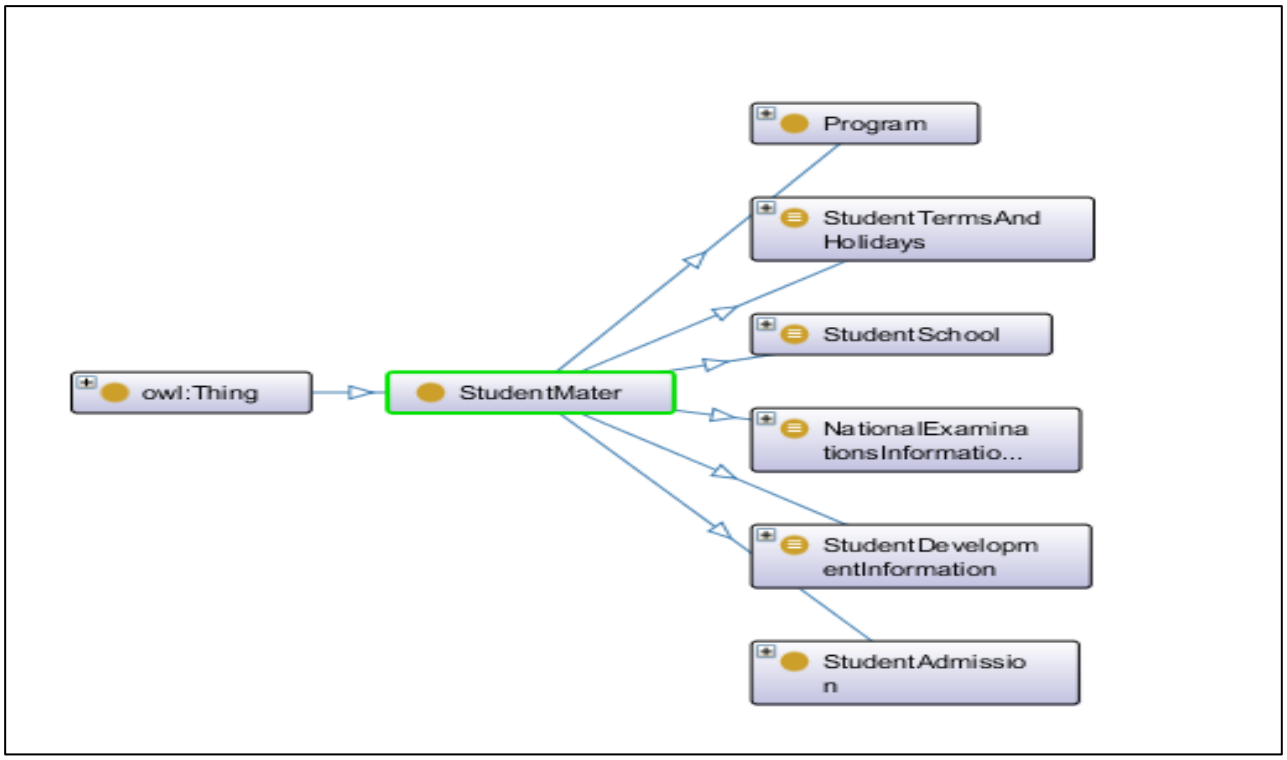


Figure 5-31 Student Matter Main Class

While the Student Mater Core Class participates in more than 15 usages specified in Figure 5-32, which are split into classes, subclasses, properties, and restrictions toward providing a comprehensive intelligent implication. The client can infer the information with better ability and proficiency.

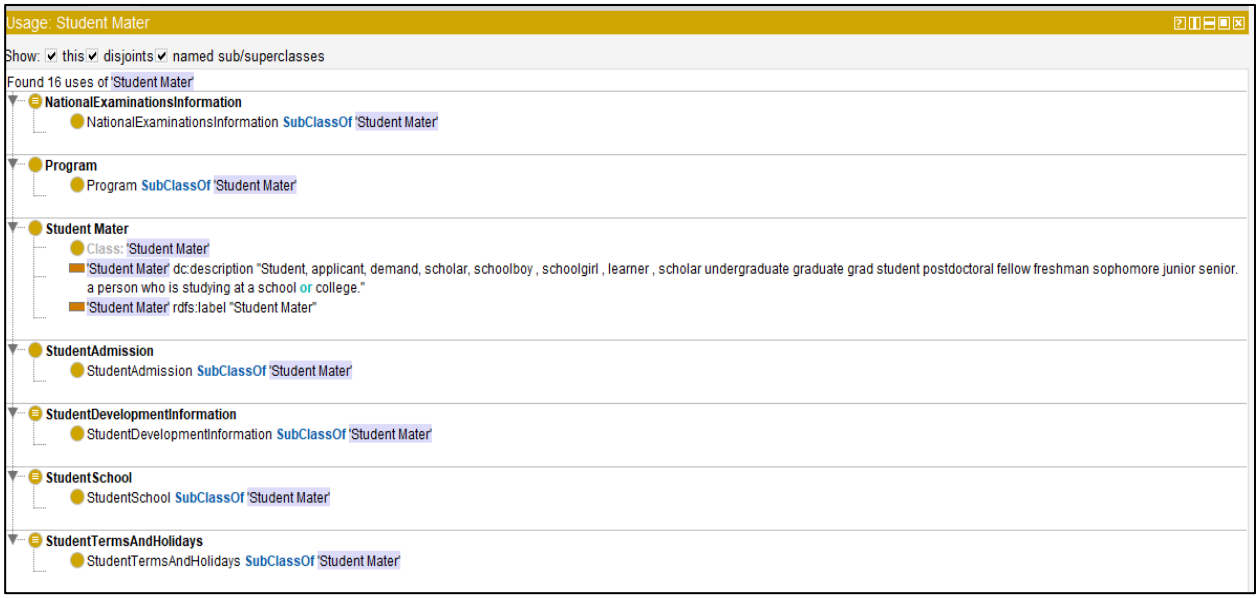


Figure 5-32 Student Mater Core Class joins

5.7 Define the Properties.

Properties or Characteristics, also called restrictions or attributes, express a group or series of rules used to form a link between classes, individuals, and ontology entries. In the OSE Ontological system, more than 47 Object Properties are considered an essential part of

creating an anthology of strength, intelligence, and effectiveness. Figure 5-33 labels the properties of OSE ontology.

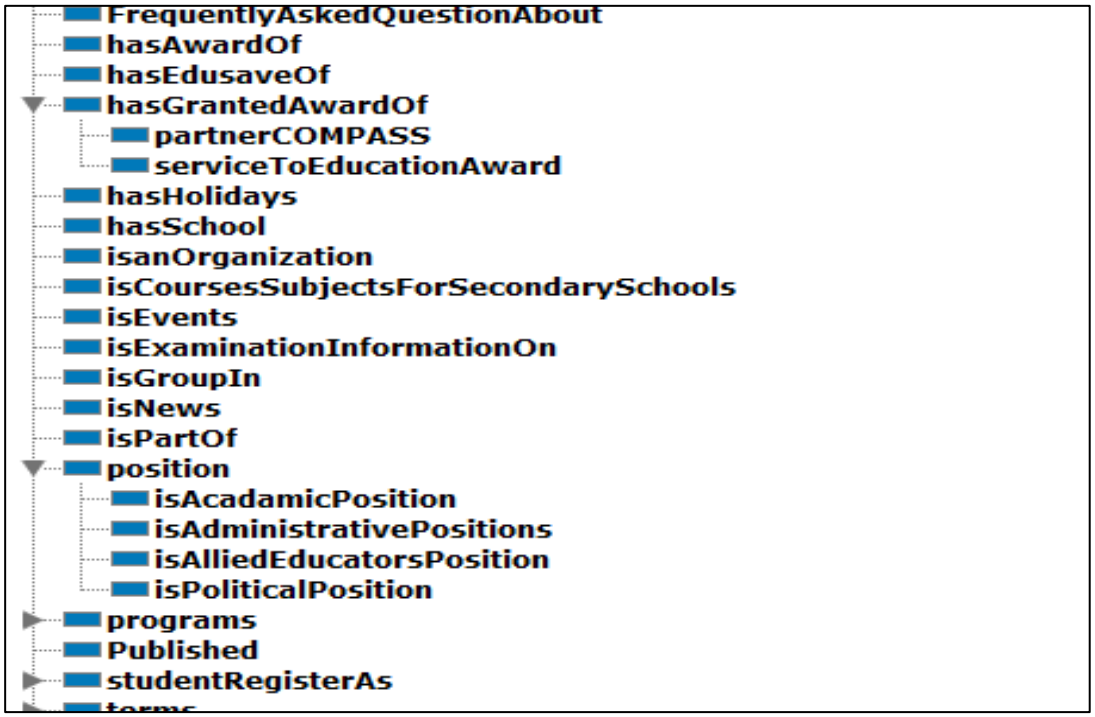


Figure 5-33 Object Properties in OSE

However, some of these characteristics cover a wide range of class domains, while others are of lesser scope. Some of the characteristics and areas of their use can be described as follows:

- Figure 5-34 described frequently asked questions about object property.

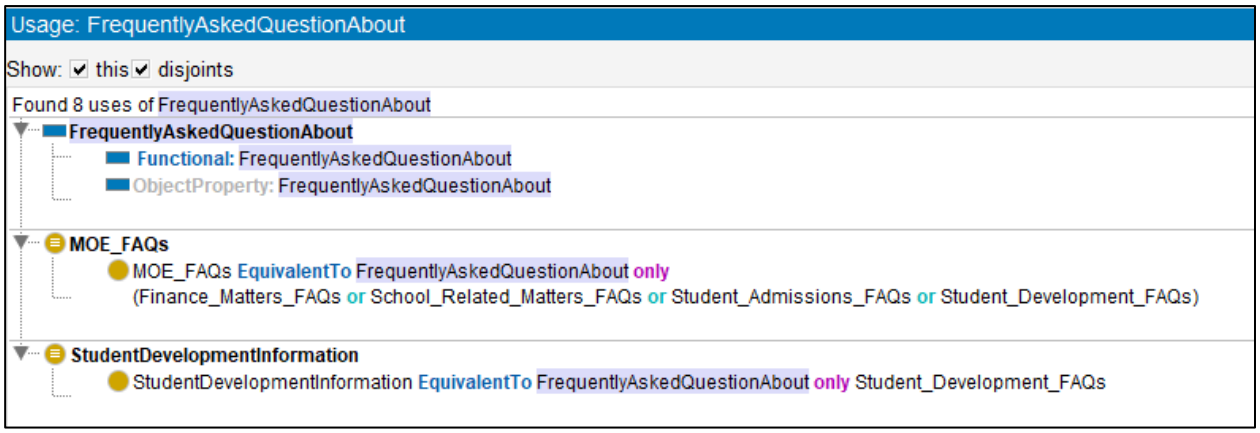


Figure 5-34 Frequently Asked Question About Property

- While award properties illustrated in Figure 5-35

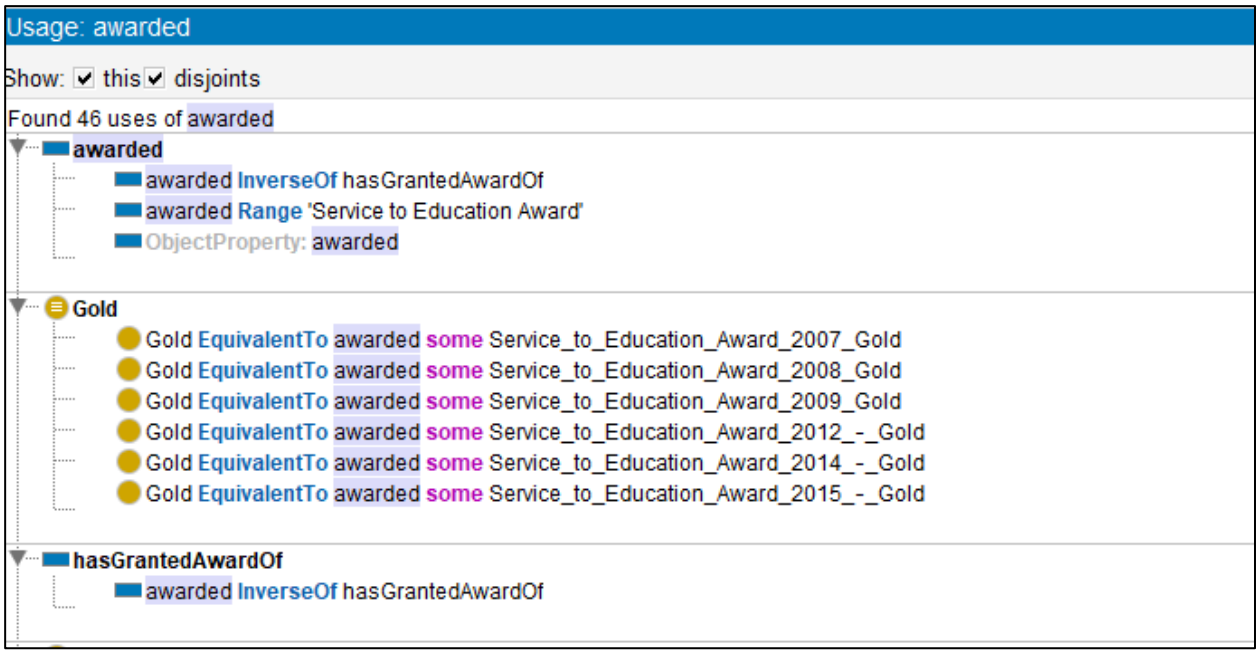


Figure 5-35 Award Properties

- The programs properties demonstrated in Figure 5-36 have three sub-properties: course syllabus, school program, and special need program.

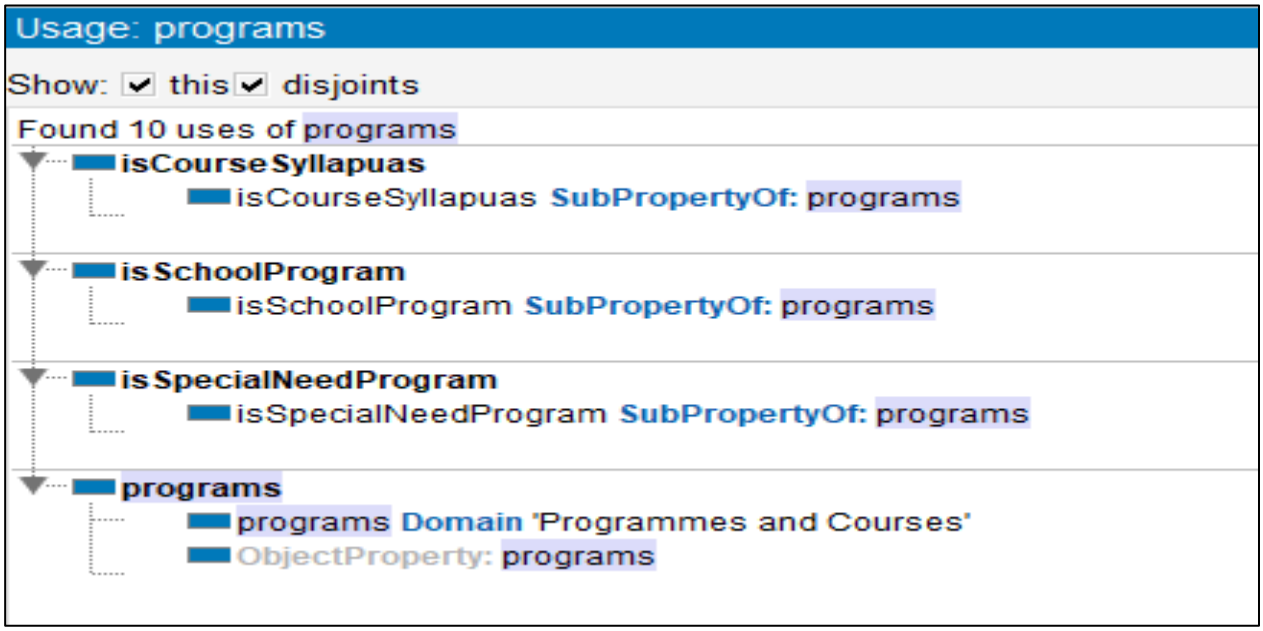


Figure 5-36 Programs Properties

- Position object property shown in Figure 5-37 comprises four sub-properties: academic position, administrative positions, allied educators' position, and political position.

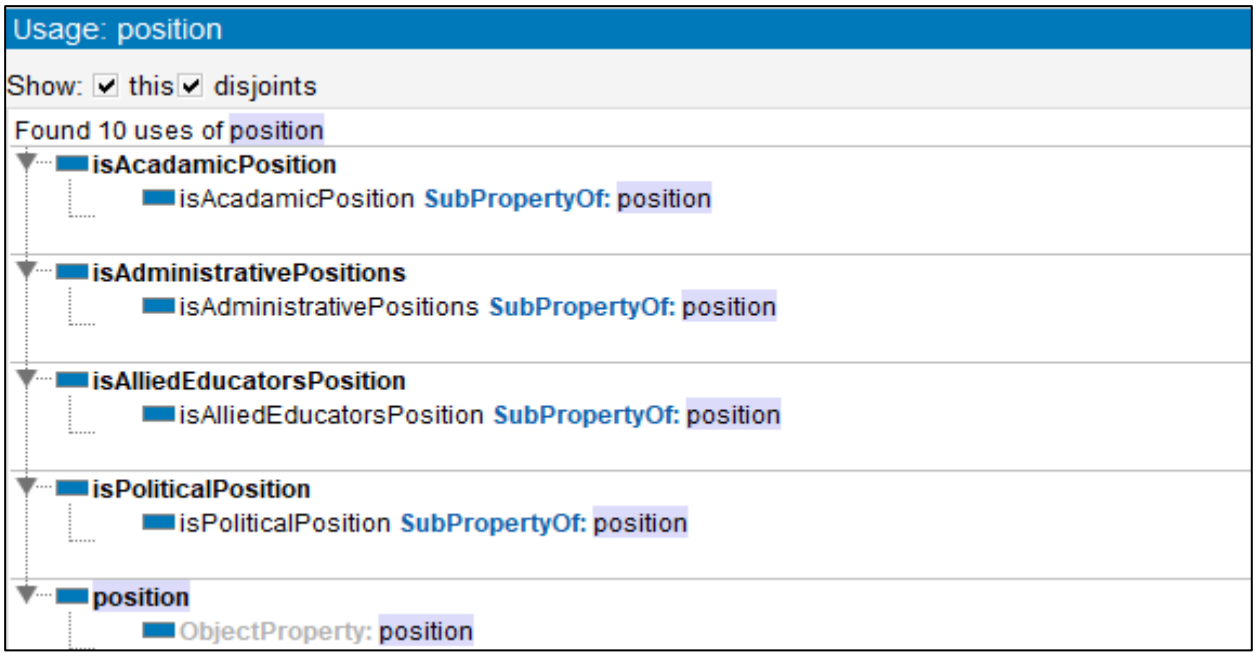


Figure 5-37 Position Property

Student Register as/ international sub-property displayed in Figure 5-38.

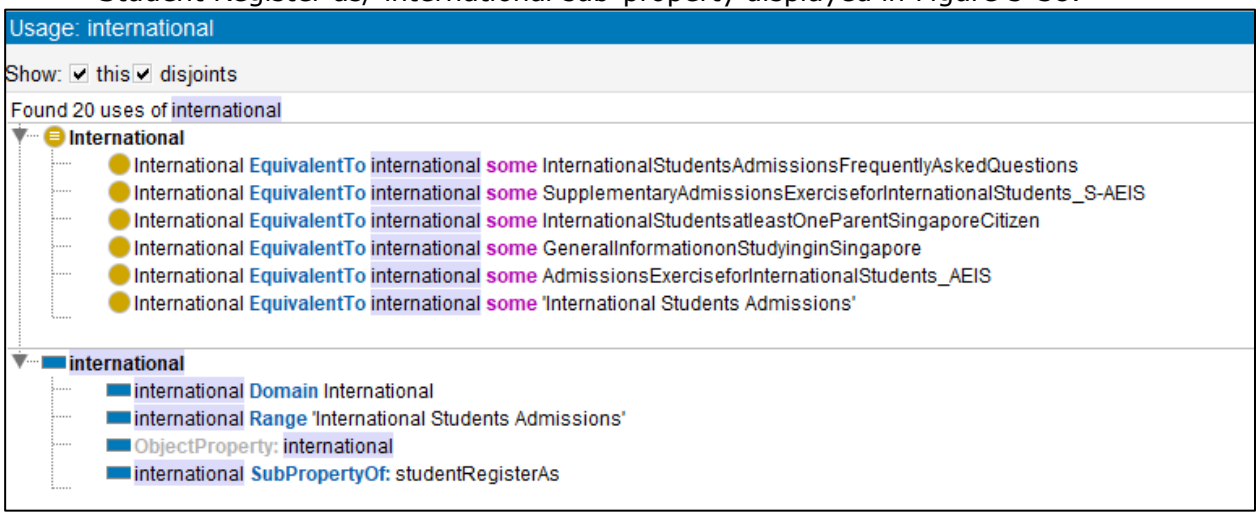


Figure 5-38 Student Register as International Sub-Property

5.8 Define the Individuals.

Individuals, or what can be called an instance, represent the link between the classes and their meaning, i.e., providing a link that is inferred through the meaning.
In the ontology of OSE, the researcher entered a total of 68 items, part of which is described in Figure 5-39.

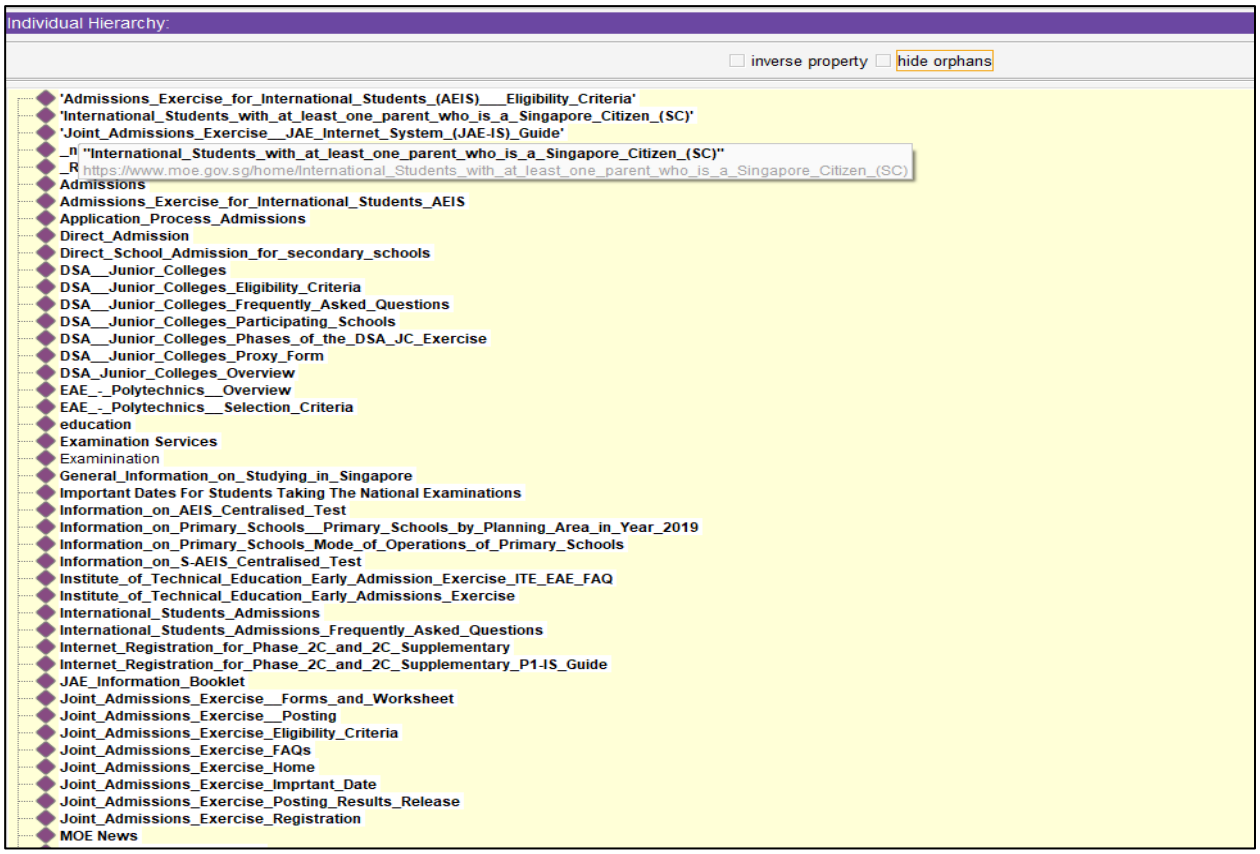


Figure 5-39 Individual Hierarchy

5.9 Ontology for Singapore Education system Website (OSEW)

Ontology for Singapore Education system Website (OSEW) is a website created by the researcher author to allow OSE ontology viewing to view and explore the Ontology for the Singapore Education system (OSE).
Also, OSEW permit you to fill the questionnaire (Survey) attached in the OSEW (you can view the site using the link:(https://sites.google.com/view/ontology-e-government/home).

However, OSEW comprises comprehensive descriptions of OSE ontology, enabling the client to fill in the form designated to evaluate the system easily and clearly.

OSEW lets the user investigate the OSE system (i.e., classes, properties, individual, system viewing).

Figure 5-40 OSEW Home Page

As illustrated in Figure 5-40, the main web page of OSEW involves the subsequent of five webpages described as follows:

1. OSE System Home Page: provide an overview OSEW Ontology for the Singapore Education system (OSE). It also supplies information about the (OSE) e-system developer, Protégé editor.
2. OSE Ontology display page is shown in Figure 5-41: allow a user to transfer and/ picture a full edition of the Ontology in various structures utilizing the connect OSE Ontology technique

- display OWL Version.
- display Ontology utilising Web Protégé, and
- HTML Structure.

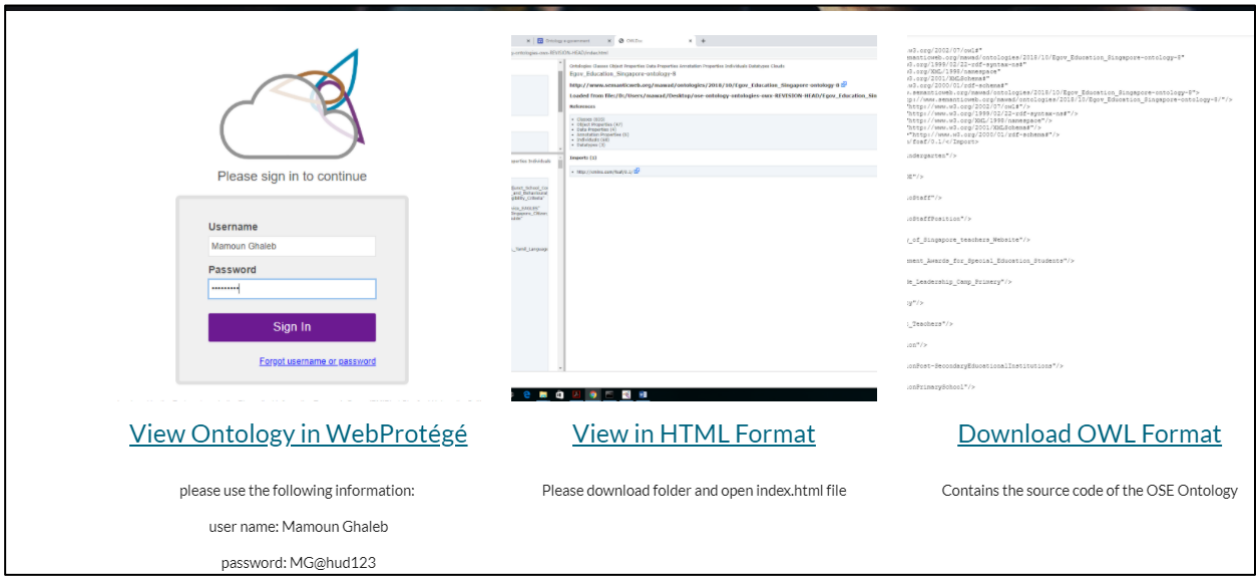


Figure 5-41 OSE Ontology Display Page

3. OSE Ontology Classes page shown in Figure 5-42: describe the fifteen main classes to view by user.

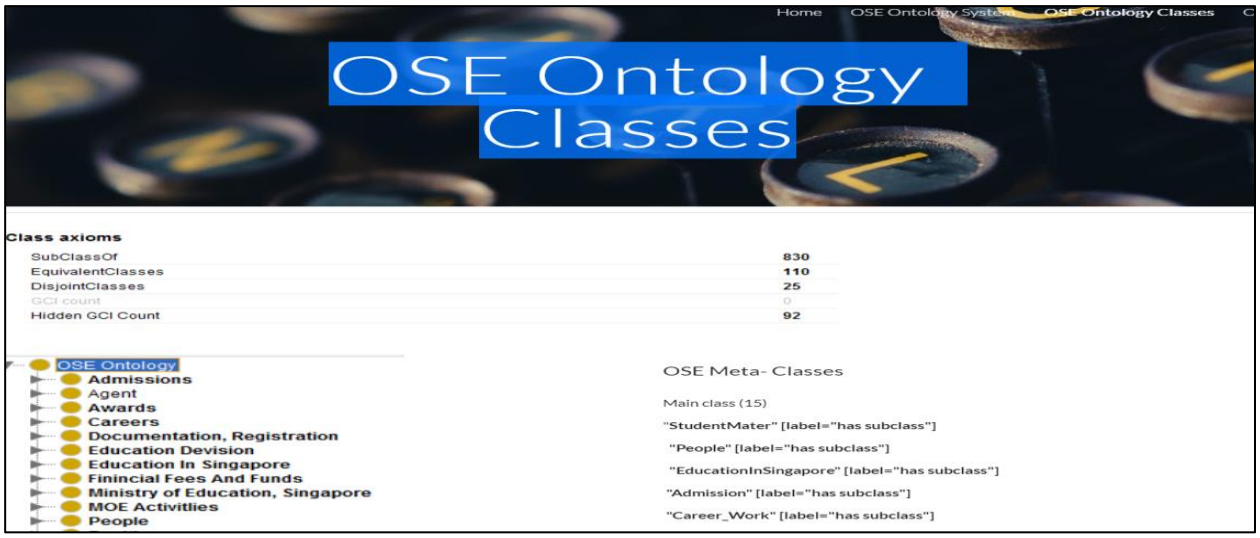


Figure 5-42 OSE Ontology Classes Page

4. OSE Ontology Properties: explained a comprehensive explanation of properties.

5. Evaluation Form Page presented in Figure 5-43.

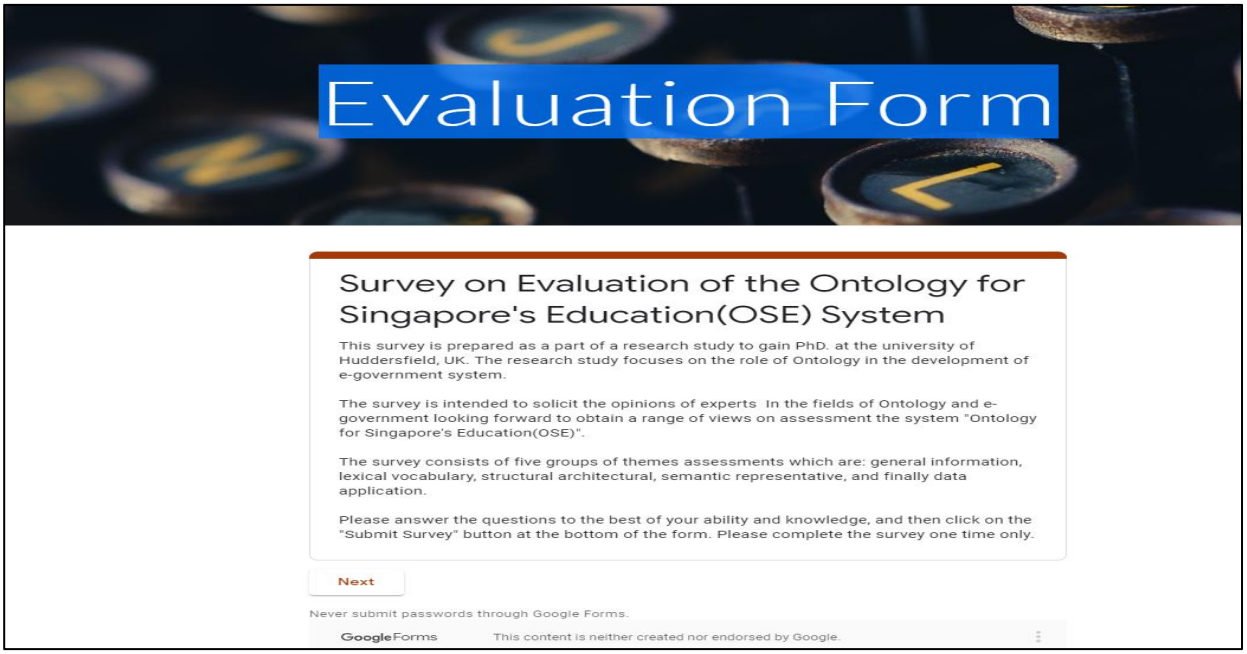


Figure 5-43 Evaluation Form Page

5.10 Summary

The primary consideration for developing OSE ontology is to develop a formal model and a basic knowledge base that represents the domain of e-government.

Emphasis taken when designing OSE that the ontology construct should be a formal model that can be reused within the domain of e-government.

However, the built knowledge base constitutes a basis for evaluating and studying the effectiveness of the ontology in developing e-government, which is the main objective of this study.

The design and development of the OSE system relied on a Methontology methodology, where the methodology is suitable for developing the OSE system. The methodology consists of seven steps, starting with specification and end with documentation.

The OSE system consists of a massive number of classes, specifically 835, in addition to 193 assertions, with further than 80 rules and interactions, to handle the strong intelligence articulation capacity. However, the strength of the OSE was demonstrated in a large number of Axiom numbers higher than 2600.

Finally, the OSEW was designed to allow the user of OSE ontology to view and explore the Ontology for the Singapore Education system (OSE).
Also, OSEW permits to fill the questionnaire (Survey) attached to the OSEW

6.Chapter 7: Results and Discussion

The chapter attempts to evaluate and estimate the results obtained in the research, which are related to the evaluation of the OSE ontological system environment developed by the researcher. While the full system checks and the verification process used are built from early release to the full system environment.

Concerning the aim of the evaluation, it is clearly expressed by trying to collect and analyses the set of responses to the ontology developed by the researcher with the combined evaluation method. Though, a unique website has been created that aims to collect feedback from knowledge experts in the field.
The researcher's response is to review and provide additional attention that helps in developing the OSE environment.

6.1 Evaluation OSE Ontology

Through a careful review of the various evaluations that were followed by a group of researchers that were evaluated and discussed in the second chapter, "Literature Review," the researcher concluded that the use of ontology assessments has two main components explicitly, validation and verification adapted by Gómez-Pérez et al. (2004).
Evaluating the system is based on the superiority and fulfilment of the study requirements, as the approach shows a clear superiority over other methods, such as comparing ontology and the golden rule (more details in the system second chapter, the ontology assessment section).
Table 6-1 draws a complete detail of the evaluation method, evaluation approach, and description that the researcher will follow to evaluate the OSE ontological system.

Table 6-1 Evaluation Method

OSE Evaluation	Method Applied	Utilized Approach
Consistently	Validation	Utilize plug-in Debug/ HermiT reasoner available in Protégé
Coherency	Validation	Use Debug/ HermiT plug-in reasoner available in Protégé
Logical Syntax checking	Validation	Employ HermiT plug-in reasoner available in Protégé
Axiom Ontology Check	Validation	Utilize HermiT plug-in reasoner available in Protégé
Clarity\ Vocabulary and lexical	Verification	Knowledge Expert in the field to evaluate OSE ontological system using filling Survey
Structural\ Architectural layer	Verification	Knowledge Expert in the field to evaluate OSE ontological system using filling Survey
Representational and Semantic layer	Verification	Knowledge Expert in the field to evaluate OSE ontological system using filling Survey
Data \ Application layer	Verification	Knowledge Expert in the field to evaluate OSE ontological system using filling Survey
Sematic search System retrieval	Verification	Experiment-development approach

6.1.1 OSE Validation

The purpose of conducting validation is to guarantee that the OSE ontological system was enhanced with checking of luxuriousness of vocabulary and syntactic. However, the validation approach was established on the basis of the following arguments:

- Figure OSE ontology written (consistency and Coherency).
- Ensure that OSE syntax built does not include errors and changes.

The Next important aspect is testing the cohesion of knowledge by using the features and tools available in the program Protégé modelled by HermiT reasoner. Accordingly, it is ensured that the constructed system is a system that is free from errors, clear words and comprehensive.

Accordingly, HermiT reasoner applied to the OSE ontological system in several stages, starting from the first stage to the end of the investigation.

However, HermiT reasoner shows errors in classes by showing them in red, which means there is an error in the naming of classes or combinations. Errors must be corrected before continuing to construct the ontology system.

After several attempts by the researcher to investigate and correct the ontology, all classes appeared without errors. The ontology was constructed correctly, as shown in Figure 6-1, which allowed the work to be completed.

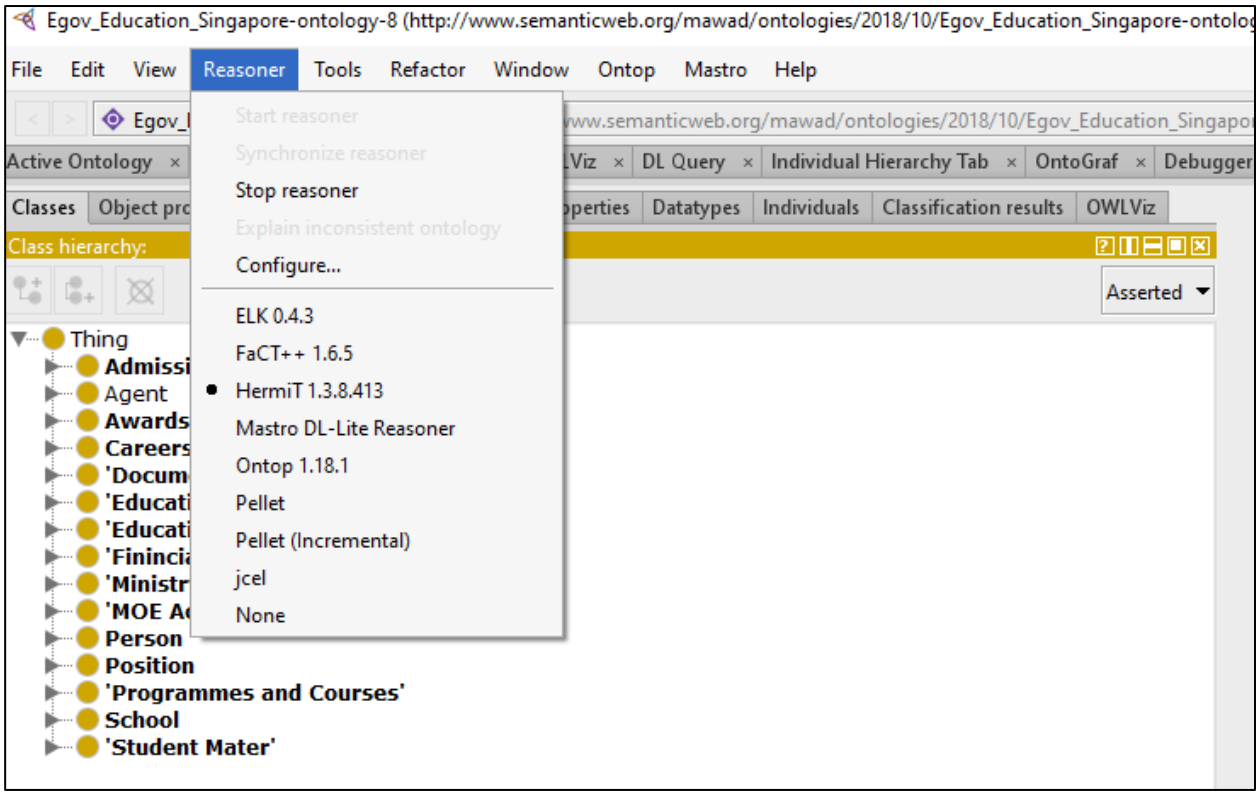


Figure 6-1 Part of OSE ontology verification Results Showing No Error

As for checking both consistency and Coherency, Debug, which allows to verify checking after performing the examination, confirms that the system is successful, as shown in Figure 6-2.

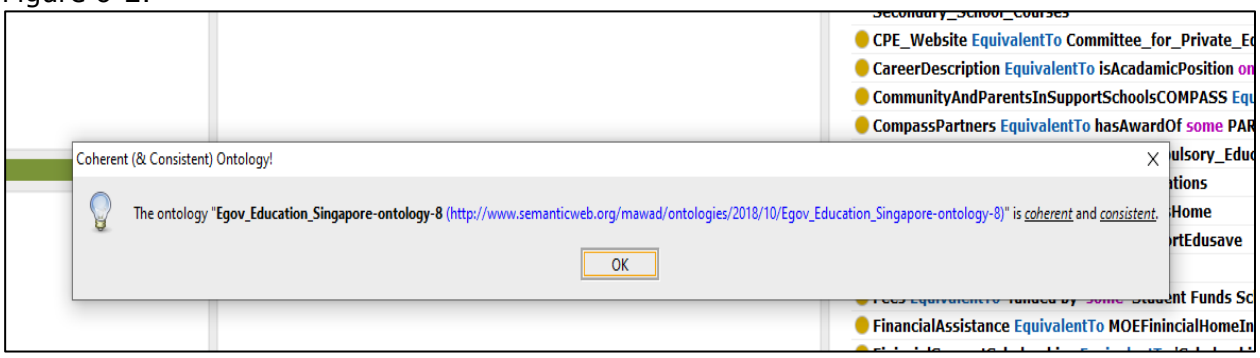


Figure 6-2 OSE Shows Coherence and Consistence

Nevertheless, after analysing and confirming that the OSE ontological system contains no error, consistency, and coherence, it was presented to the specialists to be assessed.

6.1.2 OSE Verification

E-government knowledge specialists assessed the OSE ontological System. While knowledge experts in either area of e-government or ontological System attempted to supply their acknowledged in specific attributes such as some valid names (classes, properties), clarity and unambiguous of the structure of OSE, system semantically, and architectural building of the system.

Also, knowledge experts allow to modify the ontological system by adding or dividing certain classes (when needed). But requests for modifications were processed with irregularities.

The next part provides a full explanation of the evaluation procedure of ontology verification.

6.1.2.1 State of Evaluation

The evaluation scenario implements the user case, which presents the fundamental processes of ontology assessment.

The researcher creates the early form of the OSE ontology using Google Forms. Throughout the movement, the ontology is assessed from expertise professionals' people.

In the created website and form, the researcher indicates the taxonomy of OSE on OSEW to be Considered and accessible.

The investigator is also concerned with OSE utilised in different formats and making it available and accessible to the experts.

Figure 6-3 shows the possibility for experts to review the ontology using the Web Protégé tool, where OSE has been loaded into the program. However, the experts have given the ability to modify the version without affecting the original version of the OSE system.

Access to the Web Protégé program requires a username and password that has been provided to the experts who will evaluate the system.

The researcher also explained the instructions through the special platform established by the researcher OSEW.

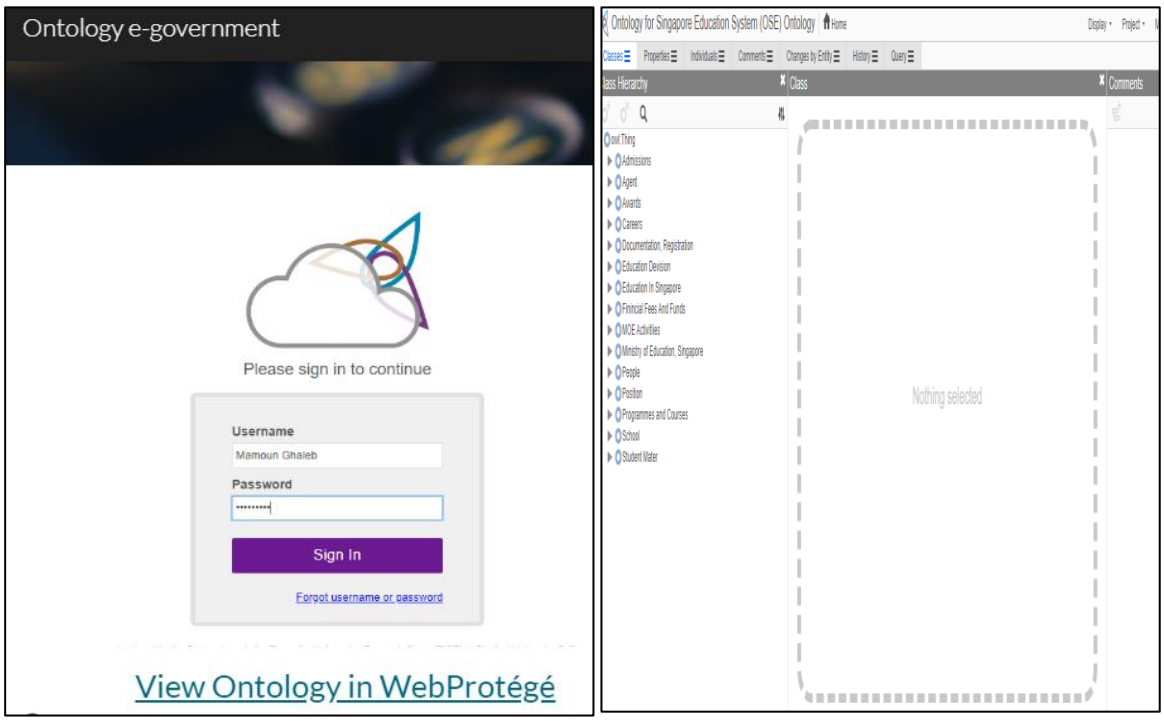


Figure 6-3 View Ontology in Web Protégé

6.1.2.2 Questionnaire

A questionnaire on Evaluation of the Ontology for Singapore's Education (OSE) ontological System was distributed among the knowledge exporters.

However, experts were called upon to complete the questionnaire based on the prior assessment of the OSE system.

The questionnaire was provided through the special website established by the researcher on the Internet (OSEW).

The questionnaire provides an opportunity to provide suggestions for improvement, based on criteria described in Chapter Two, "Literature Review.

Invitations were sent to the concerned experts via electronic messages, inviting them to participate in filling out the questionnaire and directing them to the special website, see Figure 6-4.

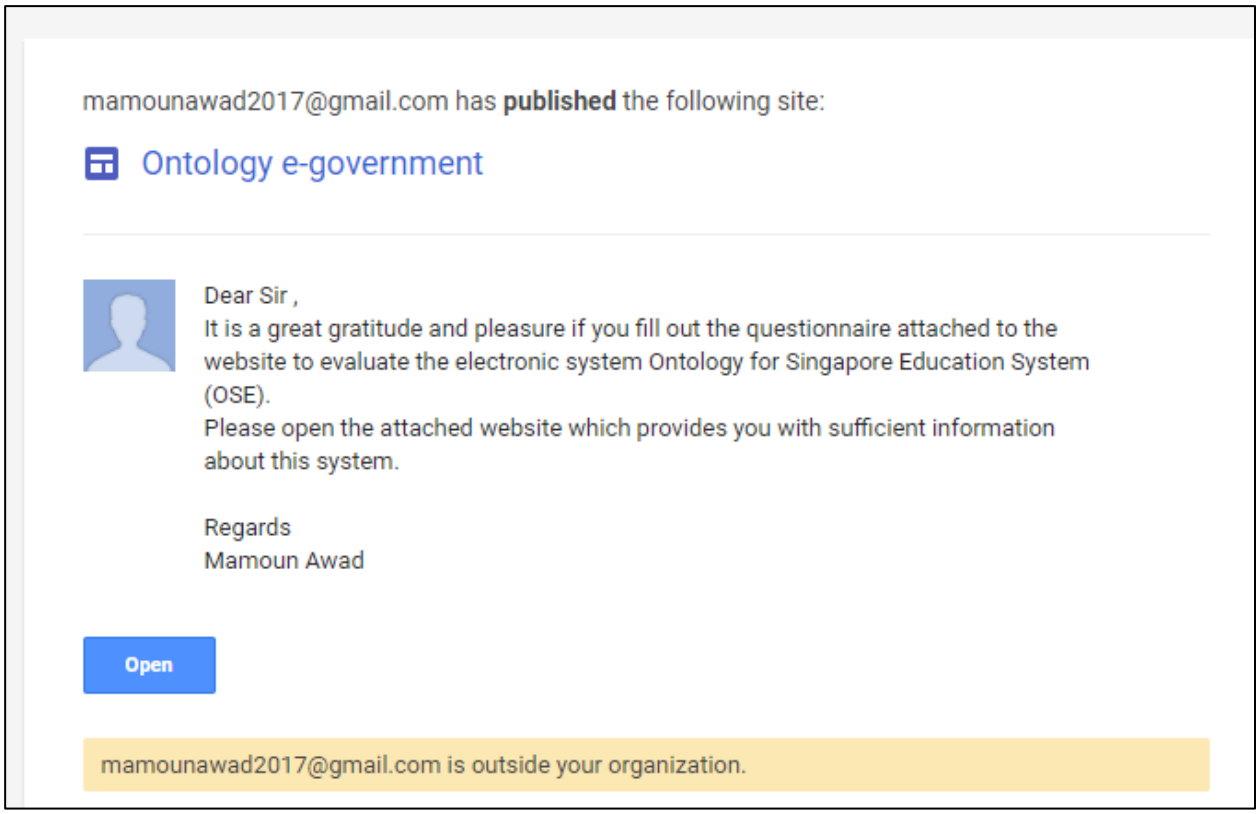


Figure 6-4 Ontology e-government - Experts Invitation

The survey is intended to solicit the opinions of experts in the fields of Ontology and e-government looking forward to obtaining a range of views on the assessment of the system "Ontology for Singapore's Education (OSE)."

The survey consists of five groups of themes assessments which are:

1. General information.
    - Expert's knowledge (categories fields and experiences).
    - Evaluate the current Singapore education portal (quality of services and meet satisfactions need).
2. Lexical vocabulary.
3. Structural architectural.
4. Semantic representative.
5. Data application.

Earlier requesting the participants to respond to the queries on the OSE ontological system and conveyance comment, a few explanations are shown on OSEW to provide experts with clarification.

6.1.2.3 Questionnaire General information

Table 6-2 displays the general six questions and the type of question given to Experts.

Table 6-2 General Question

G.Q 1 Where of the following categories you consider/find yourself? (How likely, is you consider/ find yourself?).	• Type: Expert's knowledge
G.Q 2 Please select the domain knowledge which you belong to?	• Expert's knowledge
G.Q 3 How long have you been worked in the field of e-government / Ontology semantic web?.	• Expert's knowledge
G.Q 4 Overall, how satisfied or dissatisfied are you with services offered in Singapore's education portal?.	• Evaluate the current Singapore education portal.
G.Q 5 How well does Singapore's education portal meet your needs?	• Evaluate the current Singapore education portal
G.Q 6 How would you rate the quality of Singapore's education portal to deliver the various services?	• Evaluate the current Singapore education portal

6.1.2.4 Questionnaire Clarity\ Vocabulary and lexical

This section is concerned with how effectively the vocabulary and lexical elements are described in the OSE system.
The question is described in Figure 6-5.

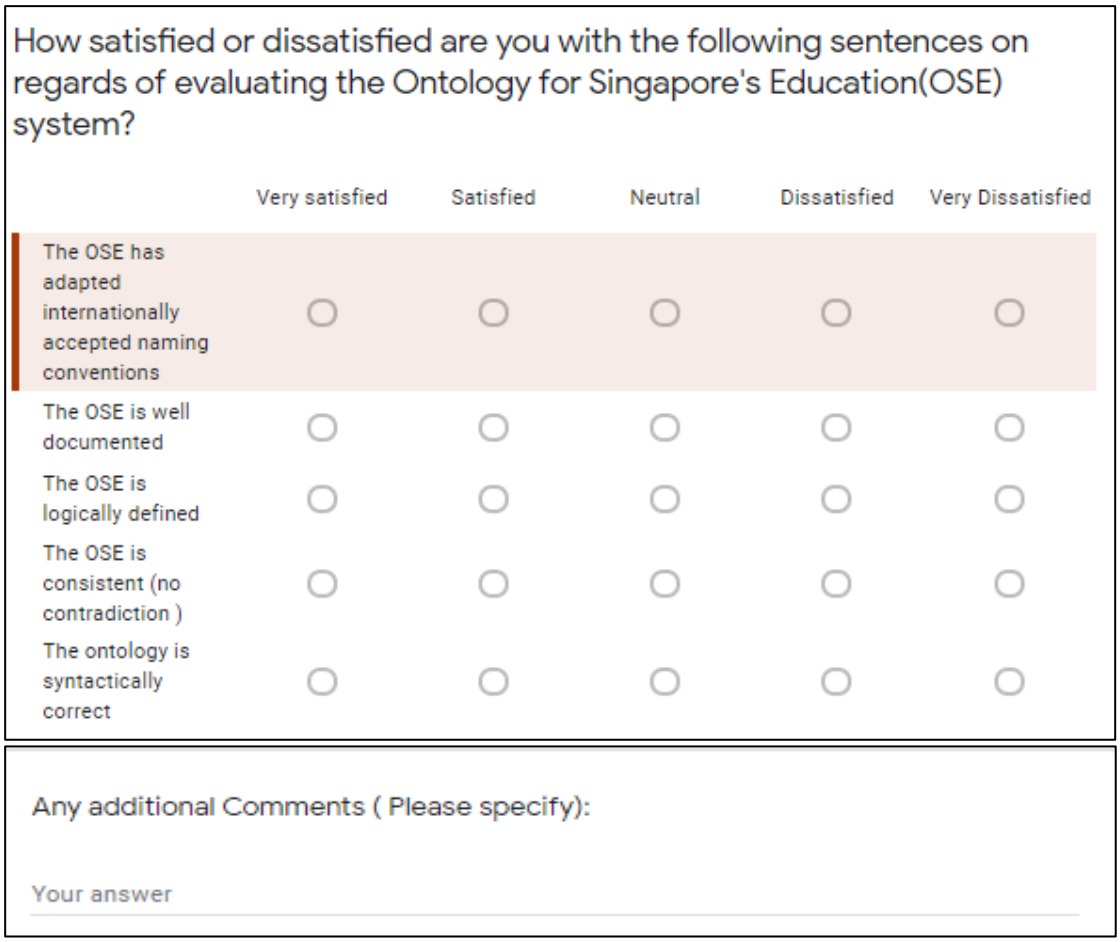


Figure 6-5 Clarity\ Vocabulary and lexical

6.1.2.5 Structural\ Architectural layer

Figure 6-6 shows Structural\ Architectural layer questions, which contain three questions and comments and suggestions of the Structural\ Architectural l of the OSE.

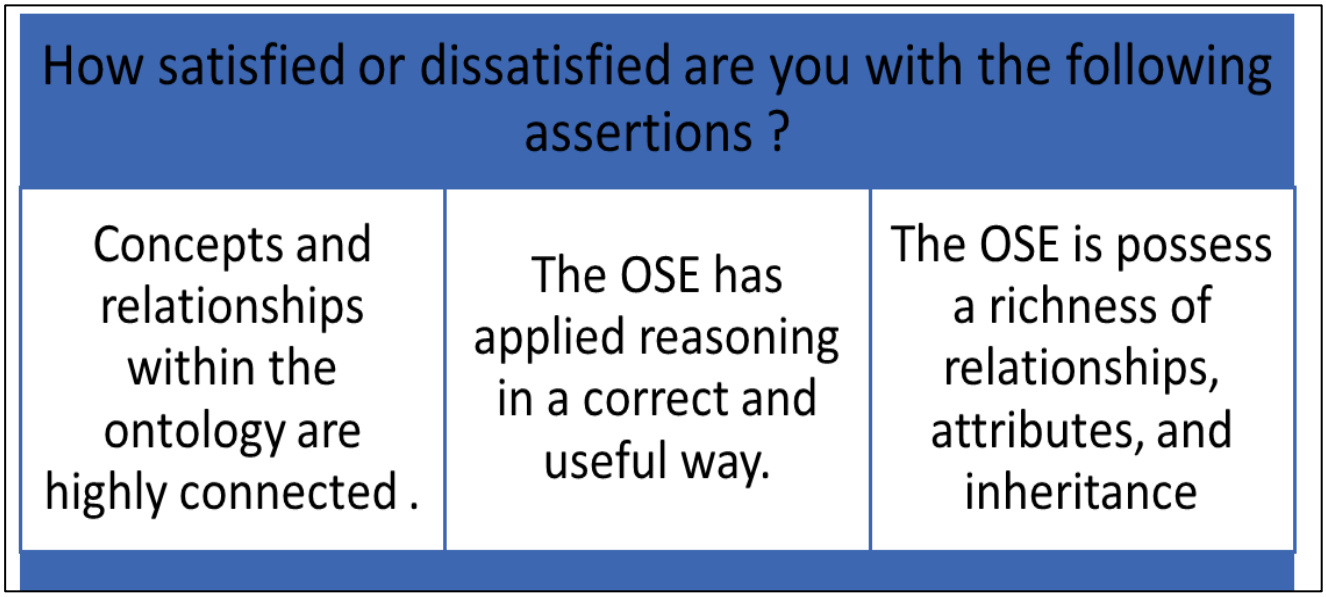


Figure 6-6 Structural\ Architectural layer

6.1.2.6 Representational and Semantic layer

Figure 6-7 described questions used to evaluate the semantic factors of the OSE composition are assessed in the section as it is worried about how well the ontology structure has characterized conceptual description.

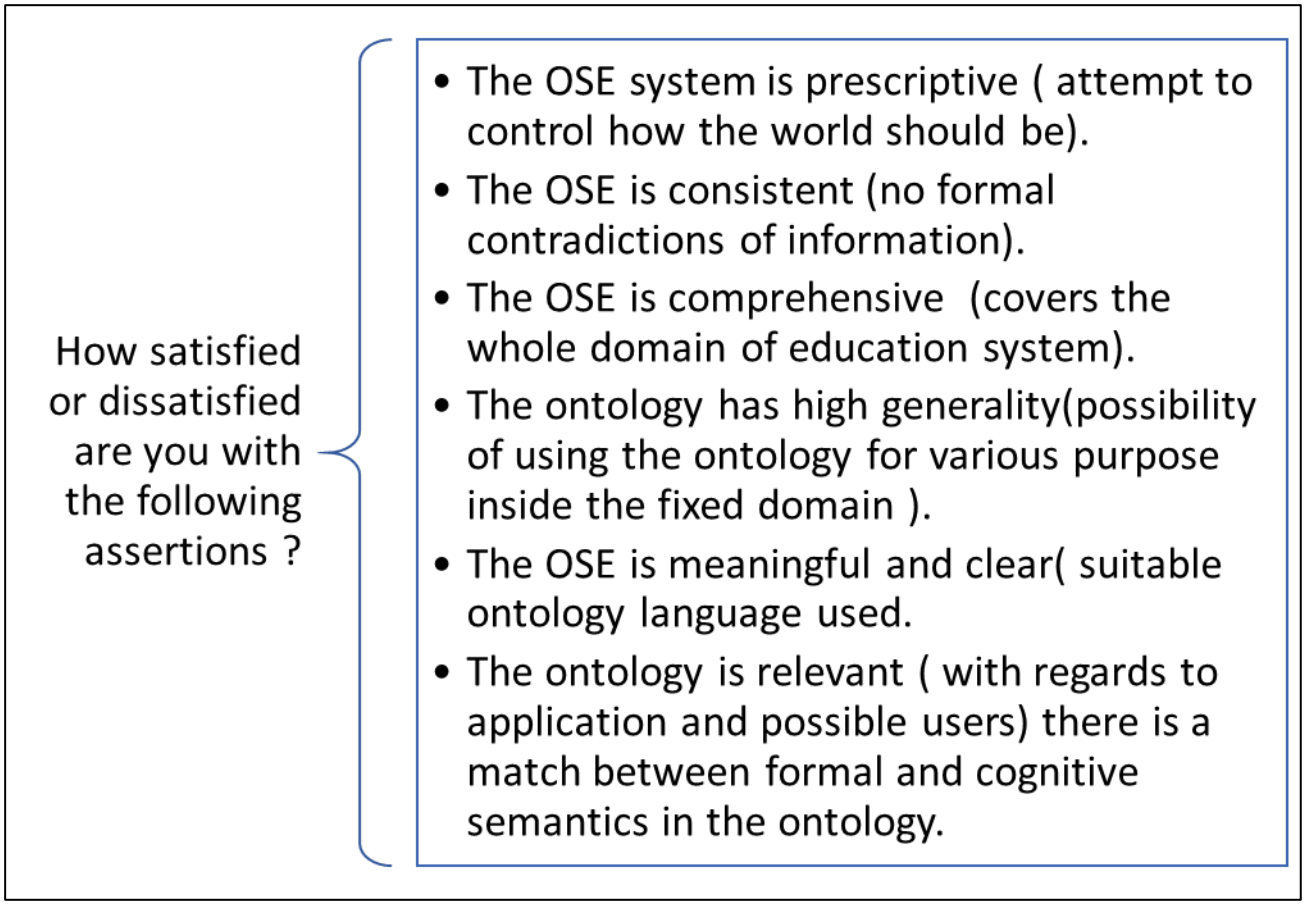


Figure 6-7 Representational and Semantic layer Questions

6.1.2.7 Data \ Application layer

This section is concerned with the ontology's capability to demonstrate the understanding in each field. Figure 6-8 refers to questions used to evaluate the data and application layer.

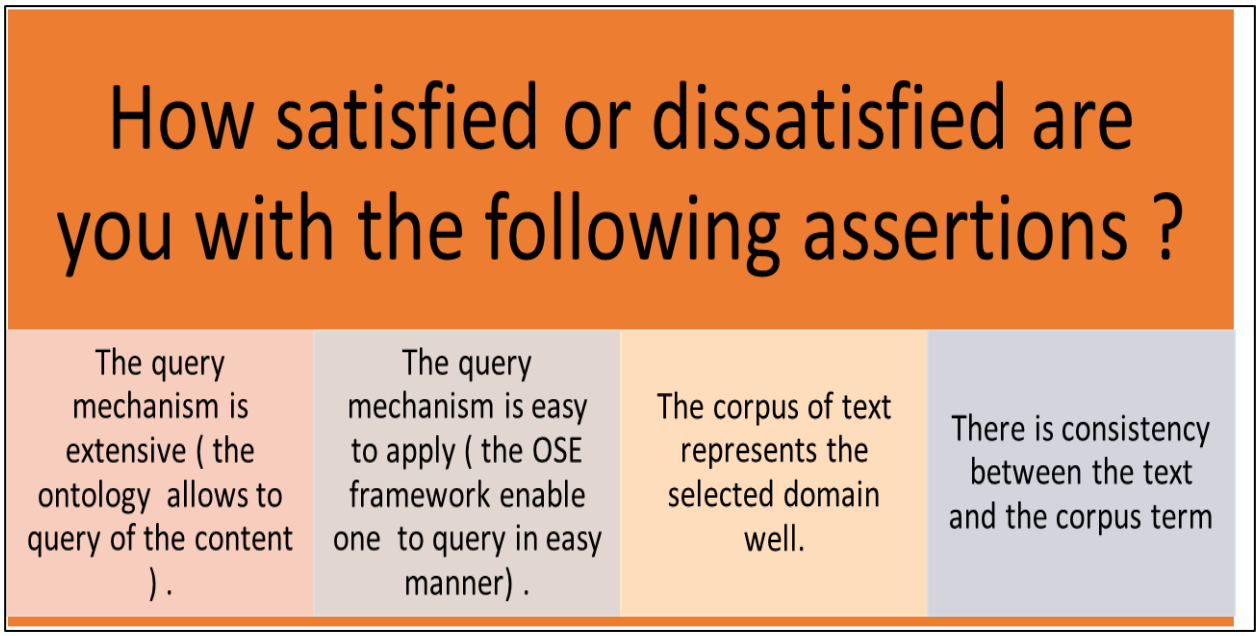


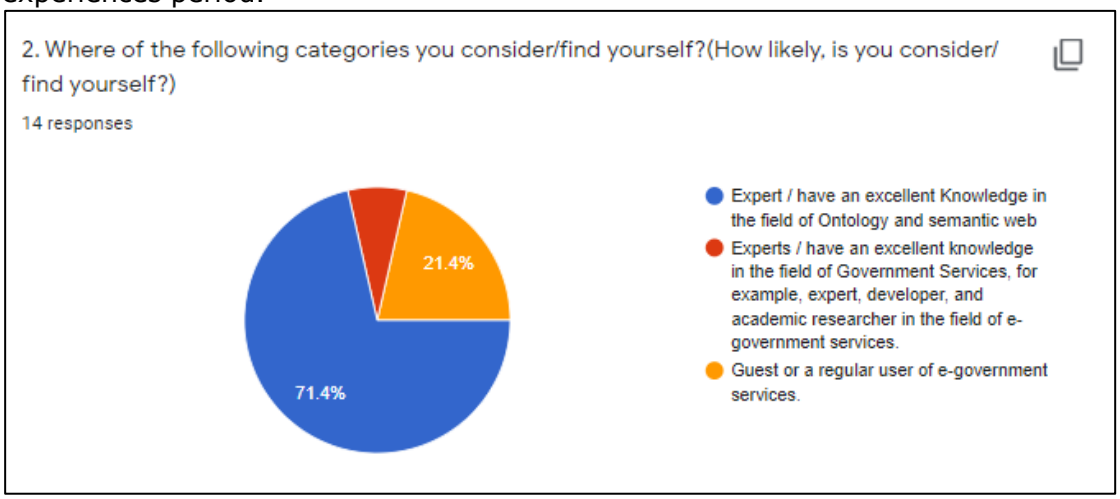
Figure 6-8 Data \ Application layer

6.1.3 Survey Evaluation Result

The total numbers of responders who download and fill the survey are fourteen experts. It is important to note that the target audience in the survey naturally represents the knowledge experts of e-government and/or semantic web ontology technology; however, experts belong to various countries. Also, it has been communicated in different ways, including social media, smartphones, and e-mail.

6.1.3.1 General information results

Figure 6-9 shows the results obtained from the experts regarding the domain category and experiences period.



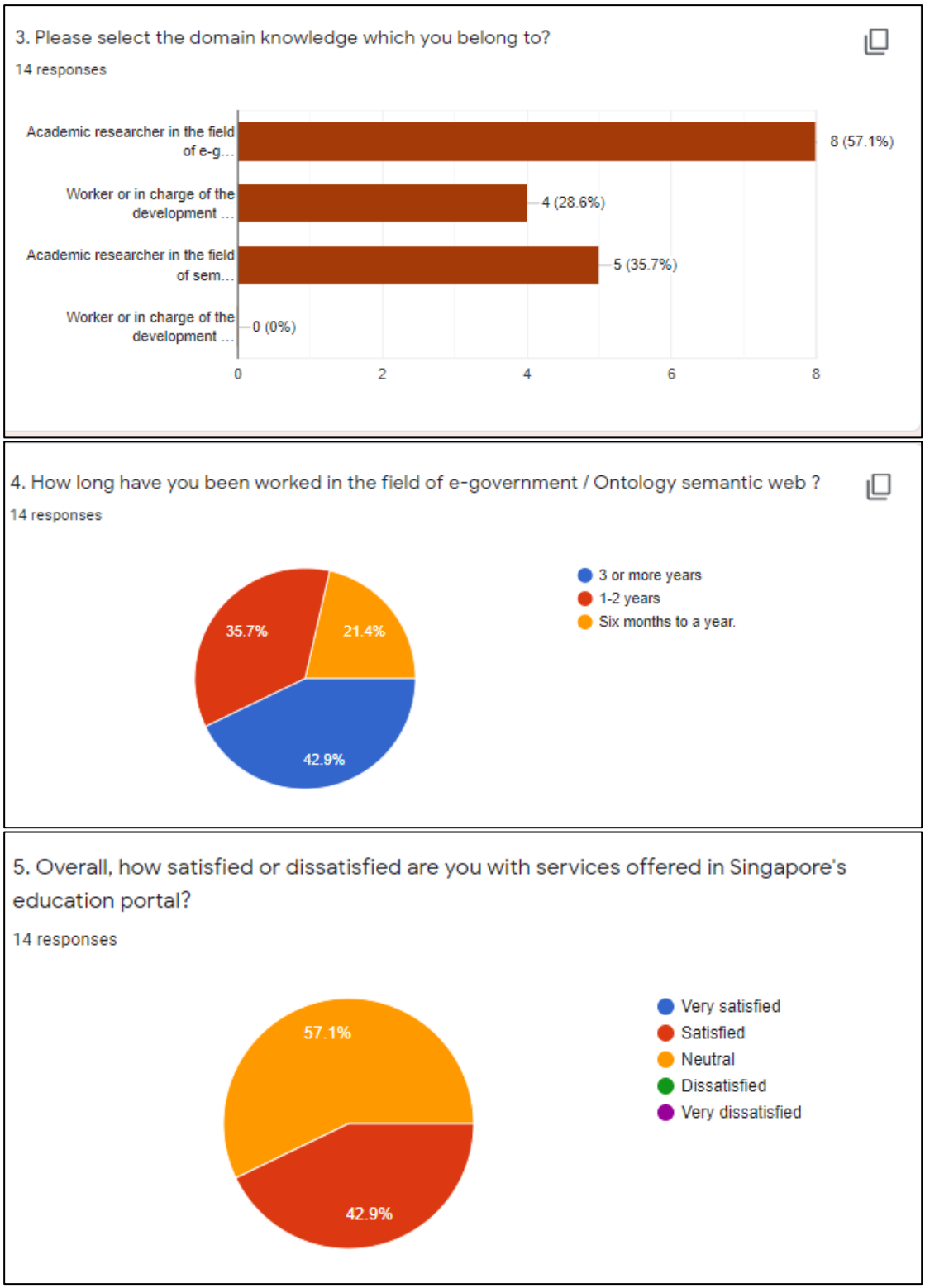


Figure 6-9 General information results

6.1.3.2 Clarity\ Vocabulary and lexical

Figure 6-10 shows Clarity\ Vocabulary and lexical results. Overall, 11 responses were satisfied, 2 very satisfied, while one response left the question blank.

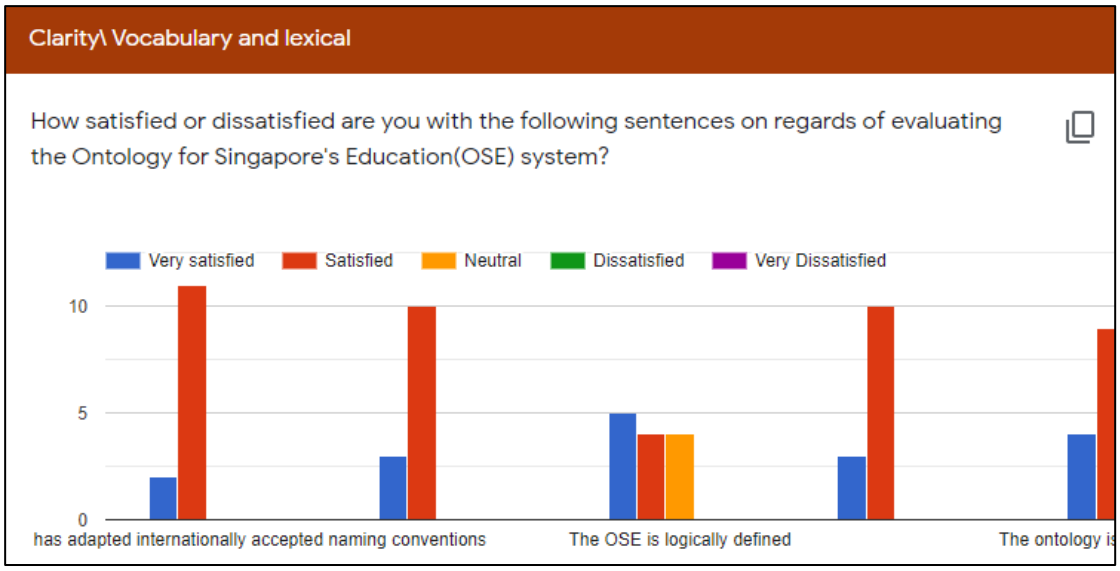


Figure 6-10 Clarity\ Vocabulary and lexical Result

For the answer to the question to specify any additional Comments:
4 responses

- Some classes and properties are vague.
- One property may affect the reasoning of ontology.
- Some names are not clear, especially property names.
- Please use examples to make questions easy to understand names should be clear.

6.1.3.3 Structural\ Architectural layer Results

The figure 6-11 described Structural\ Architectural layer results. Overall, 10 responses were satisfied 2 very satisfied, while 2responses neutral.

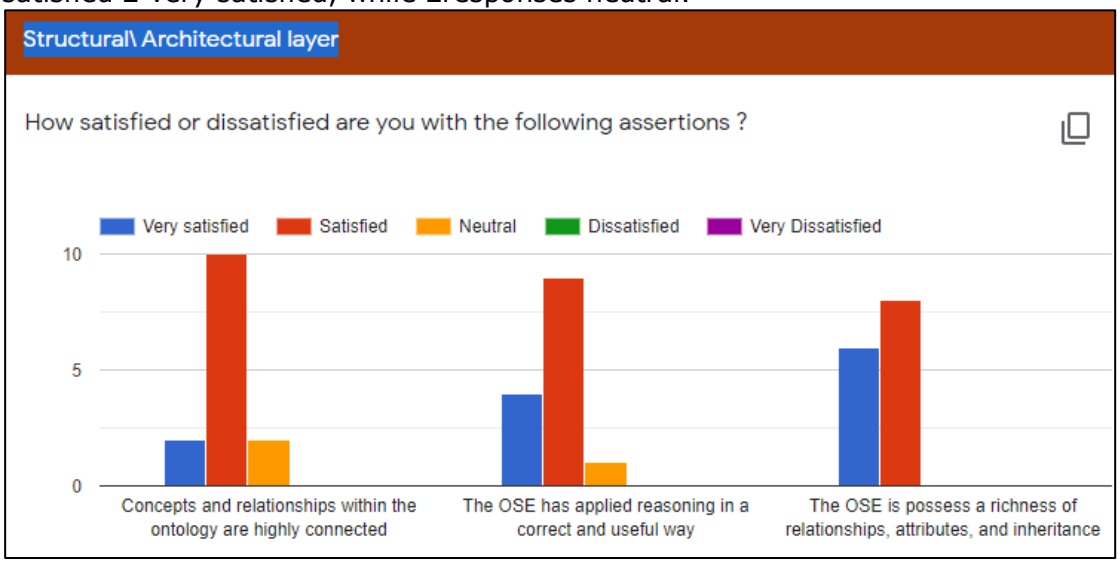


Figure 6-11 Structural\ Architectural layer results

Any Additional Comments (Please specify):
4 responses

- Reasoning not clear
- Some questions need to be clearer and more provided with examples in question.
- Difficult to judge.
- Need to give examples to make questions easy to understand.

- Need to provide a system to evaluate.

6.1.3.4 Representational and Semantic layer Results

Figure 6-12 illustrated the results obtained from information on the Representational and Semantic layer. Overall, 8 responses were satisfied 4 very satisfied, while two responses neutral.

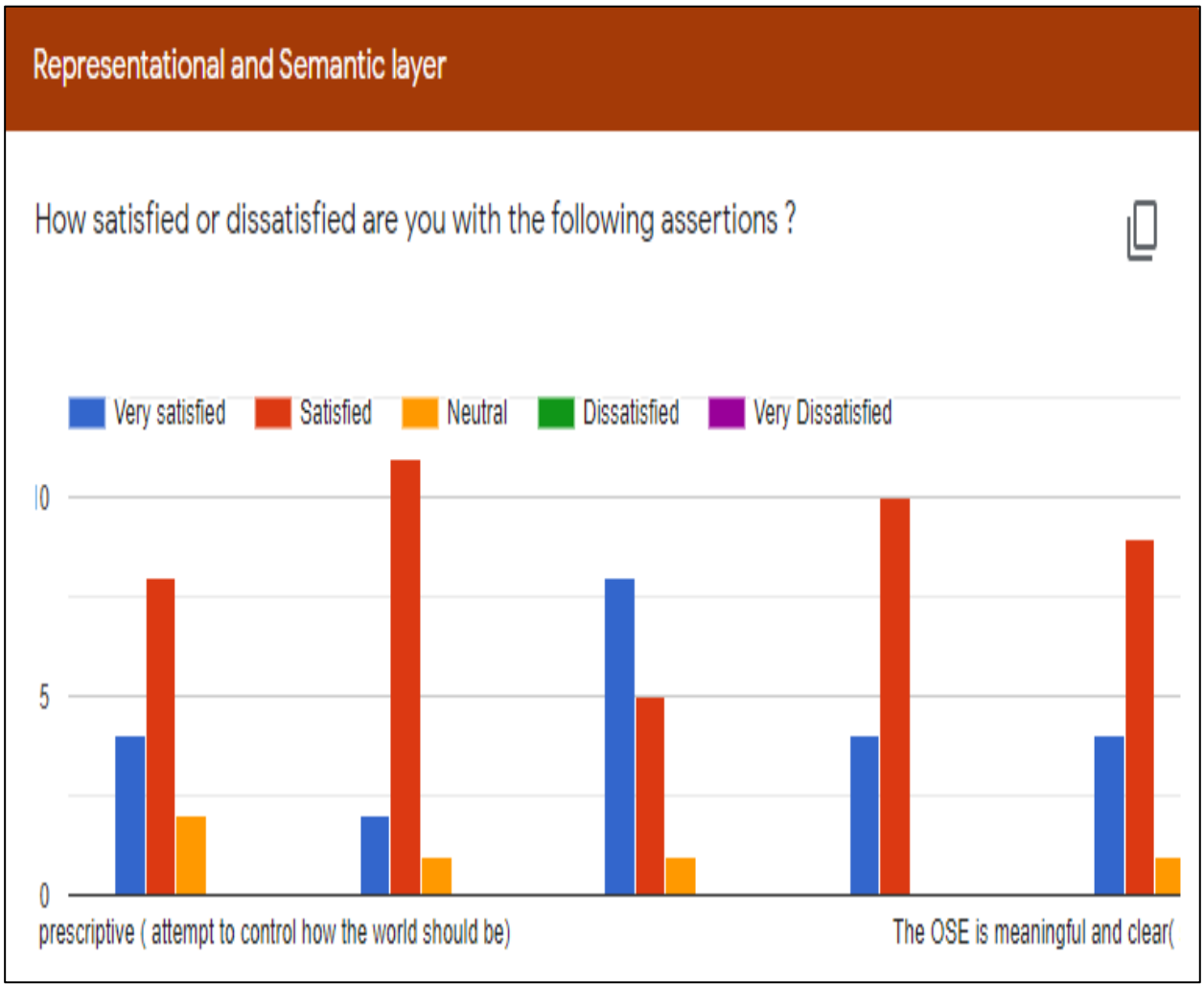


Figure 6-12 Representational and Semantic Results

Any additional Comments 3 responses

- Questions should be clearer.
- Difficult to judge.
- Some name of properties needs to be simplified.

6.1.3.5 Data \ Application layer

Data \ Application layer results are described in Figure 6-13. Overall, 10 responses were satisfied 3 very satisfied, while one response neutral.

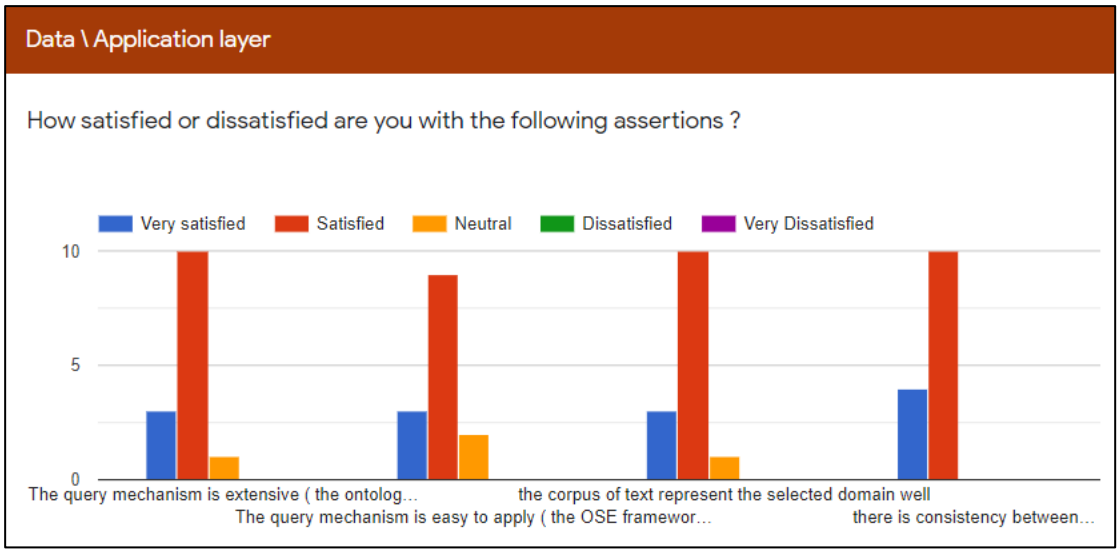


Figure 6-13 Data \ Application results

Any Additional Comments (Please specify):
5 responses

- Better to use web interface for query
- Use the web interface to allow query.
- Difficult to query. Need a system in real to examine the query.
- Use names to query better.
- Better to provide real system

Table 6-3 summarises the degree of acceptance and conviction made for the four-tier experience assessments.

Table 6-3 Degree of Satisfaction

Degree of satisfaction	Clarity\ Vocabulary and lexical	Structural\ Architectural layer results	Representational and Semantic layer results	Data \ Application layer	Total
Very satisfied	2	2	4	3	11
Satisfied	11	10	8	10	39
Neutral		2	2	1	5
dissatisfied					
Very dissatisfied					

6.2 Analysis and discussion

In this research, a model representative semantic structure has been built using the Singapore education system to represent the domain of e-government.
The main reason for conducting the evaluation of this framework is divided into two basic principles: first to know the effectiveness of the framework in achieving citizens' desires to communicate information effectively.
Secondly, which is the most important component, is the semantic framework appropriately strong to allow it to use in another environment.

In this method, the structure was assessed by looking for the opinions and observations from fourteen experts who have extensive experience in both ontology development and extensive knowledge of the e-government.
In the process of analysis and discussion, each of the questionnaire sections will be taken separately first, and then the system will be considered in general to take the suggestions into consideration to improve the efficiency of the system.
The survey contains five collections of themes assessments: general information, lexical vocabulary, structural architectural, semantic representative, and finally, data application.

6.2.1 General information

General information sought to gather two types of information.

1. Some basic information describes the expert of the survey and the extent of his/her knowledge of e-government and ontology development.
2. Assesses the current Singapore education portal related to the e-government system. There is also, an assessment of the quality of the delivery of the services. However, this aspect will serve the study in the part of the evaluation system.

The number of experts who participated in the evaluation questionnaire is fourteen experts with more than three years of experience (i.e., 43%). The number of experts in the field of semantic web and ontology is the largest number (i.e., 71%), while the experts in the field of e-government were the lowest percentage (i.e., 5%).
Academic researchers in e-government and experts have had the largest share of participation (i.e.,57%); they belong to several countries (six countries) from different regions.
Rigorous evaluation: the element that the ontology has been placed to a collection of experts is an indication that the framework has been exposed to rigorous evaluation.

There is a relative, not great satisfaction (i.e.,42%) with the level, quality of services, and method of access in the educational system in Singapore. This is expected, with the aspirations of experts from the e-government and the services it can provide, different from the traditional way of providing information.

6.2.2 Clarity\ Vocabulary and lexical

The OSE has adopted internationally accepted naming conventions has had greater satisfaction compared to the rest of the values, while there was a satisfactory balance on regards the OSE is logically defined.

6.2.3 Structural\ Architectural layer

Ideas and relations within the ontology are extremely linked was approved that it has more contentment associated with the rest of the standards.

6.2.4 Representational and Semantic layer

The ontology has high generality, the query of chances of enhancing OSE ontological System in other ontological System inhabited a high degree of very satisfaction. This result shows the robins of OSE. Also, the OSE is consistent (no formal contradictions of information) has greater satisfaction than the rest of the standards.

6.2.5 Data \ Application layer

Among Data \ Application layer, there is a balancing of satisfaction for various evaluation standards.

6.3 Evaluate OSE ontology

Figure 6-14 shows the extent of the participants 'conviction with the system, as it responded to the question raised about the extent of the participants' satisfaction with evaluating the system from the view of the experts. According to experts of the OSE assessment, most of the respondents expressed their positive opinions and their conviction in general.

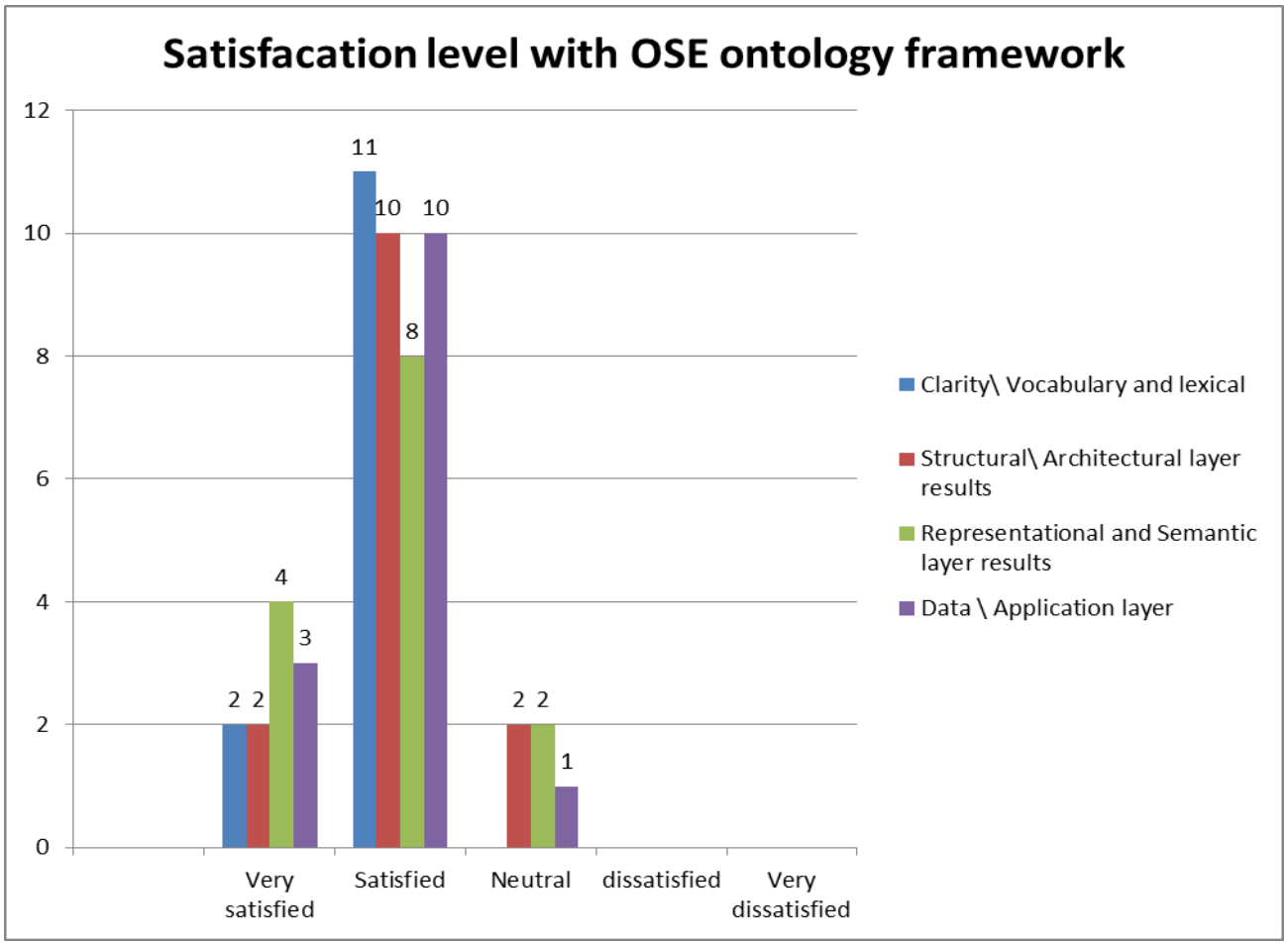


Figure 6-14 Satisfaction level with OSE ontology framework

The system showed a high rate of acceptance and satisfaction in the four layers of the evaluation. The assessment layer Clarity\ Vocabulary and lexical (i.e.,11) showed off the largest proportion of satisfaction, while the Representational and Semantic layer occupied the largest number of complete acceptance (i.e., 4), which represent a respectable percentage that reflects the subject of topics to evaluate the system.

In general, the opinions of experts agreed and supported the following points.

- The ontology has adapted a suitable naming agreement and that the ontology is syntax right.
- The OSE has a properly characterized structure, which shows that the correlation attributes and inheritance have been built in a powerful approach.
- The OSE is consistent (no formal contradictions of information).
- The OSE system is prescriptive (attempt to control how the world should be).
- The OSE is comprehensive (covers the whole domain of the education system).
- The ontology has high generality (probability of applying the ontology for several functions inside the static domain).
- The OSE is meaningful and clear (appropriate ontology language used.

- The ontology is appropriate (with regards to usage and potential users); there is a contest between proper and intellectual semantics in the ontology.
- The OSE adapted the query mechanism is extensive (the ontology allows to query of the content).
- The OSE improved the query mechanism is easy to apply (the OSE framework enable one to query in an easy manner)
- The OSE adapted applied the corpus of text which represents the selected domain well.
- There is constancy between the content and the corpus word.

6.3.1.1 Expert's Commentary

The experts stated in an ensuing manner:

- OSE has a good ability to act queries and displaying the findings within the selected area.
- Some classes can be conveyed in a stronger manner, and some of the names were lengthy, and the circumstances of the names were not noticed.
- A Few properties' reputations must be reduced more so that they can be more understood.
- It should give clear examples of some questions that are vague in nature, as well as giving greater explanations for some terms and how to measure them.

Based on the group of suggestions submitted by the experts, the researcher made some modifications to the system specifically; the researcher shortened some of the names of the classes and properties to be clearer, changing Come Back symbolization.

Regardless Of the limitation of current ontology development tools deployed in the research, the researcher tries to focus on remarks and recommendations received by the experts. In the brief case where there was restricted capability in questioning the web boundary submission, the researcher clarified that the emphasis was on the capability of the OSE structure and not possible the excellence of the customer interface.
However, reduced evaluation of both a separate and browser interface was completed to validate the data contained in the ontology might be queried and recovered.

6.4 Summary

In this chapter, the researcher evaluated the OSE. This evaluation is based on the use of ontology assessments that explicitly consist of two main components: validation and verification adapted by Gómez-Pérez et al., (2004).

The purpose of performing validation is to guarantee that the OSE ontological system improved and checked the luxuriousness of vocabulary and syntactic.

But verification is assessed by e-government knowledge specialists. The knowledge expert in either area of e-government or ontological system. However, experts' effort to supply their acknowledged in specific attributes such as the validity names (classes, properties), clarity and unambiguous structure of OSE, system semantically, and architectural building of the system.

The main reason for evaluating this framework is to assess the effectiveness of the OSE framework in achieving citizens' desires to convey information. In addition, to assist the semantic framework sufficiently robust to use in an alternative environment.

However, the research found that the ontological technique can be employed to reach successful e-government.

The OSE ontology indicates the fulfilment quantities of specialists, including OSE ontology. The system showed a high rate of acceptance and satisfaction in the four layers of the evaluation.
Finally, the assessment layer Clarity\ Vocabulary and lexical showed off the largest proportion of satisfaction, while the Representational and Semantic layer occupied the largest number of complete acceptances, representing a respectable percentage that reflects the subject of topics to evaluate the system.

7.Conclusion and Future Work

By presenting the conclusion, this study is completed in this chapter. Addressing the research problem and clarifying the series of actions taken to achieve the study's objectives and responding to a set of questions derived from the problems are described. In addition to an extensive discussion of the contributions/achievements produced by the study as well as define the limitations.

The research began by defining the problem by introducing the main question. Then identify established objectives toward achieved, in addition, answered the formed of sub-questions. Accordingly, the OSE was created and developed. Response and assessment received from a variety of experts in the field to continuously improve the OSE ontology system. At the end of this chapter, suggestions for possible research leads for the future are addressed.

The main problem concerning this research was to find the answer to the following question:

Can an ontology within the e-government framework create and describe a recommended standard for providing succeeding governmental services and information delivery?

However, to find an answer to the raised question, the aim was established. The research aims to verify whether the ontology technology can be described and considered a reference technology for providing e-government services over the Internet.
Consequently, the research presents a practical method established on experimental research that moves nearer to the fact of the true function of ontological procedure in the field of e-government.

In this study, the educational system in Singapore is used to represent the domain of e-government in which research questions are raised and addressed; also, general impressions can be tested and originate.

7.1 Achievement

Figure 7-1 illustrated the followed process to achieve the objective of build and develop a model of ontology for the educational system to represent the domain of e-government.

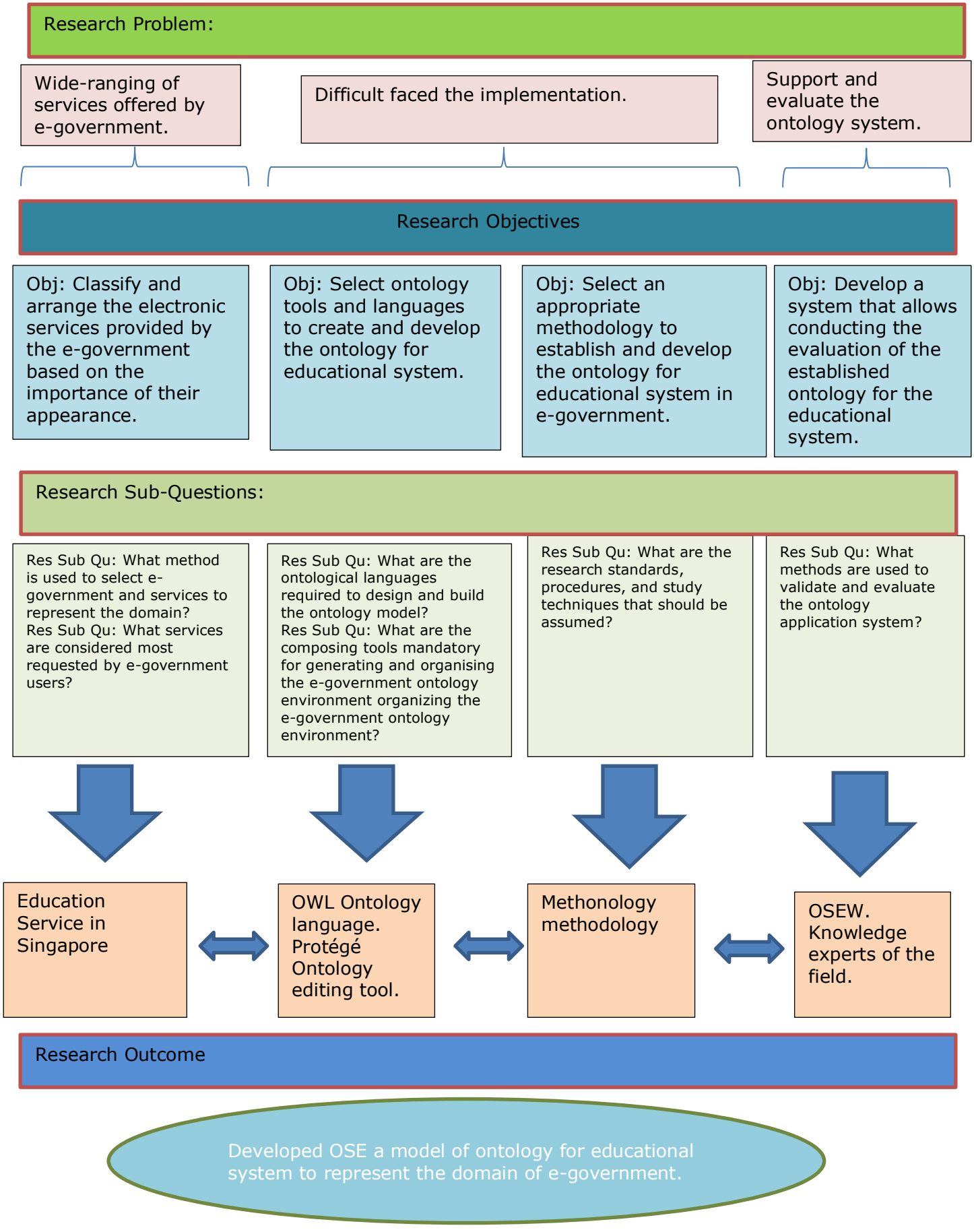


Figure 7-1 Research Outcome

As shown in Figure 7-1, to achieve the objective of build and develop a model of ontology for educational system to represent the domain of e-government. Three problems faced towards achieving the objective which are the broad services provided by the e-government, difficulties encountered in implementation, and difficulties encountered in the evaluation process. Therefore, the objectives and the four sub-questions were set in a procedure to achieve the objective.

In selecting and categorising services, we applied a mechanism that merges a qualitative (i.e., survey) and quantitative (i.e., mathematic metric) approach for identifying the value of public services in the e-government system. However, three e-government cases were studied (i.e., Singapore, Oman, and Bahrain) in terms of the importance of the services provided. The Education domain in the Singapore e-government sector was selected to represent e-government as it contained the highest number of services among other domains and government sectors.

The research-formed ontology for the Singapore education system (OSE) model uses OWL to implement the (OSE) model. OWL is the extremely applied to the ontology languages. Also, implement Protégé ontology managing tool, which presents a graphic user interface for characterising ontologies.

The design and development of the OSE system relied on a Methontology methodology, where the methodology is suitable for developing the OSE system. However, many methodologies were investigated, such as Tove, Sensus, Cyc, and Methonlogy. By comparing methodologies, it was found that Methonlogy methodology, with its characteristics method, is largely accepted in the most formed. The methodology is mainly based on the development of an ontology using seven steps, starting with specification and ending with documentation.

An evaluation of the OSE was conducted. This evaluation is based on the use of ontology assessments that explicitly consist of two main components: validation and verification adapted by Gómez-Pérez et al. (2004).

The purpose of performing validation is to guarantee that the OSE ontological system improved and checked the luxuriousness of vocabulary and syntactic.
However, verification was assessed by e-government knowledge specialists. The knowledge expert in either area of e-government or ontological system. However, experts' effort to supply their acknowledged in specific attributes such as the validity names (classes, properties), clarity and unambiguous structure of OSE, system semantically, and architectural building of the system.

Finally, the OSE system consists of a massive number of classes, specifically 835, in addition to 193 assertions, with further than 80 rules and interactions, to handle the strong intelligence articulation capacity. However, the strength of the OSE was clearly demonstrated in a large number of Axiom numbers higher than 2600.

Object Establish a framework of ontology for educational services in the e-government domain.

Through the previous answers to both sub-questions raised in chapter 3:

What is the framework, philosophy, paradigm, and research theory assumed in the research?
What are the research standards, procedures, and study techniques that should be assumed?

The research procedure is working under the epistemology of the philosophy of science, "design science paradigm" is a theoretical perspective, and the research methodology employed the "embedded case study"."
The research methodology utilised in the research has the advantage of being consistent in the case study. Inside the case study, both quantitative and qualitative methods are applied to collect data and gain access to an answer to the research question.

In this study, the educational system in Singapore is used to represent the domain of e-government in which research questions are raised and addressed; also, general impressions can be tested and originate.

The area is widely considered to be the proper expressive of the large scale.
Several elements and rules of different governments and countries are consistent with the Singapore government and environment. For example, the educational services we find in systems such as Australia, Bahrain and Oman are essentially tailored and are very similar to the education system in Singapore, where all e-governments include services and information about students, jobs, schools, and the education system.

The educational system model is a practical foundation for building the e-government framework, as the study relies on the ontology analysis of the educational model in the e-government framework. In addition, the developed model represents a formal framework built with employing (OWL). Furthermore, services in the educational environment in any e-government, such as Australia, UK, and Oman, are very similar, so we build a formal practical framework, as (OSE) build concepts for educational services, properties, and links between services. Therefore, the OSE model represents a formal framework that can be reused for the e-government framework, where many of the classes and properties are the same as obtained of other e-governments, and the design and construction of the model are very similar to each other.

7.2 Contributions

Table 7-1 illustrated the achieved contribution along with objectives.

Table 7-1 Achieved Contribution.

	Objective						
Contribution	Build and develop a model of ontology for educational system.	Establish a framework of ontology for educational services	Classify and arrange of the e-services	Select ontology tools and languages	Develop a system to conduct the evaluation	Assess the ontology for educational system	Achieved
Creating an ontology model for the Singapore education system (OSE) environment.	☑						Ch.5 Section 5.2
Construct framework of the educational system model.		☑					sections (2.3), (2.1.5), (3.6),(3.7) and (5.3).
Identify the priority of services.			☑				Ch.4
Design Ontology for Singapore Education system Website (OSEW)					☑		Section 5.9
Adapting Methontology for applying (OSE)	☑						sections (2.6) (5.1).

structure in this research.							
Evaluation and testing of the (OSE) system.						☑	sections (2.7) and Ch.6.

Through the earlier answers to all the sub-questions raised along with the achievement of the research objectives, the main problem concerning this research was to find the answer to the following question:

Can an ontology within the e-government framework create and describe a recommended standard for succeeding in delivering governmental services and information?

The finding of the study concluded:

Ontology technology can be used as a basic reference in building and developing e-government to deliver the services successfully and effectively over the Internet.

7.3 Future work

This research still requires more work to be more complete. However, it cannot be hidden that the ontology technology is not easy to use, but there are a set of completeness elements that can be considered as follows:

- Comprehensiveness of services.
- Sectors Integration
- Modelling the system in a real government web environment
- Further investigation of retrieval data; and
- The possibility of re-use of the system by governments or other researchers.

In terms of service coverage, services can be expanded and modelled using the ontology. For example, health services can be added, which are ranked second in terms of demand.

This certainly gives greater opportunities to evaluate the strength of the ontology. Integration of sectors can also include the system on the business sector and government. This enables the ability of the ontological to make a difference in the ability to communicate information in an integrated manner.

The system lacks a real model, i.e., a website that can fetch information or data so that the truth is measured more. This can be done using the Top Braid ontology tool.

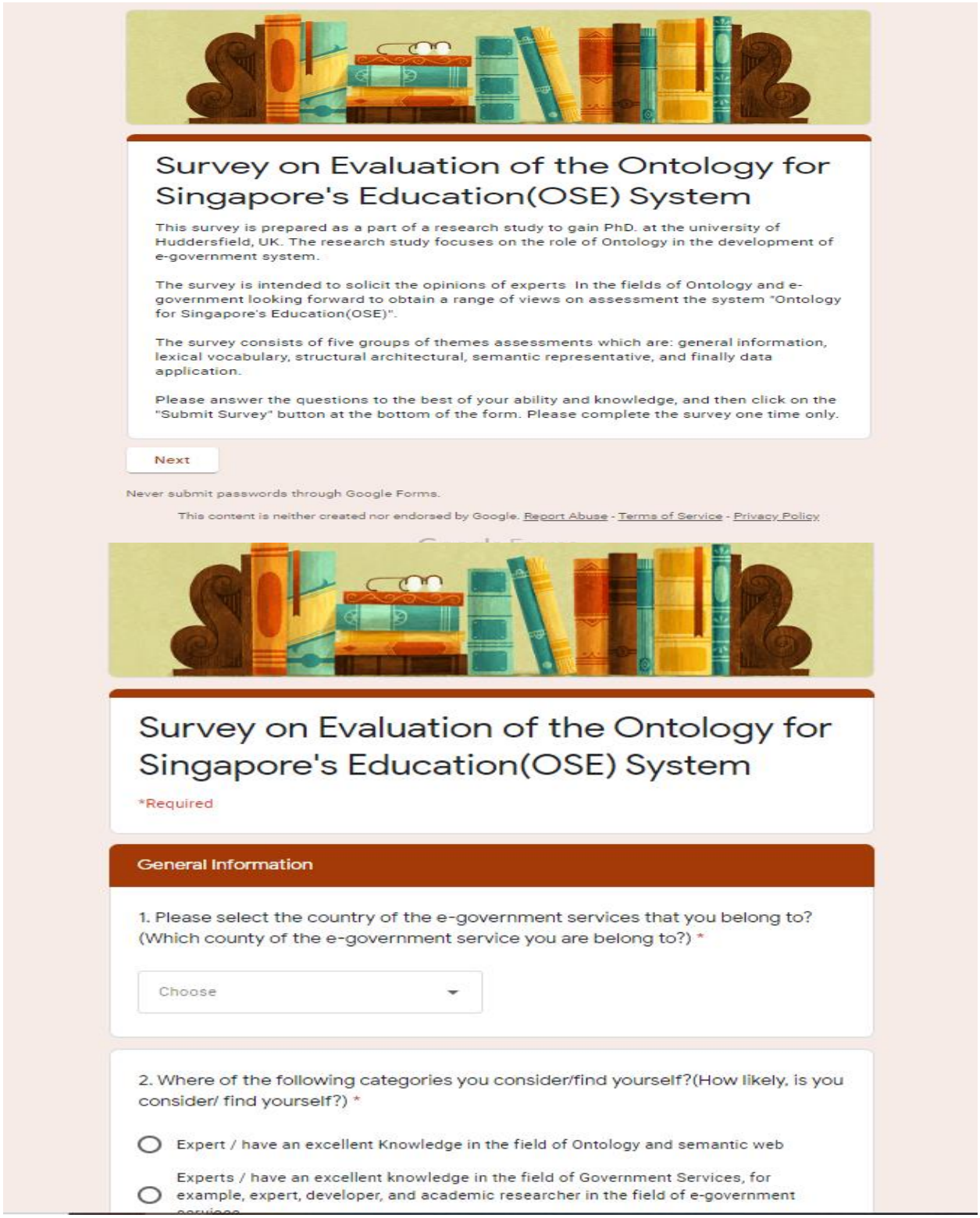
The study lacks more procedures for data retrieval using a special language for data retrieval, such as, such as SPUARQ, which is the most common language for the query of data.

For reprocessing, distribution, and repairs of the OSE ontological system, potential issues that communicate to OSE ontology that necessary remain measured.

It also converts ontology into further language, perhaps Arabic.

8. Appendices

8.1 Appendix 1 Questioner conducted



Survey on Evaluation of the Ontology for Singapore's Education(OSE) System

This survey is prepared as a part of a research study to gain PhD. at the university of Huddersfield, UK. The research study focuses on the role of Ontology in the development of e-government system.

The survey is intended to solicit the opinions of experts In the fields of Ontology and e-government looking forward to obtain a range of views on assessment the system "Ontology for Singapore's Education(OSE)".

The survey consists of five groups of themes assessments which are: general information, lexical vocabulary, structural architectural, semantic representative, and finally data application.

Please answer the questions to the best of your ability and knowledge, and then click on the "Submit Survey" button at the bottom of the form. Please complete the survey one time only.

Next

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Survey on Evaluation of the Ontology for Singapore's Education(OSE) System

*Required

General Information

1. Please select the country of the e-government services that you belong to? (Which county of the e-government service you are belong to?) *

Choose

2. Where of the following categories you consider/find yourself?(How likely, is you consider/ find yourself?) *

- Expert / have an excellent Knowledge in the field of Ontology and semantic web
- Experts / have an excellent knowledge in the field of Government Services, for example, expert, developer, and academic researcher in the field of e-government

services.

- ○ Guest or a regular user of e-government services.
- ○ Other: _____

3. Please select the domain knowledge which you belong to? *

- ☐ Academic researcher in the field of e-government and its services.
- ☐ Worker or in charge of the development of e-government and its services.
- ☐ Academic researcher in the field of semantic web or Ontology.
- ☐ Worker or in charge of the development of e-government and its services using Ontology or semantic web .
- ☐ Other:

4. How long have you been worked in the field of e-government / Ontology semantic web ? *

- ○ 3 or more years
- ○ 1-2 years
- ○ Six months to a year.
- ○ Other: _____

5. Overall, how satisfied or dissatisfied are you with services offered in Singapore's education portal? *

- Very satisfied
- Satisfied
- Neutral
- Dissatisfied
- Very dissatisfied

6. How well does Singapore's education portal meet your needs? *

- Extremely well
- Very well
- Some what well
- Not so well
- Not at all well

7. How would you rate the quality of the Singapore's education portal to deliver the various services? *

- Excellent
- Very good
- Good
- Fair
- Poor

Singapore's education portal
See information at / available on (website) URL:
https://www.moe.gov.sg

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Survey on Evaluation of the Ontology for Singapore's Education(OSE) System

Clarity\ Vocabulary and lexical

This section is concerned with how effectively the vocabulary and lexical elements are described in OSE system.

How satisfied or dissatisfied are you with the following sentences on regards of evaluating the Ontology for Singapore's Education(OSE) system?

	Very satisfied	Satisfied	Neutral	Dissatisfied	Very Dissatisfied
The OSE has adapted internationally accepted naming conventions	○	○	○	○	○
The OSE is well documented	○	○	○	○	○
The OSE is logically defined	○	○	○	○	○
The OSE is consistent (no contradiction)	○	○	○	○	○
The ontology is syntactically correct	○	○	○	○	○

Any additional Comments (Please specify):

Your answer

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Survey on Evaluation of the Ontology for Singapore's Education(OSE) System

*Required

Representational and Semantic layer

The semantic factors of the OSE structure are evaluated in the section as it is concerned with how well the ontology structure has defined conceptual description.

How satisfied or dissatisfied are you with the following assertions ? *

	Very satisfied	Satisfied	Neutral	Dissatisfied	Very Dissatisfied
The OSE system is prescriptive (attempt to control how the world should be)	○	○	○	○	○
The OSE is consistent (no formal contradictions of information)	○	○	○	○	○
The OSE is comprehensive (covers the whole domain of education system)	○	○	○	○	○
the ontology has high generality(possibility of using the ontology for various purpose inside the fixed domain)	○	○	○	○	○
The OSE is meaningful and clear(suitable ontology language used	○	○	○	○	○
The ontology is relevant (with regards to application and possible users) there is a match between formal and cognitive semantics in the ontology.	○	○	○	○	○

Any additional Comments (Please specify):

Your answer

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Survey on Evaluation of the Ontology for Singapore's Education(OSE) System

*Required

Data \ Application layer

This section is concerned with ability of the ontology itself in representing the knowledge in a given domain.

How satisfied or dissatisfied are you with the following assertions ? *

	Very satisfied	Satisfied	Neutral	Dissatisfied	Very Dissatisfied
The query mechanism is extensive (the ontology allows to query of the content)	○	○	○	○	○
The query mechanism is easy to apply (the OSE framework enable one to query in easy manner)	○	○	○	○	○
the corpus of text represent the selected domain well	○	○	○	○	○
there is consistency between the text and the corpus term	○	○	○	○	○

Any additional Comments (Please specify):

Your answer

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8.2 Appendix 2 General service

Item of Services	Number of services (NS)			Indicator of services (IS)			Total Sevices			Priority Index of the services (PS)
	Singaphore	Bahrain	Oman	Singaphore	Bahrain	Oman	Singaphore	Bahrain	Oman	
Education Matters	7	14	11	8	8	8	15	22	19	1.56
Health Matter	22	10	7	6	6	2	28	16	9	1.47
Interior Affairs	13	8	6	8	8	6	21	16	12	1.36
Man Power/Employment	18	2	6	8	6	6	26	8	12	1.28
Motoring and Transport	14	12	7	6	4	2	20	16	9	1.25
Housing	19	2	8	6	4	4	25	6	12	1.19
Social Benefits and Grants	20	3	5	8	4	2	28	7	7	1.17
Law and Justice	10	8	10	6	4	2	16	12	12	1.11
Financial Matters	16	2	3	8	2	2	24	4	5	0.92
Tourist / Travelling	7	3	9	6	4	4	13	7	13	0.92
Foreign Affair	8	2	2	6	4	2	14	6	4	0.67
Relegion	5	2	5	6	4	2	11	6	7	0.67
Business										
Information for Investors	12	16	7	8	6	6	20	22	13	3.67
Trade Opportunities	16	10	8	8	6	4	24	16	12	3.47
Guide For Businesses	10	8	7	8	6	6	18	14	13	3.00
Electricity and Water	10	4	4	8	8	4	18	12	8	2.53
Economy	7	6	5	6	4	2	13	10	7	2.00
Community service										
Community Planning, Programs & Redevelopment	10	2	6	3	1	1	13	3	7	2.56
Members	4	2	1	3	1	1	7	3	2	1.33
Report	2	1	1	2	1	1	4	2	2	0.89

8.3 Appendix 3 Singapore's Education System Services

	Home page \ Service category	service sequence	Total Number of services
sequence	Education	7	174
1	Education in SG	1	12
2	Desired Outcomes of Education	1	
3	21st Century Competencies	2	
4	Our Students	3	
5	Our Teachers	4	
6	Our Schools	5	
7	Compulsory Education	6	
8	Exemptions from Compulsory Education	7	
9	Deferment	8	
10	Children residing overseas	9	
11	Compulsory Education Board	10	
12	Frequently Asked Questions	11	
		12	
13	Pre-School	2	7
14	Learning Areas and Learning Goals	1	
15	Nurturing Early Learners (NEL) Curriculum	2	
16	NEL Framework Guide For Parents	3	
17	FAQs for NEL Curriculum	4	
18	MOE Kindergarten	5	
19	Standards for Kindergartens	6	
		7	
20	Primary	3	7
21	Primary School Curriculum	1	
22	Primary School Education Booklet	2	
23	Primary 1 Registration Insert	3	
24	Subject-Based Banding (Primary)	4	
25	From Primary to Secondary Education	5	
26	Student Care Centres (SCCs)	6	
		7	
27	Secondary	4	17
28	Secondary School Courses	1	
29	Express Course Curriculum	2	
30	Changes Affecting Express Course	3	
31	Normal Course Curriculum	4	
32	Changes Affecting Normal Course	5	
33	Values in Action	6	
34	Language Programmes in Secondary School	7	
35	Other Programmes in Secondary School	8	
36	Integrated Programmes (IP)	9	
37	Art Elective Programme (AEP)	10	
38	Music Elective Programme (MEP)	11	
39	Enhanced Art Programme	12	
40	Enhanced Music Programme	13	
41	Applied Learning	14	
42	From Secondary to Post Secondary	15	
43	Secondary School Education Booklet	16	
		17	
44	Special Educational Needs	5	11
45	How do I know if my child has Special Educational N	1	
46	How do I select the right school for my child	2	
47	Mainstream Schools	3	
48	Special Education Schools	4	
49	List of SPED Schools	5	
50	Provisions & Support in SPED Schools	6	
51	Education Pathways For Children with SEN entering	7	
52	SPED Curriculum Framework	8	
53	How do I apply for a place in the School for my Child	9	
54	What Financial Support is Available for SPED School	10	
		11	
55	Post-Secondary	6	2
56	Institute of Technical Education	1	
57	Polytechnics	2	
58	Pre-University Education	7	17
59	Universities	1	
60	Publicly-Funded Private Arts Institutions	2	
61	Other Government-Affiliated Educational Institutio	3	
62	Through-train Pathways for Normal (Academic) Stud	4	
63	Post-Secondary Education Brochure	5	
64	Post-Secondary Admissions Exercises Brochure	6	
65	Frequently Asked Questions on Post Secondary Edu	7	
66	Post-Secondary Education Account	8	
67	About the PSEA	9	
68	Eligibility	10	
69	Usage	11	
70	Frequently Asked Questions	12	
71	Contact Information	13	
72	Pre-University	14	
73	GCE 'A' Level Curriculum	15	
74	Framework for the 2006 GCE A Level curriculum	16	
75	From Pre-University to University Education	17	
76	Private Education	8	11
77	Admissions into Private Schools	1	
78	List of Private Schools	2	
79	Registering a Private School	3	
80	Registering Courses	4	
81	Registering Committee of Management	5	
82	Registering Teachers	6	
83	Relocation or Expansion of School	7	
84	Change of School Name	8	
85	Termination or Closure of School	9	
86	Certificates issued by Private Schools	10	
87	Private Education Useful Links	11	
88	School Programmes	9	47
89	Gifted Education Programme	1	
90	Rationale and Goals	2	
91	GEP Identification	3	
92	Click here for updates on GEP Selection Exercise	4	
93	Enrichment Model	5	
94	Individualised Study Options	6	
95	Special Programmes	7	

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