Development of a Program for an Automated Bill of Materials for Engineers

Geraldine B. Mangmang1*  
Rec Alfonso P. Cinco2

1College of Computer Science and Information Technology  
Southern Leyte State University  
Sogod, Southern Leyte, Philippines  
2College of Engineering and Technology  
Southern Leyte State University  
Sogod, Southern Leyte, Philippines

Abstract

To account or the impacts on construction projects, estimates must be thoroughly designed, planned, procured, and managed. This study sought to develop a system that will generate an automated bill of materials with cost estimates. The study was conducted using developmental evaluation design. The researcher applied the ISO/IEC 25010:2011 software standard for measuring and evaluating system and software product quality both existing and the new software to be developed in this study. Performance of the existing and developed system was compared using quality in use model particularly efficiency, and flexibility, and the product quality model specifically performance efficiency, and functional suitability. Data in this study were gathered within Southern Leyte Province. The Microsoft Visual Studio 2012 software and Microsoft SQL Server 2005 database management application, embody the new system. Results revealed that the developed automated bill of materials achieved specific goals with satisfaction, flexibility, performance efficiency, and performance suitability. Successful investigation in the manual preparation offers an opportunity to innovate a new and accurate system.

Keywords: Challenges; cost estimates preparation; innovation; system

Introduction

Cost estimates must be considered a dynamic and integral part of the technical and financial functions of an organization or business activity (Stewart et al., 1995). Oberlender et al. (2001) stated that the accuracy of an estimate is measured by how well the estimated cost compares to the actual total installed cost. The preparation of detailed estimate consists of working out quantities of various items of work and then determines the cost of the item. Some articles provide useful information on the manual preparation of estimates; however, the generation of the bill of materials with cost estimates was time-consuming and less effective based on the assessment conducted before the development of the new software.

Accurate, reliable and ubiquitous information is critical to the flow of products in any supply chain (Eastman et al., 2011; Akintoye et al., 2000; Azhar, 2011). The importance of accurate estimates of capital projects does significant implication. Early estimates have limited scope definition that often leads to questionable estimate accuracy (Trost et al., 2003). The architecture, engineering and construction industry has

*Correspondence: geraldine_mangmang@yahoo.com
ISSN 2545-9732
long sought techniques to decrease project cost, increase productivity and quality and reduce project delivery time (Azhar et al., 2008). Azhar (2011) stated that Building Information Modeling (BIM) is one of the most promising recent developments in the architecture, engineering, and construction (AEC) industry. However, it has lack of determination of ownership of the BIM data, and it needs protection through copyright laws and other legal channels.

Although there are related studies about the creation of a bill of materials with cost estimates, engineers still long for an efficient automated system. No study thus far has looked into the automated billing of materials, which is the technology to be developed in this study. This innovation will enlighten the challenges in the creation of the bill of materials.

Identifying and analyzing difficulties of the factors particularly in the manual preparation of estimates of engineer’s may lead to new development. In this study, perceptions and challenges met by engineers were determined and served as the basis for the automated billing of materials with cost estimates.

Objective

This study intended to develop and implement an automated bill of materials with cost estimates.

Specifically, this study aimed to:

1. Assess the performance of the existing system in the preparation of estimates.

2. Evaluate the functionality of the developed system regarding satisfaction, flexibility, performance efficiency, and functional suitability.

Framework of the Study

Figure 1 shows the operational paradigm of the study. In the assessment phase, the researchers gathered the needed data through a survey questionnaire around Southern Leyte area to determine the features to be incorporated in the design phase. Designing the new software was done after the problem identification. The user was permitted to use the developed system in the implementation phase. Evaluation was conducted to prove the functionality of the developed system.

Methodology

Research Design

This study was conducted using developmental evaluation design, an approach to understanding the activities of a program. The design centers on innovation and considered knowledge rather than typical results and is much a way of thinking about programs-in-context and the feedback they produce. According to the study of Richey et al. (2014) averred that this kind of design is distinctive to the instructional design and technology field dedicated to the creation of new knowledge and the validation of existing practice.

Research Participants

The research respondents of the study were the new engineering graduates, practicing engineers, engineering instructors, and contractors randomly chosen who are currently working in Southern Leyte related to engineering.

Research Instrument

This study utilized a questionnaire where the performance of the existing and the developed system was matched based on satisfaction, flexibility, performance efficiency, and functional suitability. This comparison was implicitly done based on a metrics of the quality of use model (i.e., satisfaction, flexibility) and the product quality model (i.e., performance efficiency, functional suitability),
which the researcher defined according to the ISO/IEC 205010:2011 standard.

**Results and Discussion**

**Phase I: Assessment of the Existing System in the Preparation of Bills of Materials**

The results revealed that the respondents strongly disagree in the flexibility and the performance efficiency of the existing system (Table 2). Furthermore, the system didn’t satisfy the user and disagreed regarding functional suitability (Table 2). In the study of Smith (2013), stated that the subject of estimating revolves principally around the need for all interested parties involved in the building process, mainly the Contractor to be able to predict as accurately as possible the costs of construction. Furthermore, Gopalakrishnan et al. (2015) stated that the overall profitability appears to be a priority for the majority of industry firms. Materials management should be truthful, adept in the art of communication, intelligent, loyal to the organization and should suppress personal greed and obviously serve the user. In the study of Kim et al. (2014), stated that the current practices in planning and managing are often manual and reactive, especially when a construction project is

**Data Collection**

Figure 2 displays the data gathering procedure. Data gathering happened during the researchers’ travel within the Southern Leyte Province.

**Developed System**

In the developed system, the software used was Microsoft Visual Studio 2012 as the front-end and Microsoft SQL Server 2005 as the database system. Figure 3 shows the flowchart on how the system works.

This study followed the step by step process like the Software Development Life Cycle (SDLC). Every stage needs to be done first before moving on the next level. Figure 4 illustrates the SDLC process.
already underway. Widespread results are code compliance problems, inefficiency, and the waste of procuring and managing materials. The study conducted by Clough et al. (2015), revealed that the disadvantage of the current practices is not a complete and integrated design because of the assumptions that needed to be made earlier. The study of Yildez et al. (2014), affirmed that operational risk assessment and management is critical for success in construction projects. In a study conducted by Ashworth et al. (2015), he stated that the importance in the preparation of estimates is the understanding of construction economics and cost control, particularly during the design stage of projects.

**Phase II: Design of the Developed System**

Different features that comprise the developed system were identified and enumerated.
Figure 4. The Software Development Life Cycle (SDLC).

Table 1. Assessment of the existing system

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satisfaction</td>
<td>1.8</td>
<td>0.171791</td>
<td>Dissatisfied</td>
</tr>
<tr>
<td>Flexibility</td>
<td>1.73</td>
<td>0.201663</td>
<td>Strongly Disagree</td>
</tr>
<tr>
<td>Performance efficiency</td>
<td>1.56</td>
<td>0.091606</td>
<td>Strongly Disagree</td>
</tr>
<tr>
<td>Functional suitability</td>
<td>1.97</td>
<td>0.107112</td>
<td>Disagree</td>
</tr>
</tbody>
</table>

Note:
- 1.00-1.75 –Very Dissatisfied; Strongly Disagree;
- 1.76-2.50 –Dissatisfied; Disagree;
- 2.51-3.25 –Satisfied; Agree; Secure
- 3.26-4.0 – Very Satisfied; Strongly Agree;

Table 2. Evaluation of the developed system

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satisfaction</td>
<td>3.59</td>
<td>0.11941</td>
<td>Very Satisfied</td>
</tr>
<tr>
<td>Flexibility</td>
<td>3.51</td>
<td>0.089098</td>
<td>Strongly Agree</td>
</tr>
<tr>
<td>Performance efficiency</td>
<td>3.37</td>
<td>0.16224</td>
<td>Strongly Agree</td>
</tr>
<tr>
<td>Functional Suitability</td>
<td>3.5</td>
<td>0.07964</td>
<td>Strongly Agree</td>
</tr>
</tbody>
</table>

Note:
- 1.00-1.75 –Very Dissatisfied; Strongly Disagree;
- 1.76-2.50 –Dissatisfied; Disagree;
- 2.51-3.25 –Satisfied; Agree; Secure
- 3.26-4.0 – Very Satisfied; Strongly Agree;
Figure 5. The Main Menu

Figure 6. Column details of the new system

Figure 6 shows the main menu.

**Phase III: Assessment of the Developed System**

Results revealed that the developed system met the satisfaction of the user (Table 2). Moreover, the new software achieved the specific needs of the user which includes flexibility, performance efficiency, and functional suitability (Table 5). In the study conducted by Culler et al. (2007) revealed that implementing better decision making tools and standardizing transactions in digital format would reduce the workload on critical personnel and archive valuable knowledge for analysing company methods and expertise. In the study of Ratna et al. (2014), he affirmed that in a computer integrated manufacturing environment, proper planning, control and operational processes require a proper combination of expert knowledge of the area along with powerful decision support capabilities. Taking into account various possible projects variations, it is impractical to prepare designs manually for all (Kim et al., 2014). The study of Enshassi et al.
(2015), affirmed that cost estimation is a fundamental part of the construction practice as it represents the compilation and analysis of many items that influence, and contribute to, the total cost of the project.

**Conclusion**

The findings of the study provide information in the development of an automated bill of materials. Successful investigation of the performance of the manual preparation offers the opportunity to innovate a new and accurate system.

**References Cited**


Richey, R. C., & Klein, J. D. (2014). Design and development research. In Handbook of research on educational communications and technology (pp. 141-150). New York, NY: Springer


