Reusability in Component Based Software Development - A Review

Swati Thakral, Shraddha Sagar and Vinay

Galgotias University, Gr. Noida, India
Keystone Group of Institutions, Jhunjhunu, India

Abstract: The paper demonstrates a literature review of various software reusability concepts. It provides a brief and systematic review of available reusability metric proposed by different researchers in different journals and conferences. The Objective is to collect useful information on software component reusability and the factors on which reusability of the component is highly dependent. As a result of literature review we found that reusability is highly dependent on customizability, interface complexity, documentation quality and portability.

Key words: Component-Based Development · Software Reusability · Software metrics · Component Based Software Engineering

INTRODUCTION

Component Based Software Development (CBSD) has gained popularity in the past decade. This was due to the increase in demand of software on time delivery with cost constraints [1]. To develop a component from the scratch may be expensive and can take long time to complete, which may even loose the market because of critical applications with strict time limits. All these issues are being resolved by the evolution of a new approach called Component Based Development (CBD) which uses the concept of reusability in application development [2]. Component Based Software Engineering (CBSE) helps in reduction of cost and time and thus improves the quality of software [3]. In this approach appropriate off-the shelf components are first selected and then assembled with well defined software architecture [4]. The principle behind CBSE is to focus on reusing a software component. It follows-“Buy, don’t build philosophy”. Mc. Ilroy [5] introduced the concept of reuse on the basis of software factory concept.

Improving business performance often needs the improvement in their software development performance and that is the Reason, which enforces the developers and researchers to think toward the adoption of latest technologies and development approaches [6]. The main objective of CBSD is to write once and reuse any number of times with no or minor modifications [7]. This concept is almost universally accepted because of the obvious fact that a product will work properly if it has already worked before [8]. There are many advantages of CBSD as follows [9]:

- Effective management of complexity
- Reduced time to market
- Increased productivity
- Greater degree of consistency
- Wider usability

Paper is divided into 5 sections. Section 2 discusses the method adopted to do literature review which helps to extract facts and concepts for component reusability. Basic concepts and definitions given by various researchers is discussed in Sections 3. A brief literature review on reusability estimation models are discussed in Section 4. Conclusion of the paper is described in Section 5.

Method Adopted for Research

Paradigm for Research Papers Insertion: The papers which describe the content on software component reusability come under the criteria of review. Research paper should be selected on the basis of the impact of reusability on CBSD or techniques to estimate reusability.
Table 1: Project selection matrix rules

<table>
<thead>
<tr>
<th>Name of Researcher</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freeman [10]</td>
<td>“Reuse is the use of any information which a developer may need in the software creation process.”</td>
</tr>
<tr>
<td>Basili and Rombach [11]</td>
<td>“Software reuse is the use of everything associated with software with a software project, including knowledge.”</td>
</tr>
<tr>
<td>Tracz [12]</td>
<td>“Reuse is the use of software that was designed for reuse.”</td>
</tr>
<tr>
<td>Braun [13]</td>
<td>“Use of existing software components in a new context, either elsewhere in the same system or in another system.”</td>
</tr>
<tr>
<td>Cooper [14]</td>
<td>“Reuse is the capability of a previously developed software component to be used again or used repeatedly in part or in its entirely, with or without modification.”</td>
</tr>
<tr>
<td>Krueger [15]</td>
<td>“Reuse is the process of creating software systems from existing software rather than building them from scratch.”</td>
</tr>
</tbody>
</table>

**Approach of Searching Papers:** Various papers are collected by investigating various journals, conference publications and other sources applicable to our domain.

**Quest Methods and Data Elicitation:** For selecting suitable papers, we searched journals and conference proceedings by using different keywords like “Component Based Software Development”, “Software Reusability”, “Software Metrics” etc. After thorough reading of abstract and conclusion of those papers, finally we selected 19 research papers based on CBSD and the reusability impact on CBSD.

**Reusability:** Reusability plays an important role in CBSD and also acts as the basis for CBSD. The basic criterion for evaluating component is reusability. If a component is not reusable then the whole concept of component based software development fails. The definition of reusability from various researchers are summarized below:

**Factors Affecting Reusability:** Factors like Interface Complexity, Customizability, Portability, Documentation Quality, Understandability, Adaptability, Usefulness, Quality, Costs, Configurability and Compatibility affect reusability.

**Benefits of Software Reusability:** The main benefits of software reusability are as follows:

- Improved quality
- Minimized costs
- Increased productivity
- Reliability
- Interoperability

**Different Types of Reuse:** Sametinger [35] had given different models of reuse as follows:

**Ad-hoc Reuse:** Ad-hoc reuse is preferred when reuse occur within projects. Bidirectional exchange is been done between the application groups.

**Repository Based Reuse:** Repository Based Reuse is done when component repository is used and can be accessed by various application groups. It is based on quantity because any number of components can be put into the repository and there is no control over their quality and usefulness. Here the repository is the exchange medium between the application groups.

**Centralized Reuse:** In Centralized Reuse component group is explicitly responsible for repository. The group determines which components are to be stored in the repository and ensures the quality of these components and the availability of necessary documents and thus helps in retrieving suitable components in a particular reuse scenario. Here each application group interact with the component group, further they are connected bi directionally with the repository.

**Domain Based Reuse:** In Domain Based reuse each domain group is responsible for components in its domain e.g. Network components, user interface components and database components. Here each application group is associated with its domain group. Domain groups can further interact with other application group as well. The domain groups are attached with the repository.

**Literature Review:** Gill, N., (2003) presented concepts of CBD and its associated challenges in [16]. The author has discussed issues and benefits of component reusability based on cost and time. Some of the guidelines are suggested by the author to enhance the productivity and quality of the software. These guidelines help in improving quality and productivity of organizations adopting CBSD.

Washizaki, H., et al., (2003) proposed a metric suite for measuring the reusability of such black box components based on limited information that can be obtained from the outside of components without any source codes. Five metrics have been defined for measuring a components understandability, adaptability and portability. Reusability metric is provided by
combining proposed metrics based on a reusability model. This can effectively identify black box component with high reusability [17].

Gill, N., et al., (2006) discussed about CBD and its related issues. Also some of the issues in context of component based software development (CBSD) had been explored. Important aspects of CBSD including software component characterization, software reusability and impact of characterization of software component were also discussed [18].

Sharma, A., et al., (2007) presented a survey of few existing component based reusability metrics. Various component based reusability metrics are surveyed and analysis of quality factors related to reusability was also described [19].

Sharma, A., et al., (2007) discussed various reusability concepts and several metrics are explored which could help in measuring reusability of components [20].

Suri, P., et al., (2009) enumerated various metrics of software to evaluate the reusability of the modules. Also a new metric was introduced by the author for evaluating the independence of a software component which will access the degree of those components [21].

Sharma, A., et al., (2009) considers the issue of reusing component effectively. Software component reusability was evaluated by an approach based on artificial neural network. This will help the developers to select the best component in terms of its reusability. Also the network is further validated by applying the proposed approach on test data [22].

Lee, S., et al., (2010) discussed about measuring reusability of software components. This paper introduced a new method to measure component reusability [23].

Nerurkar, N., et al., (2010) discussed reusability in relation to CBD and proposed a reusability metric for black box components. Some of the factors were identified and a relationship was been established between those factors and reusability. A fuzzy logic based approach was used to estimate reusability. The approach was validated by applying on different components. The result obtained showed that the approach was able to predict the reusability of those components [24].

Niar, T., et al., (2010) proposed an effective estimation model for reusability. This will help in modules redesigning at design phase to achieve the desired level of reusability. This model is based on complexity effects of structural design properties of Object-Oriented paradigm [25].

Singh, S., et al., (2010) discussed the concepts related to component based system based on reusability. Also some existing metrics are explored for both black and white box components for reusability measurement [26].

Singh, Y., et al., (2011) proposed a model based on four parameters for accessing software reusability levels using soft computing techniques like Fuzzy Logic, Neural Network and Neuro-Fuzzy. Results showed that the Neuro-Fuzzy technique proves to be a powerful tool to tackle important problems in software engineering [27].

Amin, F., et al., (2011) discussed about the current state of the reusability assessment of software components. This work highlights the applicability of available reusability assessment approaches with a view to identify research gaps in this area [28].

Jatain, A., et al., (2012) discussed some quality attributes of components. Also a fuzzy rule based for estimating component reusability of system was proposed for some real time projects [29].

Trivedi, P., et al., (2012) presented a set of software metrics which help in checking the interconnection between the software component and the application. This could also help in estimating the software reusability in a software program. Also it will check whether the use of the component based approach in the system is favourable to the system or not [31].

Ravichandran, K., et al., (2012) developed an automated process of component selection by using adaptive Neuro-fuzzy interference system (ANFIS) based technique. Also to check accuracy a model fuzzy weighted relational coefficient (FWRC) matrix is derived between the components. The validation of the approach was also done and the results showed that reusability can be accurately predicted with this approach [32].

Imeri, F., et al., (2012) presented a literature survey on the reusability concepts. Overview of software components, CBD, benefits and obstacles to software reuse were also discussed [33].

Yasir, N., et al., (2013) presented an application to handle database. This could help the model to access different reusable components stored at different repositories which further enhances productivity of the software along with reduced cost and time efforts [34].
Table 2: Compiled Table

<table>
<thead>
<tr>
<th>Name of Researcher</th>
<th>Year</th>
<th>Focused On</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nasib S. Gill [16]</td>
<td>2003</td>
<td>Discussed about CBD and its challenges Hironori</td>
</tr>
<tr>
<td>Washizaki [17]</td>
<td>2003</td>
<td>Metrics are proposed for measuring reusability.</td>
</tr>
<tr>
<td>Arun Sharma [22]</td>
<td>2009</td>
<td>Artificial neural based approach is been proposed to access the reusability.</td>
</tr>
<tr>
<td>Seungwon Lee [23]</td>
<td>2010</td>
<td>Introduced a new method to measure reusability.</td>
</tr>
<tr>
<td>N.W. Nerurkar [24]</td>
<td>2010</td>
<td>An approach based on Fuzzy Logic is used to estimate reusability.</td>
</tr>
<tr>
<td>Sarabjeet Singh [26]</td>
<td>2011</td>
<td>Discussed reusability concepts for component based system.</td>
</tr>
<tr>
<td>Yogesh Singh [27]</td>
<td>2011</td>
<td>Proposed a model for accessing software reusability by different soft computing techniques.</td>
</tr>
<tr>
<td>Prakriti Trivedi [31]</td>
<td>2012</td>
<td>Proposed metric to estimate software reusability which helps in determining the applicability of the component in application.</td>
</tr>
<tr>
<td>Florinda Imeri [33]</td>
<td>2012</td>
<td>Presented a survey on software reusability.</td>
</tr>
<tr>
<td>Nida Yasir [34]</td>
<td>2013</td>
<td>Presented a new model to handle data on web.</td>
</tr>
</tbody>
</table>

CONCLUSION

In this paper, different concepts of reusability for software component are studied. The criteria was to study papers related to reusability for CBSD. In the whole literature review we found that reusability is one of the most important factor which is to be taken in consideration at the time of selection of the component. Then further those metrics that are responsible for evaluating the reusability of a component are determined.

REFERENCES