MEASUREMENT MODEL OF CRITICAL SUCCESS FACTORS FOR ENERGY MANAGEMENT IN MALAYSIAN UNIVERSITY

Alia Abdullah Saleh, Siti Norsazlina Haron, Nur Azfahani Ahmad, Nor Eeda Ali

Faculty of Architecture Planning & Surveying, Universiti Teknologi MARA, Perak Branch, Seri Iskandar Campus, Seri Iskandar, 32610, Perak, Malaysia

E-mail: alia796@perak.uitm.edu.my

Received: 30 May 2018
Accepted: 3 Sept 2018
Published: 31 December 2018

ABSTRACT

The increasing number of staff and students in Malaysian universities has led to consume energy excessively. The activities of the university's management to reduce the energy expenditure is critical, where critical success factors (CSFs) are the few issues that must be addressed as well as to ensure the accomplishment of an organisation. Unfortunately, most Malaysian universities are lagging in determining the relationship of identifying CSFs for EM with KPIs towards a sustainable university. Therefore, this research focuses on critical success factors (CSFs) for energy management (EM) towards Malaysian sustainable university. This inquiry is broadened by taking a conceptual measurement model using Partial Least Square-Structural Equation Modeling (PLS-SEM). The assessment demonstrates that the construct of CSFs for EM which comprises of 'Top Management Provision', 'Commitment from EM Team', 'Planned Maintenance Management', 'Consciousness' and 'Good Relationship among Stakeholders' were maintained and some of the indicators relate to this construct were expelled. In conclusion, the findings obtained can assist the decision maker in the university to identify the areas that need improvement in order to increase the performance of EM. This study is very beneficial to all universities, especially universities in Malaysia which practice EM. The existing guidelines also can be improved so as to be more effective and able to be applied to all universities in Malaysia.

Keywords*: Measurement model, Critical success factors, Energy management, Sustainable university*

INTRODUCTION

The Earth is presently confronted with the danger of crisis. For example dwindling energy resources, environmental change, and in addition ecological contamination and corruption (Lombard et al., 2008). Energy consumption is increasing significantly, particularly in developing countries and Malaysia is not exempted from this issue particularly with expanding activities of modernization and population (Wilson, 2013). Indeed, even universities are devouring more energy because of expanding activities and population. Thus, the Malaysian Ministry of Higher Education has asked all universities to save energy on a high energy usage which has resulted into worriness of many parties. EM has been a noteworthy instrument to enable universities to meet these fundamental targets for their transient continuance and long haul achievement. With the novel advancements and elective vitality sources now accessible, universities in Malaysia could cut its energy utilization if there were no boundaries to the execution. It is extremely critical that activities to enhance energy use must be experienced which can be achieved by making a long haul manageable arrangement for future energy demand. As depicted by the Brundtland Report (1987, page number?), “Sustainable growth is development that satisfies the demands of the present without compromising the ability of future generations to satisfy their own needs”. Sustainability consists of at least environmental, societal and economic pillars. The demand to put the three main pillars of sustainability is urgent and more significant than ever. EM is rooted in all three sustainability pillars and progress in these areas can induce a substantial influence. Today, the vast majority of the energy utilized in the public eye winds up as waste. Thus, a decent EM is imperative. Albeit, sustainable university is an extremely noteworthy occasion in Malaysia, there have not been any extensive studies identified related to the current public university's drives and endeavours in sustainability (Saadatian et al., 2009). From this statement, critical success factors (CSFs) are essential regions of action that must be overseen well if university is planning to accomplish the mission, targets or objectives in actualizing EM towards sustainability. There are various, major methods and movements to increase the function of organizations. Several years ago key performance indicators (KPIs) Has become the best measurement practiced by the government agencies as well as to the universities (Hazadiah et al., 2009).

This issue beomes more discouraging when an examination done by Abdullah (2012) indicated that the Malaysian Ministry of Higher Education (MOHE) has not shown and embraced any standard KPIs towards manageability in Malaysian universities since 2010 onwards. Due to this, this study focuses on CSFs for EM towards a Malaysian sustainable university through developing a CSFs measurement model. Indirectly, by identifying these CSF and link them to KPIs towards a sustainable university, it can be a reference in helping individuals who are required to cognize precisely what CSFs construct. Besides, the indicators are almost critical for EM towards a sustainable university. This contemplates underpins the announcement by Cetinkaya (2011) who shows that the best execution in an organization is the point at which the connection amongst CSFs and KPIs can be depicted, while Haktanir and Harris (2005) upheld their perspectives on CSFs and illustrated the perceivable connection between CSFs and execution estimation utilizing KPIs.

LITERATURE REVIEW

Implementing Energy Management in Malaysian Universities

Malaysian university buildings are not exempted from the issue of high energy usage, which are categorized as commercial buildings because of its body processes and population (Sohif et al., 2009; Abu Baker et al., 2013). Since university buildings are also high consumers of energy in the category of commercial buildings, many public universities in Malaysia have started EM projects to heed the call for more secure usage of energy. This activity is imperative because in general, all colleges do acknowledge the substantial develop region, extensive offices and in addition vast quantities of building users (Sohif et al., 2009; Abu Bakar et al., 2013). EM has a noteworthy influence in accomplishing energy sustainability. Sustainable EM can be viewed as the way toward regulating the energy utilization in the organization as to safeguard that energy that has been proficiently devoured (Abu Bakar et al., 2013). The effective execution of sustainable EM in the foundation will rely upon the dedication and collaboration at all management layers. To improve this, research and preparation will be a central instrument in the most proficient way conceivable (Denny and O'Malley, 2008).

According to Van Gorp (2004), by consistently implementing EM practices, energy utilization will be able to be conserved efficiently. Figure 1 shows the portion of energy utilized as a part of university building. Tang (2012) distinguished that Heat, Ventilation, Air Conditioning (HVAC) is the most utilized in a Malaysian university building which added to 45%, followed by lighting system (42%), water heating (3%) and others (10%). This revealed that there is a request to enhance EM awareness in local universities.

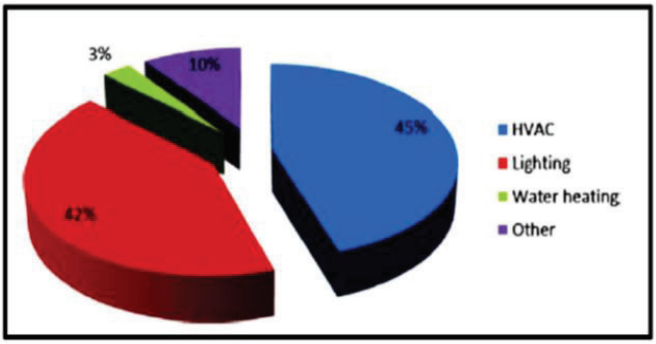

Figure 1: Percentage energy utilized in the Malaysian university building
(Source: Tan (2012))

In Malaysia, the Ministry of Higher Education (MOHE) spends in excess of ten million Ringgit yearly on the costly power charges (Choong et al., 2009). Indeed, the expansion of power tax in peninsular Malaysia incidentally influences the operational expenses for universities. Appropriately, MOHE has asked all universities to preserve energy as an upshot of the costly month to month power charge which turns into the worry of numerous parties (Choong et al., 2012). The movement towards sustainable university has been grasped by numerous universities all over Malaysia where they are in the few levels of coordinating sustainable components in the campus planning and management (Dola et al., 2013). Malaysia is faced with huge difficulties in securing sustainable improvement (Mat Said et al., 2003). In fact, initiatives towards a sustainable university in Malaysia are being obliged by various limits, including low need of natural issues on the grounds, and absence of coordination between and among advocates and key constituencies (Sohif Mat et al., 2009; Ching Sin et al., 2011). The approach towards sustainability in universities is not only unacceptable, yet additionally disappointing (Velazquez et al., 2005;

Stephens and Graham, 2010; Lozano, 2011; Blake and Sterling, 2011; Barth and Rieckmann, 2012; Lambrechts et al., 2013). In any case, there are even numerous university pioneers and employees who are unconscious of EM criteria and this brought about unsustainable universities (Lozano, 2006; Nejati and Nejati, 2013). The move towards sustainable universities has not been illustrated appropriately, and most endeavours lack of strategy for a long haul objective and are intensified by an absence of coordination among stakeholders. Subsequently, the university is prepared to grasp the concept of CSFs to build up a serious strategy to guarantee the university can accomplish the point of executing EM towards sustainability effectively.

Critical Success Factors for Energy Management towards Sustainable University

Rockart (1982) defined CSFs as “The limited number of fields in which comes about, if they are satisfactory will guarantee effective aggressive execution of the system. They are the few key areas where things must go ideal for the business to prosper”. He also concluded that CSFs are “areas of substantial capacity that ought to get consistent and cautious consideration from management.” CSFs are not targeted, but rather are the activities and processes that can be held in or influenced by the management to accomplish the organization’s aims. In late years, studies on CSFs has gradually gained interest. For example, the apprehension of the importance of CSFs in project management within an organisational context (Hyvari, 2006; Derek, 2007; Ahadzie et al., 2008; Soon Han et al., 2012). There are also studies conducted within the context of quality management system (Salaheldin, 2009; Psomas et al., 2010; Abdullah, 2012); project sponsorship (Bryde, 2008); stakeholder management (Yang et al., 2009); building maintenance projects (Zutshi et al., 2004; Lam et al., 2010; Zulkarnain and Rahman, 2011); knowledge management (Wu, 2012; Huang and Lai, 2012); waste management (Lu and Yuan, 2010); supply chain management (Tummala et al., 2006) and sustainability (Xu et al., 2011; Wai et al., 2012). The findings of past studies may change with the EM field. For instance, some normal factors that can be connected to EM. Table 1 shows the CSFs that have been distinguished in this study, either from the establishing accomplices, which are the International Association of Universities (IAU), the Association of University Leaders for a Sustainable Future (ULSF), the

COPERNICUS Program of the Association of European Universities (CRE) and the United Nations Educational, Scientific and Cultural Organization (UNESCO), which include universities to sustainable improvement. There is no KPIs from Malaysian MOHE since 2010.As a result, this study has accepted 10 point action plan from Talloires Declaration as shown in Table 1. This declaration is for sustainability, created for and by presidents of institutions of higher learning. In the Report and Declaration of the Presidents Conference, 466 universities around the world have signed this declaration. This is also supported by Saadatian et al., (2013) where they claim that Malaysia is a country which recognizes the concept of sustainable university by ratifying the Talloires Declaration.

Table 1: Critical Success Factors and Key Performance Indicators for Energy Management towards Sustainable University

Critical Success Factors (CSFs) Key Performance Indicators	Founding Partners and Past Authors							
	IAU (1950)	ULSF (1990)	COPERNICUS (1993)	UNESCO (1993)	Xu et al., (2011)	Choong, et al., (2012)	Manan (2012)	Yang (2013)
1) Top Management Provision (TMP)								
▪ Develop vitality strategies and rules (TMP1)	■	■			■	■		■
▪ Leadership (TMP2)	■				■	■		
▪ Create motivating forces for positive commitment (TMP3)							■	■
▪ Allocation of adequate resources (TMP4)	■	■	■		■	■		■
▪ Training arrangement (TMP5)			■	■		■	■	■
2) Commitment from EM Team (CEMT)								
▪ Conduct energy review (CEMT1)	■	■	■			■	■	■
▪ Operations and support (CEMT2)		■		■		■	■	

▪ Management investigation and check (CEMT3)								
▪ Continuous change (CEMT4)								
3) Planned Maintenance Management (PMM)								
▪ Risks documentation (PMM1)								
▪ Risks evaluation (PMM2)								
▪ Risks react (PMM3)								
▪ Risks estimation by building up an emergency course of action (PMM4)								
4) Consciousness (CON)								
▪ Understanding the issues (CON1)								
▪ Increase general energy consciousness (CON2)								
▪ Improve facility energy consciousness (CON3)								
▪ Education by R&D, instructing and learning (CON4)								
▪ Community commitment and association (CON5)								
▪ Energy data (CON6)								
5) Good Relationship among Partners (GRP)								
▪ Understanding of project vision and objective (GRP1)								
▪ Good communication among partners (GRP2)								
▪ Knowledge and abilities (GRP3)								
▪ Trust among partners (GRP4)								
6) KPIs towards a Sustainable University								
▪ Raised the awareness towards an environmentally sustainable future (KPI1)	10-point action plan of the Talloires Declaration towards a sustainable university							
▪ Supported the staff and students to take part in education, research, policy formation, and information exchange (KPI2)								
▪ Affirmed that all university graduates are learned and mindful on environmental management and related fields (KPI3)								
▪ Made more projects on sustainability to all undergrad, graduate, and professional students (KPI4)								
▪ Set up institutional arrangements and practices of resources preservation and environmental activities (KPI5)								
▪ Encouraged the participation of government and industry to support their solutions to environmental problems (KPI6)								
▪ Created interdisciplinary ways to deal with curricula, research initiatives, operations, and outreach activities that support an environmentally sustainable future (KPI7)								

▪ Built up partnerships with primary and secondary schools to develop the capacity with regards to interdisciplinary teaching about environment and sustainable development (KPI8)	
▪ Advanced its exertion toward a sustainable future by working with national and global organizations (KPI9)	
▪ Set up a secretariat and a directing board of trustees to proceed with this momentum, and to advise and bolster each other's endeavours towards sustainability (KPI10)	

(Source : IAU (1950); ULSF (1990); COPERNICUS (1993); UNESCO (1993); Xu et al., (2011); Choong et al., (2012); Manan (2012); Yang (2013))

METHODOLOGY

An intensive literature review was carried out to make a full list of CSFs for EM and KPIs towards sustainable university. The indicators of 23 CSFs and 10 KPIs levels were distinguished from the literature review. The levels were substantiated by experts in university and industry. Then, the list of CSFs and KPIs were displayed to 6 experts to validate the list of CSFs and KPIs before conducting the main survey. According to Creswell (2003), a suitable number of experts to validate the list obtained from literature review is between 5 to 25 people; hence the number used in this study is sufficient These experts were chosen since they had over 10 years general involvement in managing energy or have conducted various research in the area of EM or sustainability. From the meeting directed with the interviewees, all interviewees concurred that the proposed 23 CSFs indicators and 10 KPIs construct were basic and extensive, while some interviewees provided valuable comments. Then, the main survey was carried out by distributing 80 sets of questionnaire to the respondents who are experts in energy management and sustainability in selected universities which are Universiti Kebangsaan Malaysia (UKM), Universiti Malaya (UM), Universiti Putra Malaysia (UPM), Universiti Sains Malaysia (USM) and Universiti Teknologi Malaysia (UTM). The selection of these universities were based on their own strength in different aspects which have undergone changes to enhance their sustainability. In addition, they have their own research centres towards sustainability; for example UKM-Institut Alam Sekitar dan Pembangunan (LESTARI); UM-Spatial Environmental Governance for Sustainability Study; UPM-Sustainable Consumption

Study Centre; USM-Centre for Global Sustainability Studies and UTM-Sustainability Unit. Therefore, only five research universities were involved in the sampling studies.

The measurement model assessment involves an examination of the 5-point Likert scales by analysing the relationships between each CSFs and KPIs construct with its indicators. For this study, it involves five constructs of CSFs namely top management provision, commitment from EM team, planned maintenance management, consciousness and good relationship among partners with the sum of 23 indicators, while for KPIs construct, it involves 10 indicators. By utilising the Partial Least Square-Structural Equation Modelling (PLS-SEM), the reflective measurement model can be evaluated against the aspects of indicator reliability, internal consistency reliability, convergent validity, and discriminant validity.

RESULTS AND DISCUSSIONS

Indicator Reliability

The reliability of each of the CSFs may be assessed through the individual correlations between the indicators and their theoretically associated CSFs construct. A sufficient correlation between the indicators and the respective CSFs construct is vital. Indicators with outer loadings 0.70 or higher are considered very acceptable (Henseler et al. 2017; Hair, 2014). According to Hair et al. (2014), for exploratory study, the indicators with loading value of 0.40 is regarded as satisfactory, whereas those under 0.40 ought to be dropped. The cut-off value taken for outer loading in this study is 0.40 or more. As can be seen in Table 2, the loading value for the item risks documentation (PMM1) received 0.253 as the loading value, and it has been dropped. In addition, a few indicators from KPIs construct were removed including KPI8 (0.367) and KPI9 (0.303). The analysis results for other CSFs indicators and KPIs have fulfilled the criteria with loading values of more than 0.40 after running the PLS-Algorithm twice. The findings showed that all the CSFs indicators have good correlations with their associated CSFs construct that is the same with KPIs' construct.

Internal Consistency Reliability

The second parameter for reliability is measured by two criteria which are Cronbach's Alpha (CA) and Composite Reliability (CR). CA and CR show how well an arrangement of CSFs indicators evaluate a solitary CSFs construct. In any case, despite the fact that CA is frequently utilized as a part of estimating the internal consistency reliability, CR is viewed as a better measure of internal consistency because it employs the standardization of different CSFs when PLS-Algorithm is applied (Henseler et al., 2017). The suggested cut-off value for establishing internal consistency reliability must not be lower than 0.60 and preferably more than 0.70 respectively (Henseler et al., 2017). From Table 2, the values for both CA and CR are more than 0.70 in the first and final iteration of the PLS - Algorithm. In closing, whole sets of CSFs indicator have a good appraisal on a single CSFs constructs.

Convergent Validity

For the validity of variable, one of the tests is convergent validity. Convergent validity refers to the amount of variance captured by CSFs construct from its relative indicators due to measurement errors (Henseler et al., 2017). The test measures are done by evaluating the Average Variance Extracted Value (AVE). Henseler et al., (2017); Hair et al., (2014) claim that a minimum 50% of the variance from indicators are explained by the CSFs construct and KPIs to which it is allocated to. This suggests that AVE value should be 0.50. The first run of PLS-Algorithm generated results showed that construct of PMM obtained AVE values less than threshold value of 0.50. However, the second run of PLS-Algorithm revealed the AVE value is more than 0.50. Taking everything into account, this outcome of the measurement model has demonstrated an adequate convergent validity.

Table 2: Result of Measurement Model for Indicator Loadings

CSFs Group	Symbol for CSFs Indicators	PLS-Algorithm 1				PLS-Algorithm 2			
		Loading	AVE	CR	CA	Loading	AVE	CR	CA
Top Management Provision (TMP)	TMP1	0.596	0.574	0.869	0.837	0.596	0.580	0.871	0.838
	TMP2	0.889				0.890			
	TMP3	0.646				0.646			
	TMP4	0.965				0.966			
	TMP5	0.843				0.843			

Commitment from EM Team (CEMT)	CEMT1	0.701	0.666	0.907	0.887	0.701	0.701	0.923	0.888
	CEMT2	0.599				0.600			
	CEMT3	0.664				0.664			
	CEMT4	0.564				0.565			
Planned Maintenance Management (PMM)	PMM1	0.253	0.581	0.768	0.615	0.582	0.584	0.796	0.617
	PMM2	0.501				0.530			
	PMM3	0.667				0.667			
	PMM4	0.689				0.690			
Conscious-ness (CON)	CON1	0.896	0.654	0.816	0.767	0.896	0.687	0.834	0.771
	CON2	0.978				0.978			
	CON3	0.765				0.765			
	CON4	0.547				0.550			
	CON5	0.685				0.685			
	CON6	0.543				0.544			
Good Relationship among Partners (GRP)	GRP1	0.798	0.763	0.787	0.663	0.801	0.556	0.788	0.665
	GRP2	0.872				0.872			
	GRP3	0.889				0.889			
	GRP4	0.733				0.733			
Key Performance Indicators towards a Sustainable University (KPIs)	KPI1	0.717	0.542	0.892	0.858	0.717	0.542	0.895	0.861
	KPI2	0.765				0.765			
	KPI3	0.767				0.767			
	KPI4	0.824				0.823			
	KPI5	0.857				0.857			
	KPI6	0.755				0.756			
	KPI7	0.813				0.813			
	KPI8	0.367				-			
	KPI9	0.303				-			
	KPI10	0.655				0.655			

Discriminant Validity

Another type of construct validity used in PLS-SEM is discriminant validity. Discriminant validity refers to the degree which the construct does not correlate with other measures that are different from it (Hair et al., 2014). Fornell-Larcker criterion and cross-loadings are the two criteria to affirm the discriminant validity. Utilizing the Fornell-Larcker criteria, the AVE of each construct should have a higher value than its squared correlations with any other construct (Fornell and Larcker, 1981). This was done by replacing the diagonal of correlation matrix with the square root value of the AVE. For adequate discriminant validity, the diagonal elements need to be greater than the off-diagonal elements in the corresponding rows and columns (Hair et al., 2014). Table 3 presents the correlation matrix for the constructs. It shows that the diagonal values of AVE (in bold) are greater than the off-diagonal AVE. Hence, the test confirms the discriminant validity.

Table 3: Result of Discriminant Validity

CSFs Construct	AVE	TMP	CEMT	PMM	CON	GRP	KPIs
TMP	0.580	**0.687***					
CEMT	0.701	0.546	**0.765***				
PMM	0.584	0.645	0.532	**0.854***			
CON	0.687	0.613	0.723	0.563	**0.789***		
GRP	0.556	0.475	0.586	0.552	0.438	**0.598***	
KPIs	0.542	0.637	0.545	0.436	0.584	0..598	**0.686***

The next assessment for discriminant validity was based on cross loadings. Cross loadings for all the CSFs have higher values on their relative CSFs and KPIs construct as compared with the other group either in the same row or the same column as demonstrated in Table 4. This verifies that the CSFs indicators and KPIs in each construct affirmed the discriminant validity of the model.

Table 4: Result of Cross Loadings

	TMP	CEMT	PMM	CON	GRP	KPIs
TMP1	**0.596**	0.415	0.151	0.149	0.482	0.534
TMP2	**0.890**	0.532	0.103	0.431	0.442	0.628
TMP3	**0.646**	0.124	0.116	0.429	0.457	0.542
TMP4	**0.966**	0.365	0.259	0.337	0.218	0.580
TMP5	**0.843**	0.113	0.421	0.398	0.228	0.552
CEMT1	0.465	**0.701**	0.503	0.286	0.109	0.554
CEMT2	0.512	**0.600**	0.511	0.235	0.111	0.438
CEMT3	0.521	**0.664**	0.376	0.376	0.532	0.431
CEMT4	0.289	**0.565**	0.428	0.372	0.423	0.512
PMM1	0.265	0.432	**0.582**	0.387	0.442	0.519
PMM2	0.224	0.122	**0.530**	0.421	0.109	0.354
PMM3	0.276	0.154	**0.667**	0.513	0.508	0.428
PMM4	0.104	0.217	**0.690**	0.532	0.431	0.439
CON1	0.119	0.198	0.376	**0.896**	0.321	0.612

CON2	0.278	0.276	0.519	**0.978**	0.447	0.604
CON3	0.469	0.387	0.477	**0.765**	0.514	0.432
CON4	0.321	0.104	0.521	**0.550**	0.448	0.467
CON5	0.117	0.110	0.514	**0.685**	0.376	0.604
CON6	0.266	0.353.	0.128	**0.544**	0.436	0.318
GRP1	0.209	0.434	0.247	0.459	**0.801**	0.621
GRP2	0.643	0.528	0.233	0.523	**0.872**	0.327
GRP3	0.514	0.187	0.175	0.197	**0.889**	0.633
GRP4	0.146	0.109	0.133	0.139	**0.733**	0.606
KPI1	0.187	0.356	0.389	0.247	0.653	**0.717**
KPI2	0.265	0.312	0.287	0.276	0.376	**0.765**
KPI3	0.244	0.377	0.387	0.282	0.666	**0.767**
KPI4	0.476	0.432	0.338	0.143	0.649	**0.823**
KPI5	0.519	0.489	0.487	0.199	0.563	**0.857**
KPI6	0.107	0.114	0.443	0.173	0.613	**0.756**
KPI7	0.213	0.517	0.117	0.521	0.644	**0.813**
KPI10	0.365	0.528	0.490	0.438	0.528	**0.655**

From the evaluation involved, which are indicator reliability, internal consistency reliability, convergent validity, and discriminant validity, the PLS-SEM measurement model was developed as shown in Figure 2.

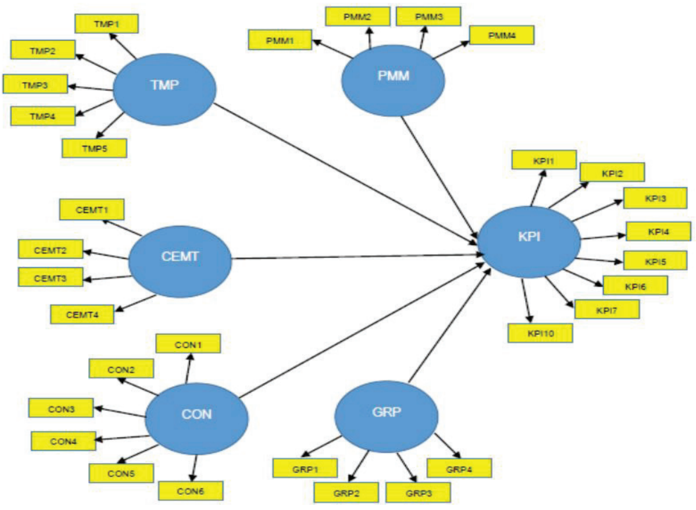

Figure 2: PLS-SEM measurement model

CONCLUSION

From the overall results of reflective measurement model evaluation, it can be concluded that five constructs of CSFs namely the top management provision, commitment from EM team, planned maintenance management, consciousness and good relationship among partners with the sum of 23 indicators remained, while for KPIs construct, it involves 8 indicators only. Top management provision is the key determinant of successful implementation efforts. Knowledgeable and credible leader shall contribute to successful implementation of EM efforts and initiatives. Besides, providing incentives and couple with a strong awareness and mind-set of the team are vital. Sufficient resources shall be suitable to act as catalyst to be implemented as well as combined with specialised training programs including on the job training. Whereas, energy policy and guidelines are the critical implementation frameworks which should be referred to in the EM execution approach. In addition, the EM team shall be committed with key personnel who are hold responsible for compliance to establish standards. The ability to undertake effective operation and support and a comprehensive approach towards EM also must be considered. Sufficient skills, motivation and relevant competence are also needed to carry out the execution. The energy manager shall be capable to translate policy whilst guided by policy to specify standards and methods to assure that the EM are implemented effectively. The pragmatic and coherent approach towards successful EM is to embark into the energy review which is to enable the establishment of benchmark or basis. Policy of adopting a planned maintenance management plan is a major contributor to EM implementation. Blended with other factors, the successful implementation of EM can be accomplished for sustainability. Besides, relationship among partners remains an important factor towards successful implementation and sustainability. With healthy relationship, all critical requirements or documentation shall be available to underpin the sustainable EM initiatives. While for KPIs, two indicators were removed. The two indicators were built up partnerships with elementary and secondary schools to develop the content with regards to interdisciplinary teaching about the environment and sustainable growth as well as working with national and global organisations toward sustainable future also was removed. This is because the strengthening of EM towards sustainable universities needs to be strengthened at the university level.

ACKNOWLEDGEMENT

Thank you to Universiti Teknologi MARA, Perak Branch for the support in carrying out the research successfully.

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