

## **Development of the Green IT Evaluation System by Using Mobile Applications to Optimize Its Value for Higher Education in Bangkok**

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### **Abstract**

The research created a *green IT assessment system* through mobile applications to optimize its value for higher education institutions in Bangkok. Two research tools were (1) green IT appraisal through mobile applications, and (2) a system performance evaluation questionnaire. Six higher education institutions--3 public universities and 3 private universities--participated in the study on a voluntary basis. Three public universities were Bansomdejchaopraya Rajabhat University, Suan Sunandha Rajabhat University and King Mongkut's Institute of Technology North Bangkok. Three private universities were South East Bangkok College, Thonburi University and Dhurakij Pundit University. The results showed that green IT quality of each institute met the green IT standards. The details of assessment in score percentages revealed a good standing of green IT environment all across six higher education institutions: (1) Bansomdejchaopraya Rajabhat University at 86.39%, (2) Suan Sunandha Rajabhat University at 87.40%, (3) King Mongkut's Institute of Technology North Bangkok achieves at 86.74%, (4) Southeast Bangkok College at 85.14%, (5) Thonburi University at 86.56%, and (6) Dhurakij Pundit University at 86.31%. The average score of the evaluation tool was high at 4.58.

**Keywords:** *Green IT, mobile application, higher education*

### **1. Introduction**

In the last two decades, information technology has played an important role in Thai society which affects people's lifestyle. It initiates patterns and opportunities of education. Public and private institutions have increasingly developed information system in support of education services and enterprises. In the past developers of information systems considered only usability, system stability, data security and system scalability without concern for environmental factors. Nowadays they are aware of the global warming issues and climate change, and try to put information technology as environment-friendly known as Green IT based on the selection of environment-friendly technology. Green IT is to increase efficiency of energy usage managements, reduce greenhouse gas release and amount of garbage, and recycle electronic waste. Each organization has focused on hardware, software or electronic solutions that help save energy for maximum efficiency. At present, higher education institutions in Bangkok still do not have any evaluation tool for Green IT and particularly, their undergraduate students do not have sufficient knowledge in Green IT.

As reported in the literature on the green movement, Bachour (2010) has introduced the concept of *optimizing the value of Green IT project method* to incorporate

Green IT strategy into an organization by using *KPIs* and *a balanced scorecard*. These tools serve as criteria in assessing organizational success.

The researchers in this research were interested in the concept and method used by Bachour (2010) and would like to develop a Green IT evaluation system by using mobile applications in optimizing the value of Green IT project method to evaluate the quality of Green IT in higher education institutions in Bangkok. The researchers were to collect data on hardware and IT usage behaviors of undergraduate students of higher education institutions in Bangkok, to compare with the existing Green IT standards. Evaluation results were analyzed to determine Green IT quality by institution, which in turn would help establish Green IT policies and plans for Green IT operations needed by each institution.

## 2. Research Objectives

There were two objectives in this study:

1. To develop a Green IT evaluation system by using mobile applications to optimize its value for higher education institutions in Bangkok.
2. To identify the quality of green IT for higher education institutions in Bangkok.

## 3. Framework of Research

The framework of this research was in six stages:

(1) Using *the principle of optimizing the value for managing Green IT project* for the created system.

(2) Using *the principle of Project Management Institute (PMI)* as a determining tool to clarify and select standards for the Green IT system.

(3) Using *the principle of Key Performance Indicators (KPIs)* and *Balanced Scorecard (BSC)* to construct Green IT quality indicators.

(4) Scopes of Green IT assessment:

(4.1) Information on hardware including PCs, notebooks, printers and servers of higher education institutions in Bangkok to be collected through search for Green IT standards information.

(4.2) Behaviors of undergraduate students of higher education institutions in Bangkok to be collected by a questionnaire.

(5) Scopes of mobile applications developed for Green IT assessment in two systems:

(5.1) Administration System to input the information on hardware concerning Green IT standards and behaviors of undergraduate students of higher education institutions in Bangkok.

(5.2) User System to develop a mobile application to display details of Green IT assessment information of higher education institutions in Bangkok in two categories: *hardwares* and *behaviors* of undergraduate students in each higher education institution in Bangkok.

(6) Scopes of tools used in system development

(6.1) Hardware

(6.1.1) Mobile phone

(6.2) Software

(6.2.1) MYSQL Database Management System

(6.2.) Application development software (Ionic framework)

(6.2.3) Programming language (angular js)

#### 4. Research Methodology

##### 4.1 Population and Samples

The research population was 869,430 undergraduate students of public universities and private universities in Bangkok.

The researchers used the Proportional Stratified Random Sampling technique to select 6 higher education institutions and used the convenience sampling technique to select 6 sample groups to study behaviors of undergraduate students in Green IT use in selected higher education institutions. The sample size was 1,200 undergraduate students.

##### 4.2 Research tools

4.2.1. Green IT appraisal form on mobile applications.

4.2.2 System performance evaluation questionnaire.

The process of tools development

Development of Green IT evaluation system:

**First step:** Information and related document study

**Second step:** Problem analysis

**Third step:** System design

The process was divided into 7 main steps:

(1) Analyze the internal data of higher education institutions

The researchers studied data on the number of internal organizations or departments using Information Technology and the number of hardwares in use.

(2) Hardware Data Analysis

The researchers gathered data on Information Technology hardwares in higher education institutions, such as brands, modes and the number of PCs, notebooks, servers, and printers.

(3) Information Technology Standard Selection

The researchers studied Information Technology Standards stated in the acquired documents and selected a set of standards for hardware considerations in higher education institutions.

(4) Analysis of green IT use behaviors of undergraduate students

The researchers analyzed green IT use behaviors of undergraduate students, such as saving energy and use of paper.

(5) Developing a behavioral assessment tool

The researchers developed a Green IT Behavior Assessment Tool in a questionnaire format; its questions items were based on the analyzed data on Green IT

use behaviors. The questionnaire’s content validity was assessed by three experts in the field of IT Green environment--yielding a content validity index.

(6) Determining the KPIs assessment, analysis and weight

The researchers determined KPIs for hardware, Green IT use behavior assessment, and the assigned weight in the assessment.

(7) Developing a mobile application

The researchers used a mobile application to display evaluation criteria, average score of information technology hardware and undergraduate students’ green IT use behaviors.

**Fourth step:** System development

The researchers used *the principle of Project Management Institute (PMI)* to develop a Green IT Assessment System. The system had two parts in (1) Hardware and (2) Green IT use behavior. There were KPIs for the assessment tool with the use of *Balanced Score Card* to determine scores based on the established criteria. A full score was 100, calculated from 100 points of *Hardware* and 100 points of *Use Behaviors*. Both were weighted to 50 points/percent each to make a total of 100 points/percent. It was set that the pass criterion of Green IT standards be at 50 points/ percent.

System development was divided into three parts:

(1) Hardware development

(1.1) Study of the data on information technology equipment in the higher education institutions, based on the Green IT concept.

(1.2) Hardware data analysis

The researchers analyzed hardware data into three categories: PCs, printers and servers. There were three selected standards--Energy Star, TCO and EPEAT--as KPIs shown in Table 1. Each IT equipment was to earn 50 points to get a *pass* on the Green IT Standards.

**Table 1:** Green IT Standard Scoring

Standard	Score
Energy Star	100
TCO’05	60
EPEAT Gold	60
EPEAT Silver	40
EPEAT Bronze	20
Not Standard	0

(2) Green IT use behavior development

(2.1) Study of Green IT daily use behavior data of undergraduate students in higher education institutions.

(2.2) Analysis of Green IT daily use behavior data in three categories

A) Energy use, such as turning off monitors after use, selecting power save mode setup and LCD monitor instead of CRT, and shutting down machine not in use.

B) Knowledge and understanding of the Green IT concept, such as the characteristics of Green IT, and awareness of major environmental issues and Green IT behaviors.

C) Reduction of paper use, such as reusing print paper and using digital copies.

(2.3) Creating KPIs for assessment

The researchers created KPIs to assess Green IT use behaviors in organizations. *Power use, Green IT knowledge, reducing paper* need to count as least 50 points/ percent to pass the standard. The scoring criteria are shown in Table 2.

**Table 2:** The Scoring Criteria in Questionnaire

Level 1	Level 2	Level 3	Level 4	Level 5
20 points	40 points	60 points	80 points	100 points

(3) Mobile application development

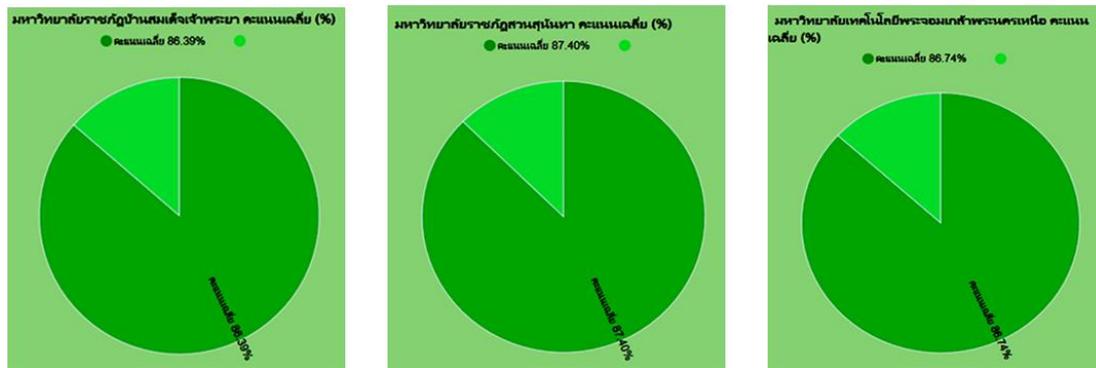
The researchers developed mobile application including (1) Screen Login, (2) Green IT quality report, (3) Summary by all institutes, (4) Summary of the Number of Hardwares, (5) Behavior summary, (6) Green IT Information, (7) Summary of hardware use and (8) Green IT use behaviors in each institute.

**5. Research Results**

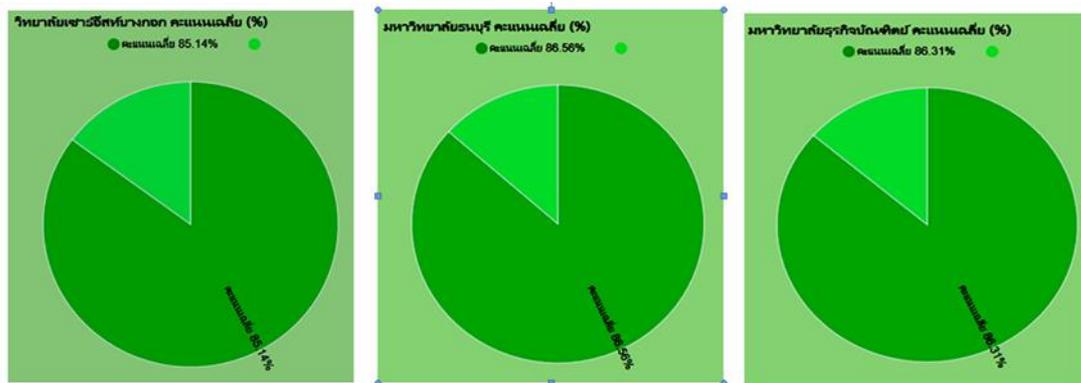
The major results were (1) system development, and (2) Green IT assessment of six higher education institutions in Bangkok--3 public universities and 3 private universities, (3) hardware data, and (4) IT use behaviors of undergraduate students.

The results on the Green IT evaluation system using mobile application are shown in Figure 1 and Figure 2: (1) Bansomdejchaopraya Rajabhat University obtained a pass score of 86.39%, (2) Suan Sunandha Rajabhat University at 87.40%, (3) King Mongkut's Institute of Technology North Bangkok at 86.74%, (4) Southeast Bangkok College at 85.14%, (5) Thonburi University at 86.56%, and (6) Dhurakij Pundit University at 86.31% .

**Figure 1:** Results of Green IT Assessment in Public Higher Education Institutions



**Figure 2:** Results of Green IT Assessment in Private Higher Education Institutions



**The results of performance evaluation system**

The result of performance evaluation system was obtained from three experts. They assessed the Green IT Assessment System using mobile application to optimize the value for higher education institutions in Bangkok. The results are shown in Table 3.

**Table 3: Results of System Performance Evaluation**

Evaluation items	Evaluation results	
	Average score	Performance system
1. Evaluation result of Usability	4.64	Excellent
2. Evaluation result of Function	4.56	Excellent
3. Evaluation result of Performance	4.55	Excellent
<b>Mean</b>	<b>4.58</b>	<b>Excellent</b>

**6. Discussion and Conclusion**

The researchers used *Optimizing the Value concept* which is generally applied to business cases in planning for energy use reduction to save operation costs. As shown in this study, the researchers used this concept to investigate 1,200 undergraduate students in higher education institutions on mobile application regarding their awareness of the Green IT and their related behaviors. The principle of *Project Management Institute (PMI)* served as a tool to investigate (1) Hardware and (2) Green IT use behaviors. KPIs

were developed for assessment and with the use of Balanced Score Card with assigned weight for reported behaviors. The evaluation questionnaire of 22 questions was content-validated by three experts with a good result.

The results on Green IT assessment in six higher education institutions—three public and three private—showed a *pass* standard. Three public universities obtained 86.39%, 86.74%, and 87.40%. and three private universities showed similar results at 85.14%, 86.31%, and 86.56%. The evaluation of the Green IT evaluation system using mobile application by three experts was excellent with the average score of 4.58.

These results appeared in support of two earlier studies by Tharach (2014) in “A Study of Green IT Framework for Rajabhat University,” and Mongkolkeha (2016) in “Green IT Management Model for Energy Saving in Rajabhat University.” The research findings as shown in two earlier studies and this present study point to a positive perspective of Green IT awareness and corresponding behaviors of undergraduate students at the higher education level. The researchers of this present student expect that their research results will highlight the vital issue of Green IT for a good attention from higher education institutions in saving energy and preserving a good IT environment. This is for such active IT users as university students to take responsibility in keeping good IT standards with their corresponding behaviors.

## 7. The Authors

Nitivadee Pathep and Nattira Yophob are working for the Faculty of Education, Bansomdejchaopraya Rajabhat University. Their research interest lies in the areas of green environment and the use of mobile applications for evaluation.

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