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Modeling Critical Success Factors Influencing Energy Management Performance towards Sustainability in Malaysian Public Universities Using PLS-SEM Approach

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Abstract

Energy usage in Malaysian universities has increased constantly. Frequent commentaries in the literature have stated by identifying critical success factors (CSFs) and continually measured using Key Performance Indicators (KPIs) will ensure successful effective performance for the organization. However, no one has yet tried to define in a formal way these relationships. Thus, this study is carried out to identify the CSFs and determine the relationship of identified CSFs with the KPIs, indirectly developing the CSFs structural model. The conceptual model is composed by exogenous latent variables (LVs) namely Top Management Support, Comprehensive Energy Management Team, Awareness, Strategic Maintenance Management and Good Relationship of Stakeholders and one endogenous LVs which is KPIs to achieve the goals of energy management performance improvement. The study presents empirical evidence from a survey of five research universities in Malaysia, where 280 sets of questionnaire were analyzed using PLS-SEM to test the conceptual model. The indicators for these enablers and result criteria were extracted from the past literature and by a pilot study. The findings show that the comprehensive EM team has the highest path coefficient (β value) which has the most significant relationship on KPIs (β=0.195; t-value=2.701) followed by strategic maintenance management (β=0.187; t-value= 2.661); awareness (β=0.149; t-value=2.336); top management support (β=0.106; t-value=1.963); and the least is good relationship of stakeholders (β=0.104; t-value=1.443). From the findings, this study provide insight to management team in universities to focus on the implications from these four constructs to improve the energy management performance within an organization.

Keywords: Critical Success Factors, Energy Management Performance, Sustainability, Malaysian Public Universities

1.0 Introduction

Energy management (EM) is a comprehensive approach to achieve and maintain the optimum of energy utilization. It is widely acknowledged as the best solution for direct and immediate reduction of energy consumption which may help in minimizing energy costs and mitigating

environmental effects (Ching Sin et al., 2011; Backlund et al., 2012). Choong et al., (2012) has identified EM as the process of planning, implementing, monitoring and evaluating in a building. Many benefits can be achieved by working continuously on EM, where it can detect inefficiencies and malfunctioning equipment, optimize the energy system and evaluate the technologies performance (Backlund et al., 2012). Infact, in economic aspect, EM is considered as profits improvement and as effort to save cost (Capehart et al., 2008). According to Payne (2001), "……when many costs are escalating and difficult to control, energy is often one area where effective savings can be made and costs can be contained……". However, in spite of this shared understanding and many benefits from effective EM does not necessarily occur spontaneously due to a variety of barriers. Therefore, all parties including staff and students in university need to play an important role in stimulating the EM improvement, lowering barriers in order to align with macroeconomic and societal goals. Before improving the EM performance in universities, the critical success factors (CSFs) have to be identified at initial stage. CSFs have been used significantly to present or identify a few key factors that organizations should focus on to be successful. CSFs refer to "the limited number of areas in which satisfactory results will ensure successful competitive performance for the individual, department and organization" (Bullen and Rockart, 1981). Identifying CSFs is important as it allows the management team in universities to focus their efforts on building their capabilities to meet the CSFs. In other perspective, CSFs refer to something, which must be implemented if universities wants to be successful in reducing the energy consumption and hence minimizing the negative impact to the environment. Many CSFs research in various areas have been conducted previously. To date, CSFs to improve EM performance in Malaysian universities has not been explored. Since the 1980s, performance measurement (PM) has become a very popular research topic where it has received considerable attention (Tangen, 2003). Amaratunga (2000) stated the importance of PM by asserting "*you can't manage what you can't measure*" and "*what gets measured gets done*". PM and CSFs are basically intertwined. When discussing this relationship, Kellen (2003) and Flanagan (2005) argued that CSFs need to be identified in order to provide focus for PM. Haktanir and Harris (2005) supported this view and have highlighted the discernible link between CSFs and PM. In determining the relationships of identified CSFs for EM with KPIs towards sustainable university using PLS-SEM, a conceptual model is developed.

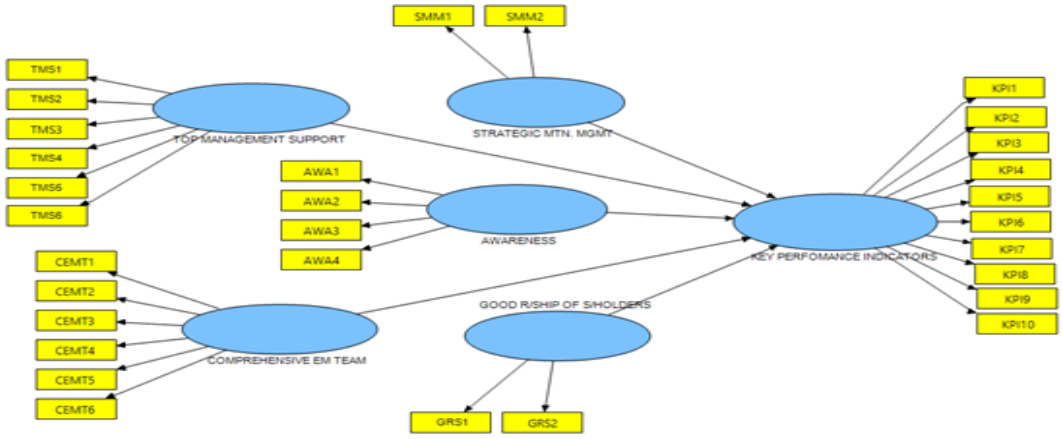

Figure 1 : A proposed conceptual model of CSFs for EM performance towards sustainable university

The proposed conceptual model is to provide an understanding on the implementation of EM performance towards sustainable university. The model was explained in the relations to latent variables (LVs) and their relative manifest variables (MVs). In this study, the exogenous LV are grouped into 5 categories namely as Top Management Support (TMS), Comprehensive Energy Management Team (CEMT), Awareness (AWA), Strategic Maintenance Management (SMM) and Good Relationship of Stakeholders (GRS), while KPIs as endogenous LV is based on 10-point action plan of Talloires Declaration.

As shown in Table 1, 20 MVs were grouped into 5 constructs (known as exogenous LV); Top Management Support (TMS), Comprehensive Energy Management Team (CEMT), Awareness (AWA), Strategic Maintenance Management (SMM) and Good Relationship of Stakeholders (GRS). The LVs in this model are drawn with oval shape while rectangular shaped elements represent MVs. Generally, the model in PLS-SEM is appraised by two assessment namely (i) measurement model or construct which relates LVs with MVs, (ii) structural model which shows the relationship between various LVs (exogenous LVs and endogenous LVs).

Exogenous LVs (CSFs)	**Manifest Variables (MVs)**	**Description**
Top Management Support (TMS)	TMS1	Develop energy policy and guidelines
	TMS2	Leadership
	TMS3	Create incentives by establishing an award for positive contribution
	TMS4	Allocation of sufficient resources
	TMS5	Training provisions
	TMS6	Knowledge and Skills

Comprehensive EM Team (CEMT)	CEMT1	Conduct Energy Audit
	CEMT2	Continuous Improvement
	CEMT3	Risks Assessment
	CEMT4	Risks Respond
	CEMT5	Risks Measurement by developing Contingency Plan
	CEMT6	Understanding of Project Vision and Goal
Awareness (AWA)	AWA1	Understanding the issues
	AWA2	Increase general energy awareness
	AWA3	Improve facility energy awareness
	AWA4	Education by Research & Development (R&D), Teaching and Learning
Strategic Maintenance Management (SMM)	SMM1	Risks Identification
	SMM2	Operation and Maintenance (O&M)
Good Relationship of Stakeholders (GRS)	GRS1	Good communication among the stakeholders
	GRS2	Trust among stakeholders
Endogenous LVs (KPIs)		Based on Talloires Declaration 10-point action plan
The management of university has raised awareness to move toward an environmentally sustainable future	KPI1	
The management of university has encouraged the staff and students to engage in education, research, policy formation, and information exchange to move toward global sustainability	KPI2	Based on Talloires Declaration 10-point action plan
The management of university has established programs to	KPI3	Based on Talloires Declaration 10-point action plan

ensure that all university graduates are knowledgeable and responsible on related fields		
The management of university has created programs to develop the capability of university faculty to all undergraduate, graduate, and professional school students	KPI4	Based on Talloires Declaration 10-point action plan
The management of university has established institutional policies and practices of resource conservation and environmentally operations	KPI5	Based on Talloires Declaration 10-point action plan
The management of university has encouraged the involvement of government, foundations, and industry to support their solutions to environmental problems	KPI6	Based on Talloires Declaration 10-point action plan
The management of university has developed interdisciplinary approaches to curricula, research initiatives, operations, and outreach activities that support an environmentally sustainable future	KPI7	Based on Talloires Declaration 10-point action plan
The management of university has established partnerships with primary and secondary schools to develop the capacity for interdisciplinary teaching about environment and sustainable development	KPI8	Based on Talloires Declaration 10-point action plan
The management of university has promoted its effort toward a sustainable future by working with national and international organizations	KPI9	Based on Talloires Declaration 10-point action plan

The management of university has established a secretariat and a steering committee to continue this momentum, and to inform and support each other's efforts towards sustainability	KPI10	Based on Talloires Declaration 10-point action plan

Table 1 : MVs of each LVs construct which is used for the assessment using PLS-SEM

3.0 Methodology

Data collection was conducted through a questionnaire survey. The respondents involved were top management team, academic staff in selected faculties, non-academic staff including energy or facilities manager who carry out their duties in sustainability centres or facilities management departments. Nominal scale was used in Part A. This scale is used to obtain personal information of respondents who answered this questionnaire. The questions formed in this section is a single option item (single-choice items) which respondents were asked to make appropriate choice based on the questions (Chua, 2011). While an ordinal scale was used in Part B and Part C. The type of measurement scale used was a *Likert* scale and it has been popularly used by many researchers in various fields, including management, business and social sciences (Hair et al., 2003; Smith and Roodt, 2003; Chua, 2011; Monette et al., 2013). 5-point Likert scale was used in this study. For example Part B is to get the perception on the importance of CSFs for EM (1=very unimportant; 2=unimportant; 3=neutral; 4=important; 5=very important); and Part C required the respondents to indicate their agreement of the KPIs where "1 equals strongly disagree and 5 equals strongly agree". Then, data was analysed using PLS-SEM 3.0 to test the relationship of CSFs for EM with KPIs towards a sustainable university. The path coefficients (β) which beta value represents the hypothesized relationships were assessed. The highest β value indicates the strongest relationship of independent (exogenous) LV towards the dependent (endogenous) LV.

4.0 Data Analysis, Results and Discussions

Hair et al., (2011) argue that path coefficients should exceed 0.10 to account for a certain impact within the model. However, β value has to be tested for its significance level through t-value test. The test is carried out by performing a non-parametric bootstrapping technique (Chin et al. 1998; Hansmann et al., 2004).

Hypotheses	Relationship	Path Coefficient (β)	t-value	Remarks
H1	Top Management Support -> Key Performance Indicators	0.106	1.963**	Significant
H2	Comprehensive EM Team -> Key Performance Indicators	0.195	2.701***	Significant
H3	Awareness -> Key Performance Indicators	0.149	2.336**	Significant
H4	Strategic Maintenance Management -> Key Performance Indicators	0.187	2.661***	Significant
H5	Good Relationship of Stakeholders -> Key Performance Indicators	0.104	1.443	Not Significant

Table 2 : SEM-PLS of Path Coefficient (β) and t-value for Structural Model

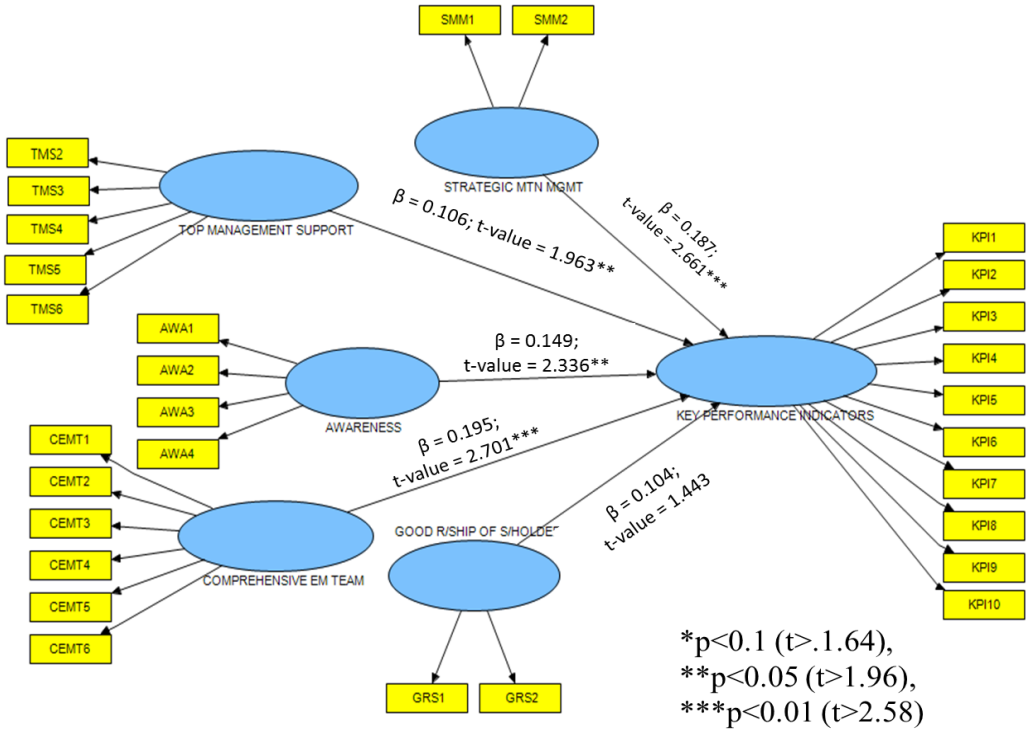

Figure 2 : SEM-PLS of Path Coefficient (β) and t-value for Structural Model

Hypothesis 1: There is a significant and positive relationship for exogenous LV of the Top Management Support with KPIs towards sustainable university. Result from the analysis above

shows that the path coefficient of Top Management Support on KPIs towards sustainable university is significant (β = 0.106; t-value = 1.963**, p<0.05). Thus, this hypothesis is accepted, and this LV of CSFs is the fourth importance on KPIs towards sustainable university.

Hypothesis 2: There is a significant and positive relationship for exogenous LV of the Comprehensive EM Team with KPIs towards sustainable university. Result from the analysis above shows that the path coefficient of Comprehensive EM Team on KPIs towards sustainable university is significant (β = 0.195; t-value = 2.701***, p<0.01). Thus, this hypothesis is accepted, and this LV of CSFs is the first importance on KPIs towards sustainable university.
Hypothesis 3: There is a significant and positive relationship for exogenous LV of the Strategic Maintenance Management with KPIs towards sustainable university. Result from the analysis above shows that the path coefficient of Strategic Maintenance Management on KPIs towards sustainable university is significant (β = 0.187; t-value = 2.661***, p<0.01). Thus, this hypothesis is accepted, and this LV of CSFs is the second importance on KPIs towards sustainable university.
Hypothesis 4: There is a significant and positive relationship for exogenous LV of the Awareness with KPIs towards sustainable university. Result from the analysis above shows that the path coefficient of Awareness on KPIs towards sustainable university is significant (β = 0.149; t-value = 2.336**, p<0.05). Thus, this hypothesis is accepted, and this LV of CSFs is the third importance on KPIs towards sustainable university.
Hypothesis 5: There is positive relationship but insignificant for exogenous LV of the Good Relationship of Stakeholders with KPIs towards sustainable university. Result from the analysis above shows that the path coefficient of Good Relationship of Stakeholders on KPIs towards sustainable university is insignificant even though the path coefficient shows there is a relationship of this LV on KPIs (β = 0.104; t-value = 1.443). Thus, this hypothesis is rejected.

5.0 Conclusions

Based on the findings discussed above, it shows that CSFs are the areas that should receive constant and careful attention from any organization and their performance by using KPIs is acrucial to monitor those identified CSFs. In conclusion, by identifying the relationship of CSFs for EM with the KPIs towards a sustainable university, this can assist the management team in the university to identify the areas that need improvements to increase the performance of EM. In order to get a comprehensive effect, this study is very beneficial to all universities, especially universities in Malaysia which are practicing EM and are implementing sustainable university agenda or aiming towards it.

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References

Ching Sin T., Mohd Sood S., & Yow Peng, L. (2011). *Sustainability Development through Energy Efficiency Initiatives in Malaysia*. Paper of Green & Energy Management: 4-5

Backlund, S., Thollander, P., Palm, J., & Ottosson, M. (2012). *Extending the energy efficiency gap*. Energy Policy 51: 392-396

Choong W.W., Low, S.T., & Mohammed, A.H. (2012). *Implementation of Energy Management Key Practices in Malaysian Universities*. International Journal of Energy; (2): 455-477.

Capehart, B. L., Turner, W.C., & Kennedy, W. J. (2008). *Guide to energy management (6th ed.*). Lilburn, GA: The Fairmont Press.

Payne J. (2001). Capturing the "multiple benefits" of energy efficiency in practice: the UK example. ECEEE SUMMER STUDY PROCEEDINGS

Bullen, C. V. & Rockart, J. F. (1981). A Primer on Critical Success Factors. Center for Information Systems Research, Working

Paper; 1220-1281.

Tangen, S. (2003). *An Overview of Frequently used Performance Measures*. Work Study; Vol. 52(7): 347-354

Amaratunga, D. (2000). Assessment of Facilities Management Performance. Property Management, Vol.18 (4): 258-266

Kellen, V. (2003). *Business Performance Measurement: At the Crossroads of Strategy, Decision-Making, Learning and Information Visualisation*. Faculty, E-Commerce DePaul University, Chicago, IL, US

Flanagan, C. (2005). An Investigation into the Performance Measurement Practices of Irish Hotel Groups. Unpublished Master Science Thesis. Dublin Institute of Technology

Haktanir, M., & Harris, P. (2005). Performance measurement practice in an independent hotel context: a case study approach. International Journal of Contemporary Hospitality Management; 17 (1): 39–50

Chua, Y.P. (2011). *Kaedah Dan Statistik Penyelidikan. Buku 5*. Statistik Penyelidikan Lanjutan. Malaysia: Mcgraw-Hill (Malaysia) Sdn. Bhd.

Hair, J. F., Babin, B., Money, A. H., & Samouel, P. (2003). *Essential of Business Research Methods*. New Jersey: John Wiley dan Son, Inc.

Smith, S., & Roodt, G. (2003). An Evaluation of Response Scale Formats of the Culture Assessment Instrument. *SA Journal of Human Resource Management*. 1(2): 60-75.

Monette, D. R., Sullivan, T. J., & DeJong, C. R., Hilton, T. P. (2013). *Applied Social Research: A Tool for the Human Services*. 9th ed. Belmont, California: Wadsworth.

Hair, J.F., Ringle, C., & Sarstedt, M. (2011). *PLS-SEM: Indeed a Silver Bullet*. JMTP, 19 (2), 139-152

Chin, W. (1998). The Partial Least Squares Approach to Structural Equation Modeling. Modern Methods for Business Research; 295 (2), Lawrence Erlbaum Associates: 295-336.

Hansmann, K.W., & Ringle, C.M. (2004). Smart PLS Manual. Hamburg: University of Hamburg.