Translation ITIL Service Operation to Ontological Artifacts

Jirasak Gornmanee, Kittima Mekhabunchakij

Abstract

This paper presents a Translation ITIL (Information Technology Infrastructure Library) Service Operation to Ontological Artifacts. The model is used to solve an unplanned interruption to an IT service or reduction in the quality of an IT service operation and the impact of incidents that cannot be prevented. The focus of the research is on IT service operation in organization, based on Incident Management and Problem Management of ITIL Framework. The research uses OWL design Ontological Artifacts and SQWRL (Semantic Query-enhanced Web Rule Language) which is a SWRL-based query language that can be used to query OWL ontologies, using Protege software as a tool. To implement Ontological Artifacts and Visualization of Process Activities we use Protege to design Business Cases. The Business Cases are presented in 4 types: Incident Management for Procurement, Problem Management for Procurement, Incident Management for Communication Network Failure and Problem Management for Communication Network Failure. The goal of this paper is to produce an OWL of those Business Cases. We organize a group of 5 domain experts to verify and validate. The mean value of evaluation is 4.60 (maximum=5) or 92%. This model has been implemented in the Computer Center’s Directorate of Communications and Electronics, Royal Thai Air Force.

Keywords: ITIL, Knowledge Management, Ontology, OWL, SWRL

1. Introduction

The ITIL is a documented set of processes designed to define how a company’s IT functions can operate. It contains a series of statements defining the procedures, controls and resources that should be applied to a variety of IT related processes. The press coverage and popular management appeal of it mean that ITIL is the safe decision for any IT executive wishing to demonstrate that they are up to date with modern IT thinking. The documented procedures and requirements for documenting activities undertaken by the IT organization mean that should key personnel decide to leave then they will leave less of a void than previously. When implementing ITIL, departmental managers will need to take time out to map their current operations to those flows defined in the framework. With structured systems come the ability to formally trace and review what was done about any particular incident or problem. [1]. In general, ITIL describes contents, processes, and aims at a high abstraction level and contains no information about management architectures and tools. The fault management is divided into Incident Management process and Problem Management process. The Incident Management contains the service desk as interface to customers e.g. receives reports about service problems. In case of severe errors structured queries are transferred to the Problem Management. The Problem Management’s tasks are to solve problems, take care of keeping priorities, minimize the reoccurrence of problems, and to provide management information. The ITIL processes describe only what has to be done, but contain no information how this can be actually performed [2]. The best thing about ITIL is it just a framework that can be adapted to any environment. A change from ITIL version 2 to version 3 attempts to consolidate and simplify its approach [3]. ITIL version 3 consist of 5 books that will be better inter-related to emphasize the process design and management [4].

Ontology is a philosophical concept concentrating on the essence of existence. But in recent decades, this concept has been applied to the computer industry and it plays an increasingly important role in artificial intelligence, computer languages and database theory [5]. A typical ontology has a taxonomy defining the concepts and their relationships of a domain, and a set of inference rules that powers its reasoning functions. Ontology is now recognized in AI community as a term referring to the
shared understanding of knowledge in some domains of interest, which is often conceived as a set of classes (concepts), relations, functions, axioms and instances [6]. The structure of an ontology is similar to an object model developed in object-oriented software development methodologies. Concepts and properties in an ontology correspond to objects and attributes, respectively, in an object model [7].

This paper presents the evolutionary construction of domain grounded ITIL. In section 2, we discuss relevant aspects of the ITIL, including Knowledge Management. A case for using a Research Framework for Incident Management and Problem Management is made in section 3 and the relevant OWL and SWRL are discussed. Section 4 describes Research Design, including the research process. Section 5 presents Implementation based on Business Cases of the Computer Center at the Royal Thai Air Force. Section 6 presents an evaluation of the research by domain experts. The paper concludes with a conclusion of the work.

2. Related Work

ITIL is a public framework that describes Best Practice in IT service management. It provides a framework for the governance of IT, the ‘service wrap’, and focuses on the continual measurement and improvement of the quality of IT service delivered, from both a business and a customer perspective. This focus is a major factor in ITIL’s worldwide success and has contributed to its prolific usage and to the key benefits obtained by those organizations deploying the techniques and processes throughout their organizations.

The current version of ITIL is version 3, consisting of five core books covering the service lifecycle, together with the Official Introduction. The five core books cover each stage of the service lifecycle, from the initial definition and analysis of business requirements in Service Strategy and Service Design, through migration into the live environment within Service Transition, to live operation and improvement in Service Operation and Continual Service Improvement [8].

In case of IT Support Center for Thailand Government, knowledge management is goal. Thus we produced research which implemented knowledge management system. That can solve the deficiency of organizational knowledge management, including in Computer Center knowledge sharing, new knowledge creation and factors that support knowledge management. The organizations tempt to make better use of their assets for improved capital investment. The model is Ontology for asset management, which use Asset Document as the key concept. The model is also useful in Help Desk operation and Supplier Performance evaluation in procurement. The design model defines the Ontology concept uses Theresa Edgington concept in system design and creation [9].

Knowledge management success is enhanced when applying a knowledge lens in an ontological manner. The resulting ontology becomes useful as a foundation for inter-organizational communication and ontology expansion, and also for training and intra-organizational value.

Base on Theresa Edgington concept of the ontology process are Design, Develop, Integrate, Validate and feed back, and Iterate process. The design process includes 5 steps: Framing the problem statement, Defining the Scope, Developing success and acceptance criteria, Investigating tasks and business are goals, and Analyzing use cases. The model use the Knowledge Lens concept. They are the ontology development for creating Target Information, which specifies sources and media information of the target document [10].

An Implementation of ITIL with an "adopt and adapt", their research presents the overall framework and design proposal of the garment industry-oriented ITSM system from the prospect of organization, process and technology, and design the business mode and data framework emphatically. The IT operation status in the garment enterprise is improved through the implementation of IT-Support system, the quality of service and the speed of solving problems are also been upgraded. By June 1st 2008, there are 19 categories and 34000 records in the CMDB of IT-Support system. 4677 effective service calls has been recorded by the service desk since the deployment of this system, 97% of which was closed successfully by IT managers or service appliers. This project got remarkable results, great economic and social benefits [11]. Similarly, a case of supply chain of tobacco industry in China. Their research proposed to develop the running mode of the supply chain from pattern of make-to-stock to
pattern of make-to-order by supporting of the common information service platform. The crucial issues of supply chain management are key data integration and information sharing of the core enterprises in supply chain. It is shown that the problems of data integration and information sharing can be well solved by building the common information service platform. The problem of security management of the platform should be taken seriously. The ITIL based running maintenance strategy of the common information service platform in accordance with ISO 20000 can effectively support the supply chain management. From point of general characteristic of production and circulation, the knowledge of supply chain management practiced by tobacco industry is very valuable to other industries [12].

3. Research Framework

3.1. Incident Management Framework

One of input ITIL process is Incident Management. An unplanned interruption to an IT service or reduction in the quality of an IT service. Failure of a configuration item that has not yet impacted service is also an incident, for example failure of one disk from a mirror set. Incident Management is the process for dealing with all incidents; this can include failures, questions or queries reported by the users, by technical staff, or automatically detected and reported by event monitoring tools. The primary goal of the Incident Management process is to restore normal service operation as quickly as possible and minimize the adverse impact on business operations, thus ensuring that the best possible levels of service quality and availability are maintained. ‘Normal service operation’ is defined here as service operation within SLA limits. Incident Management includes any event which disrupts, or which could disrupt, a service.

Incident Management is highly visible to the business, and it is therefore easier to demonstrate its value than most areas in Service Operation. For this reason, Incident Management is often one of the first processes to be implemented in Service Management projects.

Incidents can be triggered in many ways. The most common route is when a user rings the Service Desk or completes a web-based incident-logging screen, but increasingly incidents are raised automatically. Technical staff may notice potential failures and raise an incident, or ask the Service Desk to do so, so that the fault can be addressed.

The process activities to be followed during the management of an incident is shown in Figure 1. Incident Management Framework.
3.2. Problem Management Framework

One of input ITIL process is Problem Management which is the process responsible for managing the lifecycle of all problems. The primary objectives of Problem Management are to prevent problems and resulting incidents from happening, to eliminate recurring incidents and to minimize the impact of incidents that cannot be prevented. Problem Management includes the activities required to diagnose the root cause of incidents and to determine the resolution to those problems. Problem Management will also maintain information about problems and the appropriate workarounds and resolutions, so that the organization is able to reduce the number and impact of incidents over time. Although Incident and Problem Management are separate processes, they are closely related and will typically use the same tools, and may use similar categorization, impact and priority coding systems. This will ensure effective communication when dealing with related incidents and problems.

The vast majority of Problem Records will be triggered in reaction to one or more incidents, and many will be raised or initiated via Service Desk staff. Other Problem Records, and corresponding Known Error Records, may be triggered in testing, particularly the latter stages of testing such as User Acceptance Testing/Trials (UAT), if a decision is made to go ahead with a release even though some faults are known. Suppliers may trigger the need for some Problem Records through the notification of potential faults or known deficiencies in their products or services.

The process activities to be followed during the management of an problem is shown in Figure 2. Problem Management Framework [13].

![Figure 2. Problem Management Framework](image)

3.3. OWL

The OWL (Web Ontology Language) is designed for use by applications that need to process the content of information instead of just presenting information to humans. OWL facilitates greater machine interpretability of Web content than that supported by XML, RDF, and RDF Schema (RDF-S) by providing additional vocabulary along with a formal semantics. OWL has three increasingly-expressive sublanguages: OWL Lite, OWL DL, and OWL Full [14].

This research in implementation, We use Protege 3.4.5 for constructing system model. Protege is a free, open-source platform that provides a growing user community with a suite of tools to construct domain models and knowledge-based applications with ontologies. At its core, Protege implements a rich set of knowledge-modeling structures and actions that support the creation, visualization, and manipulation of ontologies in various representation formats. The Protege -OWL editor enables users to build ontologies for the Semantic Web, in particular in the W3C's Web Ontology Language. An OWL ontology may include descriptions of classes,
properties and their instances. Given such an ontology, the OWL formal semantics specifies how to derive its logical consequences [15].

OWL-DL is based on Description Logics. Description Logics are a decidable fragment of First Order Logic and are therefore amenable to automated reasoning. It is therefore possible to automatically compute the classification hierarchy and check for inconsistencies in an ontology that conforms to OWL-DL. This research focuses on OWL-DL [16].

3.4. Knowledge Management

The successful deployment of a knowledge management system must be linked to a specific business objective. By linking the system to a specific business objective, and coupling that with the use of an assessment technique such as return on investment, an organization can then identify clear costs and benefits and also be sure that the system is providing value in an area that is indeed important to the organization [17]. Similarly, focusing on the standardization and discipline that ITIL emphasizes can reduce the ongoing cost of delivering IT services at the same time the quality and consistency of service is improved. The ITIL processes help organization to effectively manage IT in alignment with rapidly changing business conditions and demands. The organizations are also able to minimize the time and cost associated with IT operations and can consistently execute best practices for delivering IT services [18]. Similarly, ITIL process integration architecture can provide the practice framework for the ITIL processes and tools in the context of organization environment from the viewpoint of security, knowledge, information, control and semantics. The project are approaching end, and the architecture facilitates their management system constructions and ITIL supporting tool development [19].

This Research in Implementation, We use knowledge management in our organization for help in designing 4 Business Case Processes. Our knowledge management system (kms) provides easy access to various information, and has many functions for use, such as knowledge collection, creation, exchange, sharing, etc.

3.5. SWRL

The SWRL (Semantic Web Rule Language) is a new kind of mark-up language for rules promoted by W3C. SWRL can use classes and properties defined in ontology to edit the rules and constraints, and with sufficient semantic description. Rules and constraints should be executed in the inference engine for applications [20]. The SWRL rules provide procedural knowledge, which compensates for some of the limitations of ontology inference, particularly in identifying semantic relationships between individuals [21]. The rules apply the syntax “Antecedent → Consequent”. Both antecedent and consequent are conjunctions of atoms of the form atom1 ^..^ atomn, where a variable is indicated by a question mark (e.g. ?x). However, adding such rules to the description logic inference engine leads to the “undecidability of inference” problem [22]. To support this knowledge extraction, a query language called SQWRL (Semantic Query-Enhanced Web Rule Language) was developed to extend SWRL to support querying of OWL ontologies. SQWRL is implemented as a built-in library using the standard SWRL built-in mechanism. It is syntactically and semantically compatible with standard SWRL [23].

The Protege system is an open-source, ontology-editing environment and knowledge-base framework developed by Stanford Medical Informatics. The Protege SWRLTab is a development environment for working with SWRL rules in Protege–OWL. It supports the editing and execution of SWRL rules and also provides high-level Java APIs that support the creation and modification of SWRL rules in an OWL ontology [24]. SWRLJessTab and JessTab are successful implementations of JESS (Java Expert System Shell) as extensions to Protege. Jess provides both an interactive command line interface and a Java-based API to its rule engine. The Jess system consists of a rule base, a fact base, and an execution engine [25].

In this research, we used Protege–OWL to edit and execute SWRL rules, and SQWRL to query OWL ontologies. For example, determining purchase requisition greater than 3 million Baht was achieved with the following SQWRL query:
The query results and more details are shown in section 5 which discusses implementation.

4. Research Design

Our research design was developed by Ontology Integration between Business Cases, a UML Activity Diagram and the ITIL Framework. This methodology, which we call Process Management, resulted in the Ontology (OWL) as shown in Figure 3.

![Diagram showing Business Cases, UML Activity Diagram, ITIL Framework, and Ontology (OWL)](image)

**Figure 3. Process Management**

1) Business Cases: we designed Business Cases based on the ITIL template correlated to procedures of the organization depicted in Figure 1 and 2.

2) UML Activity Diagram: we produced a UML Activity Diagram, i.e. Incident Management for Procurement.

3) ITIL Framework: we constructed a UML Activity Diagram based on the ITIL Framework.

4) Ontology (OWL): we used ontology tools to conceptualize the Process Activities.

5. Implementation

Our implementation was based on business cases of the Royal Thai Air Force Computer Center’s operation, which use the Thailand Government standard for operation. The implementation uses 2 business cases, i.e. Procurement Process of IT equipment, Service, Hardware with cost less than 3 million Baht, and Communication Network Failure for Implement model.

The implementation includes Incident Management for Procurement Process, Problem Management for Procurement Process, Incident Management for Communication Network Failure Process and Problem Management for Communication Network Failure Process as shown in Figures 4, 5, 6 and 7.
Figure 4. The Incident Management for Procurement Process

Figure 5. The Problem Management for Procurement Process

Figure 6. The Incident Management for Communication Network Failure Process
Figure 7. The Problem Management for Communication Network Failure Process

The implementation activity diagram which describes the Incident Management for Procurement process operation as shown in Figure 8.

Figure 8. The Activity Diagram of Incident Management Process for Procurement
Our Incident Management for Procurement Process is implemented by using Incident Management Framework. It is composed of 4 main elements:

**Input:**
1) A purchase requisition form for less than 3 million Baht (IR01).
2) Term of Reference (TOR) (IR02).

**Process Activities:**
1) The Incident Management for Procurement Process of IT equipment, Service and Hardware is identified by the analyst (AII01).
2) The IT equipment, Service and Hardware is logged by the analyst and approved or rejected by the head of analysis division (AIL01).
3) The Incident Management for Procurement Process of IT equipment, Service and Hardware is categorized by analyst (AICG01).
4) The analyst analyses the project and the purchase process, such as purchase or hire (AITD01).
5) The Incident Management for Procurement Process is approved and the analyst sends that to the procurement division (AIE01).
6) The procurement division sets a committee and the bidder makes TOR (AIVD01).
7) The procurement division announce TOR to bidders or no one bids (ARR01).
8) The project owner receives IT equipment, Service and Hardware (AICS01).

**Roles:**
1) Project owner (RR01).
2) Analyst (RIG01).
3) Head of analysis division (RIG02).
4) Bid and inventory approval committee (RIG03).
5) Procurement division (RIG04).
6) Director of Computer Center (RIM01).

**Output:**
The Purchase Process closes and the Director of Computer Center produces a monthly report (OIRP01).

In implementation our system model, we use Protege for constructing Incident Management purchase classes, data in visualization, process in visualization and OWL file. The details of purchase data are recorded by the Instance Editor of Protege tool and use the tool to generate data in visualization, process in visualization and OWL file.

![Figure 9. Incident Management for Procurement classes](image)

The visualizations most useful categorization is probably between abstract and model-based. The abstract visualizations show completely conceptual constructs relation of Incident Manage-
ment purchase data. It is composed of Input, Process Activities, Roles and Output as shown in Figure 10.

![Figure 10. Incident Management for Procurement data in visualization](image)

The most recent development in standard ontology languages is OWL. It is based on a different logical model which makes it possible for concepts to be defined as well as described. The Incident Management Purchase data OWL file as shown in Figure 11.

![Figure 11. Incident Management for Procurement data OWL file](image)
The next step of implementation semantic rules employs an editing tool and inference engine to connect OWL-based ontology. The Protege software provides a SWRL-based rule editor using software plug-in called SWRLTab. A rule inference engine such as JESS can be embedded into Protege to perform SWRL-based rules. The top frame allows users to edit rules using Horn-Like text. The bottom frame is a runtime interface that launches JESS and other related functions as shown in Figure 12.

![Figure 12. SWRLTab after Run Jess, shown result at bottom frame](image)

Our queries involved determining purchase requisition greater than 3 million Baht. Therefore, we used the Semantic Query-enhanced Web Rule Language (SQWRL) which is a SWRL-based query language that can be used to query OWL ontologies and also provides SQL-like operations to format knowledge retrieved from an OWL ontology. SQWRL queries can be written and executed on the same SWRL Rules tab as shown in Figure 13. SQWRL implements most of these operators backed by the Jess rule engine.

![Figure 13. SQWRL query to identify a Procurement requisition greater than 3 million Baht](image)
The query results indicate purchase requisition greater than 3 million Baht as shown in Figure 14. The analyst can use these results to identify Purchase Process of IT equipment, Service, and Hardware at Activity Diagram AII01, see Figure 8.

6. Evaluation

The implementation was based on business cases of the Computer Center at Royal Thai Air Force, which uses Thailand Government standards for IT operations. The implementation uses 2 business cases: Incident Management for Procurement and Problem Management for Procurement. The implementation uses an activity diagram to describe those business cases. The activity diagram must be correct, along with rule’s procurement of Thailand Government standard. Thus, we organized a group of 5 domain experts (specialists in Procurement, Security, Communication & Networking and IT Management) to verify and validate. As shown in Table 1, the evaluation result has the mean value of 4.60 (maximum=5) or 92%.

Table 1. A evaluation of domain experts

<table>
<thead>
<tr>
<th>Domain Experts</th>
<th>Evaluation Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Person 1:</td>
<td>4.67</td>
</tr>
<tr>
<td>Person 2:</td>
<td>4.58</td>
</tr>
<tr>
<td>Person 3:</td>
<td>4.67</td>
</tr>
<tr>
<td>Person 4:</td>
<td>4.58</td>
</tr>
<tr>
<td>Person 5:</td>
<td>4.50</td>
</tr>
</tbody>
</table>

7. Conclusion

In this paper, we have described a model to solve an unplanned interruption to an IT service or reduction in the quality of an IT service operation and the impact of incidents that cannot be prevented. We have focused on IT service operation in an organization, based on Incident Management and Problem Management of ITIL Framework, using Protege software as a tool. We implemented Ontological Artifacts and Visualization of Process Activities, using Protege to design the business cases. The business cases are presented in 4 types: Incident Management for Procurement, Problem Management for Procurement, Incident Management for Communication Network Failure and Problem Management for Communication Network Failure.
We use the ITIL framework to produce the OWL, and configuration rules are formalized in SWRL and SQWRL for performing queries on OWL ontologies. These methods can be useful for Service Operation and our model can apply to other types of IT organizations, so that the organization can solve problems about Incident Management and Problem Management and enhance organization efficiency.

8. References


