6.1 Introduction

This chapter explains on the implementation processes and also testing which is performed to determine if there is any unnecessary error. After the designing phase completes, the development process begins where the proposed system is written and implemented. Then, system testing is performed to ensure the desired output is obtained. Testing phase represents the identification of how well and accurate the final output of the system to meets the user’s requirements. It also reviews the completeness and reliability of the system. By having a series of tests, it can verify the findings of the research and also putting the prototype of e-BSC system as a pilot deployment before executing the actual and the exact system. User acceptance testing is the most important type of testing to be conducted in order to examine the acceptance of the proposed e-BSC system if it meets the users’ requirements and validate the analysis results which captured earlier.

6.2 Development Environment

It is essential to have a suitable development environment in building a system. By using sufficient and appropriate hardware and software, it could help to improve the speed of development processes which leads to the success of a system. The followings are the hardware (Table 6.1) and software (Table 6.2) used for the prototype development of e-BSC system.
i. **Hardware Requirements**

**Table 6.1 Hardware Requirements for the Development of e-BSC System**

<table>
<thead>
<tr>
<th>Hardware</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processor</td>
<td>Intel Centrino 1.6 Ghz Processor</td>
</tr>
<tr>
<td>Memory</td>
<td>512MB Memory</td>
</tr>
<tr>
<td>Hard Disk Space</td>
<td>60 GB</td>
</tr>
<tr>
<td>Monitor</td>
<td>15’ Color Monitor of 1024x768 resolution</td>
</tr>
<tr>
<td>Others</td>
<td>Other required standard computer peripherals</td>
</tr>
</tbody>
</table>

ii. **Software Requirements**

**Table 6.2 Hardware Requirements for the Development of e-BSC System**

<table>
<thead>
<tr>
<th>Software</th>
<th>Usage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microsoft Word</td>
<td>System Development</td>
<td>Documentation</td>
</tr>
<tr>
<td>Microsoft Windows XP</td>
<td>System Development</td>
<td>Operating System</td>
</tr>
<tr>
<td>MySQL Server</td>
<td>Database</td>
<td>Connection of database to the system</td>
</tr>
<tr>
<td>Macromedia Dreamweaver MX 2004</td>
<td>System Development</td>
<td>Programming/Coding</td>
</tr>
<tr>
<td>Adobe Photoshop 7.0</td>
<td>System Development</td>
<td>Image and Graphical Editing</td>
</tr>
<tr>
<td>Apache</td>
<td>System Development</td>
<td>Web server</td>
</tr>
</tbody>
</table>
6.3 Programming Language and Development Tools

This section explains in detail the programming languages and development tools which have been used in building the prototype of the proposed e-BSC system.

6.3.1 Client-Side Scripting Language for e-BSC system: Javascript

The selected client-side scripting language for e-BSC system is Javascript. It is developed by Netscape and using Java as the base language. Javascript is also an open source language which is one of the reasons why it is chosen for the development of the system. Functions that need user’s input such as their confirmation answer, call to display an external window, call to display error message and etc. are written using the Javascript language.

6.3.2 Server-Side Scripting Language for e-BSC system: PHP

PHP (HyperText Preprocessor) is an open-source server-side scripting language which can be embedded within HTML tags to create interactive Web pages. PHP is one of the most popular scripting languages to be used by programmers. The server processes the scripts before it is sent over to the client send so that the codes are unseen by the client but only the output. PHP also offers the direct connectivity to relational databases by using full internal functions. It supports major databases and provides the ability to run in major operating systems such as Linux, Unix, Mac OS X and Windows. By choosing PHP which is one of the open source scripting languages, lots of scripts and tutorials can be easily found from the online sources. HTML codes are written statically, that is the information remain same only if changes are made to the HTML code while PHP allows dynamically change of the Web page contents where changes can be seen when visitors perform changes by their choices or input. PHP scripting language is selected as it provides
interactivity with HTML tags. Besides, it communicates well with various databases such as MySQL, Oracle, SyBase, Informix, dBASE and etc. Therefore, it is chosen as the server-side scripting language which connects to MySQL database in the development of e-BSC system.

6.3.3 HTML

HTML (HyperText Markup Language) is a markup language for web pages. It provides the structure for text-based document and having the objects such images, interactive forms and other objects. The web pages are built with the HTML tags that define the page layout, font and graphics elements. However, it is not a programming language but it can be embedded with other programming languages to produce interactive pages such JavaScript and PHP.

6.3.4 Web Server for e-BSC System: Apache

Apache is chosen as the Web server for e-BSC system which parses any files requested by a browser and returns the correct results according to the codes within that file. Apache is an open source Web server that runs in most operating systems, which has gained high popularity among the web developers. It also provides reliability, more stable and easy to maintain. It is used for testing in running the e-BSC pages before uploading to a secure server on another machine. With the modular design of features in Apache server, it provides the ease of use and reduces the development time of e-BSC system.
6.3.5 Macromedia Dreamweaver MX 2004

Macromedia Dreamweaver MX 2004 is a web page editor application which allows developers to create web sites. It is easy to use and provide the sufficiency of web page editing features. It integrates well with other Macromedia applications to produce great web pages. This tool is used for the development of e-BSC system where it generates the programmed codes and produces the preview of the program outcome. It supports many scripting languages and numerous web-related technologies. Therefore, the selected PHP and JavaScript languages are embedded within the HTML tags to be generated in producing the desired web pages.

6.4 Development Platform

The chosen development platform for e-BSC system is Windows XP operating system. The stability of this system promotes the efficiency for the development process. Besides, it has been the familiarity for most users to use this operating system and it is widely adopted in organization-wide. It is believed that upgrading work is being done to increase the stability and minimizes the failures of application which could interrupt the users’ working process.
6.5 Database Implementation

This section discusses the details about the database implementation of the proposed e-BSC system.

6.5.1 Database Server for e-BSC System: MySQL

MySQL is used as the database server for the development of e-BSC system. It enables PHP and Apache to work together for the access and retrieving data in a readable form to a browser. This Structured Query Language server is designed to process heavy loads and complex queries. With its popular features and under the license of open source, it is selected as the main database tool for e-BSC system. Besides, it also provides the ability to handle heavy loads and advanced security measures.

6.5.2 Database Connection Setting

Database connection is established to enable the access to the database from the Structured Query Language commands in the web pages. Below is the example of codes to setup the database connection:

```php
$host="localhost"; // Host name
$username="hpsoo"; // MySQL username
$password="12345"; // MySQL password
$db_name="e-bsc"; // Database name
$tbl_name="user"; // Table name

// Connect to server and select database.
mysql_connect("$host", "$username", "$password")or die("cannot connect");
mysql_select_db("$db_name")or die("cannot select DB");
```

Figure 6.1 Samples of Code for Database Connection
6.6 Development Process

The development of the proposed system requires numerous processes and the adopted development style is based on the suitability and efficiency.

6.6.1 Program Naming Convention

Naming convention is meant to have a set of rules for choosing suitable character sequence to be applied into the source code for the ease of programmers in writing the codes for the system. This provides a better readability and understanding while allows enhancement of the source code appearance. Some of the naming conventions used in the development of e-BSC system include:

- rb - radio button
- desc - description
- dept - department
- disp - display
- ap1 - appraiser 1
- fname - first name

6.6.2 Coding Styles

Coding is the main process in implementation phase where the required functionalities of the system are built through the coding behind. Coding is encouraged to be written in a systematic and standardized way to ensure uniformity and readability that ease the maintainability work in future. Besides, programmers do not have a hard time to fix the system errors which helps to speed up the debugging process.
Some of the coding styles adopted in the development of e-BSC system include:

- **Commenting PHP Code**

  Comments are statements that integrated along in the program code but are not executed. They are put in the code especially in the complex part where it is hard for programmers to understand. By having these comments, it explains the logic of the code and the purpose of a particular program block or other descriptive label.

- **Indentation**

  Indention is applied in the program to allow structure control and increases the ease of reading and tracing of codes. Codes within a control structure are indent once at the first level, then twice at the second level and so on. By doing so, it makes the codes clearer to be read as a whole control structure while having sub control segments within it.

- **Variable Names and Function Names**

  Mostly, the standard used for variable and function naming are by the usage of character cases. Variable name or function name initialed with a lower-case letter, continued in lower-case until the first letter of each concatenated word is written in uppercase. For example, “checkHiddenField” represents the name of the function to check the value of the hidden field.

- **Styles adopted**

  Choosing the right styles to write the entire program codes is important. It ease the whole writing process and also allows balanced reliability and performance of the system.
Some of the coding styles that have been considered during the coding process include:

- **Readability** – Codes are written into a clear understandable format which ease the work of future enhancement. Strategies to be used to ensure high readability include choosing meaningful variables and label names, encouragement of spacing or line breakers between different sections, commenting and proper identification.

- **Maintainability** – Codes are written in an organized manner to enable the ease of maintainability in future and also ease the work of other programmers to take over the program.

- **Reusability** – Codes are easily developed for reuse, especially for tasks that cross application boundaries. It is an important method for improving product quality throughout the system development process. By having the easiness in reading the codes, it helps to reduce the coding time as well as the testing and documentation time.

- **Testability** – Modules can be tested easily. Modularization breaks up the code coverage task into smaller and manageable units. The system has the ability to check on the system’s input to ensure correct data is inserted in order to provide system integrity.
6.6.3 Coding Methodology

There are two common coding methodology which include top-down and bottom-up approach.

- **Top-Down Approach**

  In top-down approach, from the main functionality of system, it is broken down into modules where each module may be continued to be further decomposed into smaller sub modules. Therefore, a full understanding of the whole system is crucial for this approach. Besides, it also enables developers to keep clear and stay focus with the goal. However, during the final stage where testing process need to be performed, it might be complicated because executions are only be done at the final stage.

- **Bottom-Up Approach**

  Bottom-up approach allows the individual base elements of the system are first specified in great detail. These elements are then linked together to form larger subsystems, which then in turn are linked, sometimes in many levels, until a complete top-level system is formed. This strategy often resembles a "seed" model, whereby the beginnings are small, but eventually grow in complexity and completeness.

- **Coding Methodology for e-BSC system: Bottom-Up Approach**

  Bottom-up approach is chosen for the development of e-BSC system. Individual parts are specified in detail at the initial stage. Then, codes are written for the functionality of these sub modules and are tested. When successful results are obtained, these small parts are linked and integrated to for the larger module. Finally, after integration has been done, the
system is tested as a whole. By using this approach, it helps to reduce the complexity especially for the testing process.

### 6.6.4 Testing and Evaluation of Development Process

During the development of e-BSC system, after the codes for a certain page have been written, the process of testing and debugging need to be performed. The page is executed to discover if the desired output is obtained. The debugging process also intends to find errors found and takes suitable solutions to fix it. A few debugging strategies are applied which include:

- **Displaying result of passing values on screen**
  - When functions have been written to pass values from a screen to another, there are possibilities that wrong information has been passed. To ensure the accuracy, the passing value is displayed on the screen for viewing for better confirmation.

- **Status Checking**
  - In the proposed e-BSC system, there are some processes which are depending on each others. One must be successfully executed to allow another process to be performed. If it fails, the connected process may fail as well. To avoid this, a success status is set in returning a true or false value. This is to check whether the pre process is successfully executed or else, the option might be to end the program or displays error message to indicate what errors occur.

- **The usage of Structured Query Language (SQL)**
  - There are also transaction errors that happen because of the incorrect syntax in the written SQL statements. Database might unable to be accessed or the
intended data is unachievable due to the wrong SQL statements being sent. Therefore, testing need to be done for the SQL statements to ensure the obtained results appear to be what have been expected.

6.6.5 Programming Techniques

A few techniques of programming are practiced to increase the efficiency of the development process.

6.6.5.1 Modular Programming

To ease the work of writing the codes, the proposed system is divided into few modules to be programmed such as staff module, appraiser module, faculty module and administrator module. Besides, these modules can be decomposed out into its sub modules for better programming work. For example, in staff module, sub modules may include contracting module, tracking module and final performance report review module. By having the division of system into modules, codes can be written specifically on the required functions for that particular page.

6.6.5.2 Modules Integration

When the codes for each module are completely written, the integration process is needed to deliver a whole functional system. This is important especially when pages are linked to each other. Besides, the codes in calling other modules are to be ensured for its appropriateness if the desired module is displayed in the correct sequence of flow.
6.7 System Testing and Evaluation

System testing is one of the essential processes in developing a system to ensure the whole functionality of the system besides to identify how well the final output of the system. Programs are executed to find unnecessary errors and to check for the completeness and reliability of the system.

6.7.1 Testing Techniques

There are a few level of testing techniques applied in the evaluation of the development processes.

6.7.1.1. Unit Testing

Unit testing is done by carry out testing to identify whether every unit of system is coded appropriately and expected functions have been carried out. This is the initial stage in testing phase where all the small components in a module are tested before moving to the bigger testing phase. It also ensures bugs and errors are fixed without affecting the running of the system. Basically, testing techniques can be divided into two types:

- **White Box Testing**

  White box testing enables performance of data processing and calculations of accuracy tests, software qualification tests, maintainability tests and reusability tests. In requires verification of every program statement and comment. It also helps to identify the correctness of processing operations and the sequence of statements is programmed accurately. Therefore, by using this kind of testing technique in our system, it could help to seek the quality of coding work.
• **Black Box Testing**

Black box testing allows us to perform output correctness tests. It identifies bugs only from the reveal of its output, while disregarding the internal paths of statements or calculations. It also allows us to perform majority of testing classes, which allows system performance tests such as load tests and availability tests.

### 6.7.1.2 Module Testing

After the completion of unit testing, modules are tested in the system to identify if desired output is obtained. Both staff and appraiser modules are tested separately if the specified functions are workable. All relevant data are entered to complete the testing process. If there is any bug or error exists in any module, the related unit of module will be tested by carry out unit testing.

### 6.7.1.3 Integration Testing

After all the modules have been tested to be workable, integration is done by combining all the developed modules. As modules might link to one another, this is the stage where series of tests are performed for whether the functions calling are done correctly. It happens at times, modules are unworkable when integration has been done. This happens when parts of codes in modules could not coordinate with each other. Therefore, it is necessary to perform integration testing in order to ensure all components are performing well after integration process has been done.
6.7.1.4 System Testing

After several types of testing processes have been done, the final testing stage will be the overall system testing. It is performed in order to check the performance of the system in meeting the expected functional and non-functional requirements which have been identified earlier. The overall system testing includes:

i.  *Functional Requirements Testing:*

The whole system is tested if it meets the functional requirements which have been stated earlier during the initial development of the system. This is most important especially to determine the developed system meets the user’s requirements.

ii. *Non-functional Requirements Testing*

Besides functional requirements testing, the testing of non-functional requirements is also important in order to examine the effectiveness of the whole system. In this case, some of the elements need to be checked which may include accuracy, system performance, user-friendliness, modularity, maintainability, reusability and etc.

6.7.1.5 User Acceptance Testing

User acceptance testing is conducted as the last testing process after all the system testing processes have been completed which are done to ensure the system is workable. The final output will be presented to the potential users in order to get their feedback if it meets their expected requirements. User acceptance test should be well-planned to effectively present the flow of the system to the users. It is also intended to check upon the user requirements which the system should conform. Test plans or testing procedures should be realistic and adequately expose the system to all possible events.
The potential users were approached and the system was demonstrated to them. They were the academic staffs of Faculty of Computer Science and Information Technology included some who previously held the position of appraiser and also the dean of the faculty. Besides, officers from Strategic Planning Unit, Human Resource Department, Information Technology Center of the University and BSC expert were approached as well. This intended to seek the opinions from different type of users who hold different responsibilities. System evaluation form was distributed to collect their feedback and comments towards the proposed system. Besides, it is to verify the usability of the proposed system prototype if it meets the users’ requirement and promotes improvements on the current performance measured use. Finally, the results were analyzed to distinguish the level of acceptance and the effectiveness of the system towards the potential users. The system evaluation was conducted within 11 days time (July 14, 2008 until July 25, 2008). The evaluation forms were collected within the few days from the distribution day. Below are four groups of participants which have been approached for the system evaluation:

Table 6.3 Participants of System Evaluation of e-BSC

<table>
<thead>
<tr>
<th>Group of Participants</th>
<th>Details</th>
<th>Objective/Role</th>
<th>Venue</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Academic Staffs</td>
<td>Academicians from FCSIT</td>
<td>To evaluate the system and emphasis is placed on the Staff Module</td>
<td>FCSIT</td>
<td>4</td>
</tr>
<tr>
<td>2. Appraiser</td>
<td>Academicians who hold the position as appraiser</td>
<td>To evaluate the system and emphasis is placed on the Appraiser Module</td>
<td>FCSIT</td>
<td>4</td>
</tr>
<tr>
<td>3. Dean</td>
<td>The current dean of FCSIT</td>
<td>To evaluate the system and emphasis is placed on the Staff, Appraiser and Faculty Modules</td>
<td>FCSIT</td>
<td>1</td>
</tr>
<tr>
<td>4. Strategic Planning Unit</td>
<td>Representatives from Human Resource Department of UM</td>
<td>To evaluate the system from the perspective of top management</td>
<td>Strategic Planning Unit Department in UM</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Human Resource Department</td>
<td>Representative from Information of Technology in UM</td>
<td>To evaluate the system from the perspective of top management</td>
<td>A meeting room at Human Resource Department</td>
</tr>
<tr>
<td>---</td>
<td>---------------------------</td>
<td>--------------------------------------------------</td>
<td>-------------------------------------------------------------</td>
<td>-------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>Information Technology</td>
<td>Representative from SPU in UM</td>
<td>To evaluate the system and emphasis is placed on the System Administrator Module</td>
<td>A meeting room at Human Resource Department</td>
</tr>
<tr>
<td></td>
<td>BSC Expert</td>
<td>A person who is experienced in using BSC in his working company.</td>
<td>To evaluate the system from the perspective of BSC expert</td>
<td>An appointment out of UM area</td>
</tr>
</tbody>
</table>

**Format of the System Evaluation Questionnaire**

After the proposed system was tested to be workable, a set of questions were developed to seek the level of users’ acceptance towards the proposed system. These questions were designed accordingly to the system’s functions for each module. Accuracy and consistency checking were performed between both researchers for all the parts of the system evaluation form. The questions were divided into two sections (the list of questions is shown in Appendix F):

i. **Section 1**: This section consists of four sub-parts where the evaluation questions are prepared for each different module. The four modules include Staff, Appraiser, Faculty and System Administrator. Each sub-part comprises the maximum of 8 questions which requires the users to rate their agreement on the functionalities and features provided by the system.

ii. **Section 2**: This section enquires the feedback from the participants of their agreement on the evaluation in overall the system. Participants are asked on the
complexity and effectiveness of the proposed e-BSC for performance planning and measurement. Besides, they are asked to rate the improvement level compared to what they are having now in the current situation.

a) **User Acceptance Testing Constraints**

i. **Time**

Time plays the major constraint. As most of the respondents are actively working people, therefore, it is difficult to get a suitable time to perform the system testing to them. Besides, the system demonstration may take some time which causes many respondents reluctant to participate in the system testing. Evaluation forms need to be distributed at an immediate time after demonstration so that respondents are still fresh with the content of the system in order to evaluate the system accurately. It also takes time to collect the evaluation forms from the respondents.

ii. **Database**

To show the respondents the real situation of the system implementation, samples of real data need to be entered into the system. Therefore, it is important to ensure that the entered data able to show all the possible events in order to acknowledge the users all the possible situations that the system can cope with.

iii. **System Presentation**

In system testing, it is important that the presenter able to precisely explain and demonstrate the flow of every process run by system in order to ensure the users have clear understanding of how the system works. The presentation must be planned orderly so that users are not confused and able to follow the flow of the presentation.
b) **User Acceptance Testing Results**

Results obtained from system testing were analyzed and charts were generated to give a better understanding of how far the system is accepted by the potential users. Besides, their feedbacks were also recorded and summarized in **Appendix G**. Figure 6.2 and Figure 6.3 show the results obtained from users on the evaluation of staff and appraiser modules during the system testing.

![Charts showing user acceptance testing results](image-url)

**Figure 6.2 Testing Results for Staff Module**
Figure 6.3 Testing Results for Appraiser Module
It can be deduced that most users agreed with the expectations of the system can perform where the respondents who chose “agree” option as their answer carry the highest percentage for most of the evaluation questions. On top of that, some even strongly agreed with the functions provided by the proposed system. There is only a small percentage of respondents expressed their disagreement to a few functionality of the system as they might have different view or higher expectation towards what have been proposed.

To investigate the effectiveness of e-BSC application towards the academician’s individual performance planning, users are required to rate whether the proposed e-BSC performance measurement system would be able to provide clear expectations on academic staffs overall performance as what academicians should perform upon what have been planned. This is done during the contracting stage where targets or expectations of academician’s performance are set. Positively, the results shown in Figure 6.4 indicates that 41% of the respondents agreed while 29% of them responded strongly agreed.

![Figure 6.4 Testing Results on the Availability of e-BSC to Provide Clear Expectations on Academician’s Overall Performance](image)

Figure 6.4 Testing Results on the Availability of e-BSC to Provide Clear Expectations on Academician’s Overall Performance
In terms of measuring the performance of individual academician, respondents were asked if the proposed system able to provide evaluative information on academicians’ overall performance which enable the appraisers to perform accurate assessment such as number of publications, teaching evaluation scores, number of supervised students and etc. In this case, 59% of the respondents rated their agreement while 23% strongly agreed.

![Figure 6.5 Testing Results on the Availability of e-BSC to Provide Evaluative Information on Academician’s Overall Performance](chart.png)

Figure 6.5 Testing Results on the Availability of e-BSC to Provide Evaluative Information on Academician’s Overall Performance

The implementation of e-BSC is expected to be a tool for the encouragement of better communication between the individual academic staff with the higher management. Academicians are allowed to send request for target change to their appraisals. Besides, by having an electronic-based system, updates can be done at the immediate time. From the results of the system testing, 41% of the respondents rated their agreement while 35% strongly agreed that the system is able to promote better communication.
Besides, the system is also tested if it is able to effectively align the responsibilities of academicians towards the University’s or Faculty’s strategies as causal and linkage relationships are initially formed. As shown in Figure 6.7, a total of 53% of respondents agreed by having 18% respondents strongly agreed and 35% agreed that the proposed system is believed to able to perform the alignment effectively. However, 47% of the respondents are unsure as they might unfamiliar with BSC as questioned during the early investigation and they do not have full understanding of how the strategy cascading process is done.

Figure 6.6 Testing Results on the Availability of e-BSC to Provide Better Communication Between Higher Management with Staff
Figure 6.7 Testing Results on the Effectiveness of e-BSC for Staffs Communication and Strategies Alignment

Figure 6.8 demonstrates the percentage of respondents rate on the complexity or learnability of the proposed e-BSC system. From the bar graph, it shows that most users felt that the complexity of the proposed system is at the moderate or average level and the dean of the faculty felt it was easy to use the system. Therefore, it shows that the users are able to understand how the system runs but more practices may be needed to increase their familiarity to the system.
However, some respondents from IT Centre and Human Resource Department rated the system to be complex. This may due to the content of the system which is meant for the measurement of academicians that is beyond the field that they are working in. Besides, in the current situation, they do not practice any similar performance measurement system that causes the proposed system is uncommon for them.

A question of the quality or effectiveness of the proposed e-BSC system to be used in University or Faculty was posted to the respondents. The results are illustrated in Figure 6.9.
Figure 6.9 Quality (Effectiveness) of e-BSC System to be used in University/Faculty

The users rated that the proposed system is suitable to be implemented into the institution to measure the performance of academicians. None of the respondents answered the proposed system is unsuitable. From the aspect of academic staffs, 75% of them felt that the system is sufficiently and can effectively demonstrate a way to measure their performance from the processes proposed by the system while the remaining felt that the system is suitable but enhancements or a few modifications may be needed to shape the performance measurement that exactly fits their expectations. Likewise, the appraisers also agreed with the effectiveness of the system but it may need to be modified or to add in extra features to have a better measurement system that is well-fitted into the institution.

In the testing process, respondents are also required to make comparison of the proposed e-BSC system to the performance measurement system which is currently used.
in the institution. From figure 6.10, it can be concluded that most of the respondents believed that the proposed system is able to provide better functionality and improvements as compared to what they are practicing in place.

![Comparison of e-BSC System to the Current Performance Measurement System Used](image)

**Figure 6.10 Comparison of e-BSC System to the Current Performance Measurement System Used**

Therefore, it is agreeable that the proposed system can replace the current system which promotes to be a better performance measurement tool for the academicians. Both academic staffs and appraisers that included the dean of the faculty are fully agreed with the proposed system. A small portion of academic staffs were unsure of the comparison as they are unfamiliar or do not involved with the current performance measurement system.
6.7.2 Test Cases and Test Data

Test cases are steps in sequence or scenarios to test the correct behavior of the system’s functionality by having the relevant data, series of tasks and the expected outputs. It includes a set of test inputs, the execution conditions and the supposed results which are developed to exercise the process flow of the system for the confirmation of a single predefined result. Test cases are carried along with the processes of unit testing until the integration testing is done with the specific results. It might also possible to perform a test case a few times to check for the accuracy of results.

6.7.2.1 Unit Test Cases

In the proposed e-BSC system, unit test cases (Table 6.4, Table 6.5 and Table 6.6) are developed to test whether the expected results from the execution of each individual independent component is accurate. Unit testing is the smallest testable part of the system to validate that the codes are working as what been expected.

Table 6.4 Samples of Unit Test Cases in Login Page

<table>
<thead>
<tr>
<th>Step</th>
<th>Test Procedure</th>
<th>Expected Result</th>
<th>Test Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Click “Submit” button without entering data into username and password fields</td>
<td>Error message indicates incomplete information will be displayed</td>
<td>Error message indication incomplete information is displayed</td>
</tr>
<tr>
<td>2</td>
<td>Enter only one field and click “Submit”</td>
<td>Error message indicates incomplete information will be displayed</td>
<td>Error message indication incomplete information is displayed</td>
</tr>
</tbody>
</table>

Table 6.5 Samples of Unit Test Cases in Staff Module

<table>
<thead>
<tr>
<th>Step</th>
<th>Test Procedure</th>
<th>Expected Result</th>
<th>Test Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Click “Tracking” icon before contracting is</td>
<td>Alert message will be displayed to indicate</td>
<td>Alert message is displayed to indicate</td>
</tr>
<tr>
<td>Step</td>
<td>Test Procedure</td>
<td>Expected Result</td>
<td>Test Result</td>
</tr>
<tr>
<td>------</td>
<td>----------------</td>
<td>-----------------</td>
<td>-------------</td>
</tr>
<tr>
<td>1.</td>
<td>Click “Read” link for a request mail</td>
<td>Display a window to show the information of the request mail</td>
<td>A window which shows the information of the request mail is displayed</td>
</tr>
<tr>
<td>2.</td>
<td>Click “Search” button after checking the radio button to search staff whose first name begins with the letter of ‘C’</td>
<td>Display the list of staffs from the appraiser’s faculty whose first name begins with the letter “C”</td>
<td>The required list is displayed correctly</td>
</tr>
<tr>
<td>3.</td>
<td>Click the “Track” link of a staff who has not contracted</td>
<td>Display alert message to indicate tracking is allowed only if staff</td>
<td>Alert message is displayed to indicate tracking is allowed</td>
</tr>
</tbody>
</table>

Table 6.6 Samples of Unit Test Cases in Appraiser Module
Module Test Cases

Module testing is performed to ensure that all the major functionalities of a module can execute appropriately and expected results are obtained. For example, the staff module of e-BSC system, the main functionalities are to confirm performance contract, update achievements, view evaluation report and view some static information. These main functionalities are tested to make sure that it able to work successfully to produce the correct output. Samples of test cases are displayed in Table 6.7 and Table 6.8.

Table 6.7 Samples of Staff Module Test Cases

<table>
<thead>
<tr>
<th>Step</th>
<th>Test Procedure</th>
<th>Expected Result</th>
<th>Test Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Click “Contract” button in Contracting Page</td>
<td>Staff’s contract will be confirmed</td>
<td>Staff’s contract is confirmed</td>
</tr>
<tr>
<td>2.</td>
<td>Add new KPI records in tracking page</td>
<td>Records will be added into the database</td>
<td>Records are successfully added into the database</td>
</tr>
<tr>
<td>3.</td>
<td>Update existing KPI records</td>
<td>Records will be updated in the database</td>
<td>Records are updated in the database</td>
</tr>
<tr>
<td>4.</td>
<td>Delete existing records</td>
<td>Records will be deleted in the database</td>
<td>Records are deleted in the database</td>
</tr>
<tr>
<td>5.</td>
<td>Submit final performance report</td>
<td>Update staff’s report submission status</td>
<td>Staff’s report submission status is updated</td>
</tr>
</tbody>
</table>
6. Click “Evaluation Report” to review staff’s own individual performance report. Staff’s own individual performance report will be displayed.

<table>
<thead>
<tr>
<th>Step</th>
<th>Test Procedure</th>
<th>Expected Result</th>
<th>Test Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Insert scores for a staff’s performance</td>
<td>Scores for the staff will be inserted into the database</td>
<td>Scores for the staff are inserted into the database</td>
</tr>
<tr>
<td>2.</td>
<td>Search for a staff who has contracted to perform performance tracking</td>
<td>The staff’s achievements information will be displayed</td>
<td>The staff’s achievements information is displayed</td>
</tr>
<tr>
<td>3.</td>
<td>Search for a staff who to review the staff’s performance report</td>
<td>The staff’s performance report will be displayed</td>
<td>The staff’s performance report is displayed</td>
</tr>
<tr>
<td>4.</td>
<td>Click “Faculty Review” icon to review the faculty’s performance</td>
<td>The page of the faculty’s performance report will be displayed</td>
<td>The page of the faculty’s performance report is displayed</td>
</tr>
</tbody>
</table>

**Table 6.8 Samples of Appraiser Module Test Cases**

### 6.7.2.3 Integration Test Cases

After all modules have been tested to be workable, the final testing stage is to link all the existing modules together to perform the integration testing. At times, there are some modules which are related to each other and therefore, it is important to ensure the results from the execution of one module are positively linked or directed to another module. For example, when a staff updates his/her achievements in the system, the respective appraiser should be able to view the updated achievements as well in the appraiser module. It is important to perform the integration testing to have the certainty that all components are working well and coordinated to each other after the integration process has been done.
Table 6.9 Samples of Integration Test Cases

<table>
<thead>
<tr>
<th>Step</th>
<th>Test Procedure</th>
<th>Expected Result</th>
<th>Test Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Staff sends a request mail to change target</td>
<td>Appraiser will receive the request from the staff</td>
<td>Appraiser receives the request from the staff</td>
</tr>
<tr>
<td>2.</td>
<td>Appraiser approves a request of target change from a staff</td>
<td>The requested target will be automatically inserted into the staff’s contract</td>
<td>The requested target is automatically inserted into the staff’s contract</td>
</tr>
<tr>
<td>3.</td>
<td>A staff updates his/her performance achievements</td>
<td>The updated achievements will be able to be reviewed by the appraiser</td>
<td>The updated achievements are able to be reviewed by the appraiser</td>
</tr>
<tr>
<td>4.</td>
<td>Appraiser submits the evaluation scores for a staff</td>
<td>The submitted scores will be displayed in the staff’s performance report</td>
<td>The submitted scores are displayed in the staff’s performance report</td>
</tr>
</tbody>
</table>

6.8 Conclusion

All the development processes and tools are discussed in this chapter. A series of tests were conducted to seek for the accuracy and validity of the developed prototype e-BSC system. The user acceptance test was crucial in verifying and validating that the users’ requirements are met. The results of the conducted system evaluation showed positive support that the proposed prototype e-BSC system meets its objectives even it cannot be denied that there is still room of improvement for a better system. However, it is found that the developed system achieved the satisfaction level of the participants and promotes better improvement compared to the current performance measurement system. Besides, users positively agreed that the system is suitable to be used for the performance planning and measurement for academicians.