CHAPTER 6

AN ONTOLOGY BASED WEB SERVICE FOR SOFTWARE RISK MANAGEMENT

6.1 INTRODUCTION

This chapter aims at building a system to aid, and in certain cases, perform the work of the project analysts. It deals with providing an ontology based web service to analyze each project, product or service, based on the factors, relationships and constraints that constitute the respective project, product or service. Its main goal is to provide project analysts with a web service to aid them in identifying and assessing the risks involved in the project, allowing them to plan for avoiding the risks, and controlling and monitoring risks. This proposed system aids risk analysts in analyzing projects, products and services, and enhancing risk management techniques, thereby increasing the efficiency of the analytic process. It also performs the function of risk analytic for small scale and medium scale projects, and provides a scenario for risk analysts to compare current and previous projects.

6.2 SYSTEM ARCHITECTURE

The whole architecture of the system is shown in Figure 6.1. The proposed system is developed as a web service, with the following seven logical components. Detailed design of the system is represented using UML diagram as given in appendix III.
The User Interface obtains the details of the project to be analyzed from the user. The User Interface constitutes a webpage/website. Based on the unique ontology defined for the project an intermediate representation of the ontology is built. The ontology builder builds the ontology for the project being analyzed. The Ontology Merger and Analyzer merge the ontology that has been created with the existing Ontology Repositories. The Ontology repository consists of Ontologies for the various processes of Risk
Management. These Ontologies describe the factors and constraints that govern the Risk Management processes. The Information Extractor extracts the analyzed information from the Onto M&A (Ontology Merger and Analyzer). This information obtained is then sent to the report generator. The report generator converts the information into a format that allows the user to understand the risks involved, and provides the techniques and solutions to avoid and/or mitigate such risks.

6.2.1 User Interface

It consists of various forms of factors that may affect the project. The numerical factors are analyzed by using a set of standard formulas, and the non-numeric factors are analyzed by requesting the user to answer a set of queries. Like computing function point analysis, these factors are used for identifying whether the project that has to be developed is highly risk prone or risk less and whether it is viable or not. Every module comprises of a separate user interface for representing its internal working.

**Input**: Factors that describe the Project

**Output**: Risk ratio observed from each factor

6.2.1.1 Non Numeric Factors

The various factors mentioned in this session are composed from the software risk assessment ontology (SRAONTO) presented in Figure 3.5. In SRAONTO, the concept ‘Factor’ comes in level I, i.e.it is one of the subclasses of the root concept ‘Risk Analysis’. The subclasses of ‘Factor’ are ‘Internal_Factor’ and ‘External_Factor’. ‘Macro_Factor’ and ‘Micro_Factor’ are subclasses of the concept ‘Internal_Factor’.
Table 6.1 Hierarchy of Non-numeric Factors

<table>
<thead>
<tr>
<th>Factors</th>
<th>External Factors</th>
<th>Macro Factors</th>
<th>Environmental, Legal, Political, Socio Cultural, Technology, Competitors, Customer, and Ecological</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Micro Factors</td>
<td>Public, and Supplier</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Internal Factors</td>
<td>Machine, Staffing, Management, Material and Monitory.</td>
</tr>
</tbody>
</table>

Here adaptability refers the rigidity of the factor and it is inversely promotional to the degree of instability.

I. **Environmental Adaptability**

1. What is the degree of instability that might occur due to a climate change in the business and organizational environment?

2. What is the degree of instability that might occur due to radical changes in the user requirements ?

3. What is the degree of instability that might occur due to a mismatch between the company culture and the required business process changes needed for the new system/project ?

4. What is the degree of instability that might occur due to a change in ownership or senior management ?

5. What is the degree of instability that might occur due to external dependencies not being met ?
II. Legal Adaptability

1. What is the degree of instability that might occur due to patents in development?
2. What is the degree of instability that might occur due to licensing issues?
3. What is the degree of instability that might occur due to the liability issues?
4. What is the degree of instability that might occur in marketing the project?
5. What is the degree of instability that might occur due to trademark issues?

III. Political Adaptability

1. What is the degree of instability that might occur due to the inability to move ideas in the organization?
2. What is the degree of instability that might occur due to the inability to reach a consensus on complex issues with a number of stakeholders?
3. What is the degree of instability that might occur due to the initiation of a project from someone's ideas?
4. What is the degree of instability that might occur due to the initiation of a project having less value?
5. What is the degree of instability that might occur due to a difference in the vision of employees for the same task?
IV. Socio Cultural Adaptability

1. What is the degree of instability that might occur due to improper shaping of a corporate culture?
2. What is the degree of instability that might occur due to the unfair success and the establishment of standards?
3. What is the degree of instability that might occur due to the inefficiency of heroic roles in the corporate sector?
4. What is the degree of instability that might occur due to not following systematic and programmed routines?
5. What is the degree of instability that might occur due to informal communication?

V. Technology Adaptability

1. What is the degree of instability that might occur due to the introduction of new technology?
2. What is the degree of instability that might occur due to technical architecture?
3. What is the degree of instability that might occur due to requirements for excessive performance constraints on the project?
4. What is the degree of instability that might occur due to improper interfacing of the software with new hardware?
5. What is the degree of instability that might occur due to the requirements demanding the use of new analytical methods?
VI. Competitor Adaptability

1. What is the degree of instability that might occur due to identifying competitors?

2. What is the degree of instability that might occur due to the inability to monitor the competitors?

3. What is the degree of instability that might occur due to the range of best competitors?

4. What is the degree of instability that might occur due to your view on having competitors?

5. What is the degree of instability that might occur due to any diversion from the current process?

VII. Customer Adaptability

1. What is the degree of instability that might occur due to lack of user involvement?

2. What is the degree of instability that might occur due to lack of user experience?

3. What is the degree of instability that might occur due to lack of user acceptance?

4. What is the degree of instability that might occur due to user training needs?

5. What is the degree of instability that might occur due to user justification?
VIII. Public Adaptability

1. What is the degree of instability that might occur due to unavailability of a team member?

2. What is the degree of instability that might occur due to lack of experience with hardware and software?

3. What is the degree of instability that might occur due to lack of experience with the process of the project?

4. What is the degree of instability that might occur due to the required amount of team productivity?

5. What is the degree of instability that might occur due to lack of knowledge with the application domain?

IX. Supplier Adaptability

1. What is the degree of instability that might occur due to inefficient financial stability of the supplier?

2. What is the degree of instability that might occur due to lack of labor stability?

3. What is the degree of instability that might occur due to lack of delivery commitment?

4. What is the degree of instability that might occur due to the quality of the supplied components?

5. What is the degree of instability that might occur due to lack of regulatory issues and compliance?
X. **Machine Adaptability**

1. What is the degree of instability that might occur due to the severity of the injury?

2. What is the degree of instability that might occur due to unreliability of the existing safety functions?

3. What is the degree of instability that might occur due to improper machine maintenance?

4. What is the degree of instability that might occur due to the workplace environment?

5. What is the degree of instability that might occur due to the complexity in handling the machine?

XI. **Staffing Adaptability**

1. What is the degree of instability that might occur due to insufficient staffing?

2. What is the degree of instability that might occur due to key players moving away from the project?

3. What is the degree of instability that might occur due to the excessive use of an outside consultant?

4. What is the degree of instability that might occur due to lack of available skilled personnel?

5. What is the degree of instability that might occur due to lack of training provided for the team?
XII. Management Adaptability

1. What is the degree of instability that might occur due to the failure to manage end user expectations?

2. What is the degree of instability that might occur due to lack of adequate user involvement?

3. What is the degree of instability that might occur due to lack of co-operation from the user?

4. What is the degree of instability that might occur due to improper management of changes?

5. What is the degree of instability that might occur due to the choice of the wrong development strategy?

XIII. Material Adaptability

1. What is the degree of instability that might occur due to unavailability of alternative materials?

2. What is the degree of instability that might occur due to a difficulty in the test methods?

3. What is the degree of instability that might occur due to the critical nature of the process?

4. What is the degree of instability that might occur due to the storage capacity of the material?

5. What is the degree of instability that might occur due to the quality of materials?
XIV. Monetary Adaptability

1. What is the degree of instability that might occur due to setting the budget for a development effort before the scope and requirements are defined?

2. What is the degree of instability that might occur due to the underfunding of maintenance?

3. What is the degree of instability that might occur due to the lack of effective tools and unrealistic cost estimates?

4. What is the degree of instability that might occur due to the non-budgeting of the entire project?

5. What is the degree of instability that might occur due to improper cash flows?

XV. Ecological Adaptability

1. What is the degree of instability that might occur due to the project causing a significant environment change?

2. What is the degree of instability that might occur due to the construction or expansion or modification of an existing facility for the proposed project?

3. What is the degree of instability that might occur due to the capability of the precedent for future actions with environmental effects?

4. What is the degree of instability that might occur due to the application of ineffective environmental standards?
5. What is the degree of instability that might occur due to the exclusion of other project activities in a cumulative effect assessment?

6.2.2 Ontology Repository

This module describes the processes of conceptualization and specification, or the building of SRMonto.

The SRMonto consists of

- Software Risk Identification Ontology (SRIONTO)
- Software Risk Analysis Ontology (SRAONTO)
- Software Risk Planning Ontology (SRPONTO)
- Software Risk Tracking Ontology (SRTONTO)
- Software Risk Control Ontology (SRCONTO)

A detailed description of the SRMonto is presented in Chapters 3 and 4.

6.2.3 Ontology Code Conversion (OCC)

The ontology builder builds the ontology for the project being analyzed, based on the input obtained from the user. The category of the risk is estimated for each and every factor (internal and external) and the results are stored internally. Figure 6.2 shows the algorithm used for the OCC.

**Input**: Risk ratio observed from each factor

**Output**: Formatted file suitable for ontology
function build_formatfile(Risk ratio list) returns formatted file
begin
    get_factor();
    get_factorriskratio();
create file for formatted input;
    write_factor();
If riskratio is present
begin
    write_factorriskratio();
else
begin
    write_defaultfactorriskratio();
end;
end;

Figure 6.2 Algorithm for Ontology Code Conversion

6.2.4 Ontology Builder

The ontology builder builds the ontology for the project being analyzed based on the input obtained from the Ontology Code Conversion (OCC) mechanism. The formatted file obtained from the OCC module forms the basis for building the new ontology. Figure 6.3 shows the algorithm for Ontology Builder.

Input: Formatted file

Output: OWL file (ontology)
function build_Ontology(Formatted file) returns owl file
begin
    get_classfactors();
    get_subclassprops();
create file for owl file;
    write owlheader();
    while class_factor present
        begin
            write_classfactor();
            write_subclassfactor();
        end;
end;

Figure 6.3. Algorithm for Ontology Builder

6.2.5 Ontology Merger and Analyzer

The Ontology Merger and Analyzer merges the ontology that has been created with the existing Ontology Repositories. The Onto Merger Algorithm is utilized for the merging process. The merged Ontologies are analyzed using a Onto Analyzer algorithm. The Onto analyzer absorbs the data from the existing owl files and compares it with the newly created owl files. The Inference obtained from the comparison forms a major part of the final report. Figure 6.4 shows the algorithm for Ontology Merger and Analyzer.

**Input**: Constructed owl file and Existing owl file.

**Output**: OWL file (ontology)
Function Merge_and_Analyze(constructed_ontology,ontology repository) returns ontology
begin
    open file Ontology repository owl file
    while classfactor present
        begin
            read classfactor();
            read subclassfactor();
            store classfactor(),subclassfactor();
        end
    close file ontology repository file
    open file Constructed owl file
    while classfactor1 present
        begin
            read classfactor1();
            read subclassfactor1();
            store classfactor1(),subclassfactor1();
        end
    close constructed owl file
    while classfactor1 present
        begin
            compare classfactor(),classfactor1();
            compare subclassfactor(),subclassfactor1();
        end
    open file Ontology repository owl file

Figure 6.4 (Continued)
open file Constructed owl file
remove owl header files of constructed owl file
append Constructed owl file to Ontology Repository owl file
close Constructed owl file
close Ontology repository file
end

Figure 6.4 Algorithm for Ontology_Merger_And_Analyzer

6.2.6 Information Extractor

The Information Extractor extracts the classes with their hierarchy structure from the inferred owl file. Figure 6.5 shows the algorithm for information extractor.

**Input**: Inferred owl file

**Output**: Formatted data

function info_extract(owl file) returns the extracted information
begin
open file Constructed owl file
while class exists
begin
extract class();
extract subclass();
if subclass not found then
continue;
store class, subclass, relation
end;
end;

Figure 6.5 Algorithm for Information_Extractor
6.2.7 Report Generator

The information obtained by the Info extractor is sent to the report generator. The Report Generator converts the information into a format, that allows the user to understand the risks involved, and provides the techniques and solutions to avoid and/or mitigate such risks. Figure 6.6. shows the algorithm for Report Generator.

**Input:** Formatted data from the Information Extractor  
**Output:** User understandable data

```plaintext
function generate_report(formatted file) returns the user understandable data
begin
    open formatted info file;
    while class present
        begin
            get_class();
            get_subclass();
        end;
    for each class
        begin
            for each subclass
                begin
                    compare subclass,prop;
                    infer weightage value;
                end
        end
    Display user understandable data(chart) for inference;
End;
```

**Figure 6.6 Algorithm for Report Generator**
6.3 IMPLEMENTATION

Since the system obtains the details of the project to be analyzed from the user, it is developed as a webpage/website. The Webpage/Website is built using C# on a .Net framework. This system is successfully implemented as a web service named PRIMES (Providing RIsk Management as wEb Service) and now the service is available at http://www.primes.somee.com/. The user is given two options to access the system by processing module by module, as well as by an entire project analysis. After successfully entering into the system, the user can input the details about the project for the questions that are related to the problems that may occur with the non-numeric factors. It consists of 15 factors and each is having 5 different questions and a list of the categories of risk involved in the project. So the process is repeated for all the factors and the input details get stored. There are five categories, such as very high, high, medium, low and very low available for selection, and the user can select any one among the five. If the default values are chosen by the skip option, the very high category is chosen for all the questions. The user input form for one of the non numeric factors “Legal Adaptability” is shown in Figure 6.7.

![Figure 6.7 Entering value for the Legal Adaptability](image-url)
Figure 6.8 shows the input for one of the numeric factors, the absorption ratio.

Figure 6.8 User Interface of the Numeric Factor

Figure 6.9 shows the aggregated risk involved in the entire project after analyzing each and every factor.

Figure 6.9 Final Visual outcome after the Risk Analysis
6.4 SUMMARY

Risk management plays a vital role in the development of a project, products or services. The ontology based system described in this chapter, provides a robust approach to aid decision makers in their decision making process. The OWL format of the SRMonto described in Chapters 3 and 4 has been used as the ontology repository. The base for the calculation of different metrics is driven through formulas, and a knowledge base is developed based on the user responses to a set of questions regarding the various issues that might influence the industry. A base of statistical and non statistical data forms the core of the system metrics, while generating the final result. The system learns new information as it encounters new scenarios, and these scenarios make the system to act genuinely intelligent. As the system goes through new scenarios and new instances it develops its knowledge base, and hence becomes Artificially Intelligent, with scope for producing results based on scenarios encountered in the past.