Reliability and Validity of Facilities Management Competencies Instrument Using Partial Least Squares

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Abstract—**Facility management competency questionnaire was developed to measure the facility management competencies required by individuals who manage the facility or facilities manager at the polytechnic. This study was conducted to produce empirical evidence of the reliability and validity of the competency of questionnaires facility manager by using Partial Least Square. This study used 36 items derived from the professional bodies and previous studies. This questionnaire administered 661 officers who manage the facilities in the polytechnics. The questionnaire measures five constructs, namely Leadership in Organization and Human Resources Management, Services Management, Operation and Maintenance Management, Working Environment and Resource Management and Law Management with six-point Likert scale. Partial least squares;** *Smart***PLS version 2.0, was used to test the reliability and validity of the questionnaire. Reliability index values obtained from all constructs is between 0.909 and 0.969. This study also describes an arrangement of items in accordance with the importance being accorded agreed upon by those who manage the facilities in the polytechnics. Results acquired have proved questionnaires used have high reliability and validity for identifying facility manager competencies in polytechnic.**

Index Terms—**Facility management competencies, reliability, validity, partial least square.**

I. INTRODUCTION

The importance of facility management competencies is not a new thing in discussing, especially in developed countries like United Kingdom, United States and Australia. Everyone needs facility management competencies to function while doing the duty effectively [1]. Facility Management competencies also been discussed at various levels, including, professional bodies, and higher education institution. For example of activities undertaken by them such as courses, seminars, workshops, etc. (website [2]-[4]). While in Malaysia the Minister of Works had emphasized to all asset managers, facility managers and maintenance contractors to improve their competencies in carrying out their respective responsibilities at Asset and Facility Management Conference Malaysia (NAFAM) [5]. Competition for employment has made Human Skills even more important. Hence, a study to identify the most facility management competencies with the current situation of this industry in Malaysia is appropriate. To ensure that the process of identifying the precise competence and quality, the

questionnaire used for this study should have the reliability and validity due to the data, and the findings are recognized by all parties. A great many authors have discussed the requirements on the general competence of managers, e.g. [6]-[8], while others have concentrated on the demands placed on ICT managers [9]-[12].

Study the reliability and validity of of questionnaires is very important to maintain the accuracy of disability of questionnaires. The higher value for the reliability and validity of the questionnaire, the more accurate the data. Reliability is defined as a measure to determine the consistency of the scores of each item [13]. Consistency means that when the same items are tested multiple times on the same subject at different time intervals but still give a decision or answer score equal or nearly equal [14]. So, the validity is the appropriateness, truthfulness, meaningfulness and usefulness of questionnaires that enable data the inherent [15]. Consequently the objective of this article is divided into two: the first one; obtain the reliability of the facility management competencies of questionnaires. Second, find out the validity of facility management competencies of questionnaires. Therefore in order to achieve the objectives of this article, further discussion is the facility management competencies elements, methodologies, finding and discussion.

II. FACILITY MANAGEMENT COMPETENCIES ELEMENT

United Kingdom ten years ago has led to increased interest in the application of the competency framework in the development and selection of expert managers and general managers. Most of the works involved in developing this framework were focused upon the role of facilities managers [1]. Therefore, professional bodies such as the IFMA and the BIFM have adopted the competency framework as a basis for professional accreditation in the field of facility management [16]. These competency areas share some of the same competences: for example, in the field of human resources, communication competence and communication of information arise within the same field. Therefore, [17] have specified five areas of facility management competencies that are essential to realize the mission to the organization. Similarly, [16] listed thirteen competencies recommended for directors and senior managers of the facility, these being issues related to the environment, visionary building design, relevant law, project management, research and analysis, facility management process, real estate portfolio management, risk management, stress management, marketing, monitoring, managing conflict and managing

time.

In contrast, [18] suggested four areas that should be prerequisites for professionals involved in facilities management, although he did not specify these areas as competencies. By referring to the literature and the above discussion, it is argued that these fields can be used as a guide for identifying competency requirements for polytechnic facility management. Then, in 2005, a further study listed ten key features for a facilities manager to be used as a reference for facility management competency [19], while the Institute of Higher Education Facilities Management Professionals in the Netherlands has identified nine key competencies for facility managers [20]. Meanwhile, as regards education organizations, [21] identified seventeen Higher Education Facility Management Associations but only four of these are active: the Association of Physical Plant Administrators (APPA) in the United States of America, the Association of University Directors of Estates (AUDE) in the United Kingdom, the Tertiary Education Facilities Management Association (TEFMA) in Australia and the Higher Education Facilities Management Association (HEFMA) in South Africa. Of these four associations, the only one that has indicated a list of core competency areas involved in higher education institutions is APPA, which sets out four areas of core competencies: General Administration & Management, Operations & Maintenance, Planning, Design & Construction and Energy, Utilities & Environment [22]. Besides that's in Malaysia there is only one preliminary study of competencies that facility manager have been conducted, of whom eight areas of facility management competencies identified at the polytechnic, namely managing people, managing resource, operation and maintenance, leadership and management, managing the working environment, understanding business organization, managing premise and managing services [23].

As such the research in facility management competencies should be viewed more closely. So by using a questionnaire which has the reliability and validity of the proposed that's the performance of services provided by organization will continue to be greatest. From previous literature [1], [16], [17], [20], [21] [23]-[32] facilities management professional bodies [33]-[37], and facility management associations of Higher Education Institutions in the United States (Association of Physical Plant Administrators (APPA)), the United Kingdom (Association of University Directors of Estates (AUDE)) and Australia (Tertiary Education Facilities Management Association (TEFMA)), we recommend eight areas of facility management competencies that need to be reviewed in order to realize the polytechnics' transformation plan, which was launched based on a synthesis of all of these sources of information. However, after the initial findings from [23] through statistical analysis (factor analysis), found facilities management competency areas for polytechnic is five. Subsequently, in light of the necessary competencies for facility manager and features that should in place, the competencies required for facilities manager in polytechnic are summarised in Table I.

TABLE I (a): THE FIVE AREAS OF POLYTECHNIC FACILITY MANAGER COMPETENCIES

Area of competencies	No. of Items	Sources
1. Leadership in Organisation and Human Resource Management	(12)	
Plan and sort the facility function		[16]; [20]; [33]; [38]
Has the characteristics of leadership and management		[22]; [33]; [38]
Understand the organization structure and organization administration		[19]; [34]; [38]
Understand organizational aim and strategy		[19]; [34]; [38] ;[39];
Area of competencies	**No. of Items**	**Sources**
Practice professionalism in management		[18]; [19]; [22]; [38]; [39];
Ability to manage change		[17]; [20]; [35]; [38]
Develop facility management strategy in line with organizational strategy		[33]; [34]; [35]; [39]; [16];[17];[19];[20]
Human resource management in facility management work process		[17]; [19]; [20];[22]; [34]; [35]; [36]; [38]; [39]
Effective communication		[18];[20]; [22]; [33]; [34]; [35]; [38]
Cooperation with suppliers and specialists for matters/work process related to facility management		[34]; [39]
Logistics management		[36]
Workplace management rapport		[17]; [18]; [19]; [20]; [35];
2. Services Management	(9)	
Management matters on organizational property		[16]; [22]; [33]; [34]; [35]; [36]; [39]
Understand building design		[16]; [22]; [34]; [38]
Maintenance of building elements (roof, floor, external wall, stairs, etc.)		[34]; [35]; [39]
Improve facility performance		[35]; [38]
Workplace management relation		[22]; [39]
Manage building service systems (e.g. Drainage, piping, sanitary, safety, or electrical system, etc.)		[33]; [34]; [35]; [39] [17]; [18]; [22]; [38]
Execute the contract management works		[36]; [38]
Manage support services (e.g. Cleaning team, caterer/food supplier, landscaping, etc.)		[18]; [33]; [34]; [35]
Project management (includes minor renovation and repair/refurbishment etc.)		[16]; [22]; [33]; [34]; [35]; [36]; [38]; [39]
2. Working Environment and Resource Management	(8)	
Environmental issues (such as recycling, energy saving, etc.)		[16]; [18]; [22]; [33]; [34]; [35];[36]; [38]
Space management		[18]; [22]; [34]; [35]; [36]; [38]
Consideration of the health, safety and physical safety management in the organization		[18]; [22]; [33]; [36]; [38]
Works related to resource procurement		[34]; [35]; [38]; [39]
Risk management involved in the work process done		[16]; [17]; [19]; [34]; [35]; [38]
Financial management in managing organizational resources		[17]; [20]; [22]; [33]; [34]; [35]; [36]; [38]; [39]
Quality management in managing the organization resources		[16]; [17]; [19]; [33]; [34]; [38]
Information management in managing the organization resources		[33]; [34]; [36];[39]
4. Operations and Maintenance Management	(5)	
Monitor the procurement, installation, operation, maintenance and disposition of internal building system		[17]; [18]; [22]; [33]; [34]; [38]
Manage the building structure and internal permanent fittings maintenance		[17]; [18]; [22]; [33]; [38]
Monitor the procurement, installation, operation, maintenance and disposal of furniture and equipment.		[17]; [18]; [22]; [33]; [38]
Monitor the procurement, installation, operation, maintenance and disposition of		[17]; [18]; [22]; [33]; [34]; [38]

TABLE I (b): CONTINUE

4. Operations and Maintenance Management (5)	
Monitor the procurement, installation, operation, maintenance and disposition of internal building system	[17]; [18]; [22]; [33]; [34]; [38]
Manage the building structure and internal permanent fittings maintenance	[17]; [18]; [22]; [33]; [38]
Monitor the procurement, installation, operation, maintenance and disposal of furniture and equipment.	[17]; [18]; [22]; [33]; [38]
Monitor the procurement, installation, operation, maintenance and disposition of exterior building elements	[17]; [18]; [22]; [33]; [34]; [38]
Implement operation and maintenance management	[17]; [18]; [22]; [33]; [36]; [38]
5. Law management (2)	
Acquire knowledge in real estate law	[36]
Acquire knowledge of relevant related	[16]; [18]; [20]; [22]; [36]; [38]; [39]

III. METHODOLOGY

A. Sample of the Study and Data Collection

This study is a survey conducted in polytechnics of Malaysia. Based on the organizational chart on the website, the estimated population sample that manages facilities in the polytechnics is 1130. Therefore the questionnaires also amounted in 1130 and 662 of questionnaires responses have been received. The method used by registered post to all polytechnics involved distributing of questionnaires to process and appoint an individual who is known at polytechnic institution for distribution and accumulation. While for polytechnic no connection, the questionnaire will be sent directly to the director of the polytechnic.

B. The Questionnaire

This study uses Facility Management Competencies Questionnaire (FMCQ) as a measuring tool. FMCQ are divided into four sections A, B, C and D. For this article only the validity and reliability of section A will be discussed. A section FMCQ was used to measure five constructs in 36 items of facility management competencies. The constructs are Leadership in Organization and Human Resources Management, Services Management, Operation and Maintenance Management, Working Environment and Resource Management and Law Management. Likert scale used six options for individuals who manage the facility stated their degree of agreement on the items presented. It are terms of importance as a (6) Very important to (1) Direct Insignificant.

C. Data Analysis

The data of this study are based on respondents' scores (individual who manages the facility) of items in the questionnaire FMCQ. Scoring is based on Likert scale as described in the questionnaire survey section A. Data were reviewed manually before using Partial Least Square analysis technique (PLS). We tested the questionnaire based on structural equation modelling using Partial Least Squares (PLS) approach. We used the Smart PLS M2 Version 2.0 [40] software to analyse the data with the application of algorithm technique to determine the reliability and validity value.

IV. RESULT AND DISCUSSION

A. Construct Validity

Construct validity will confirm the extent to which the results obtained (e.g. questionnaires) are compatible and parallel to theoretical or conceptual [41]. A measurement tool is said to have construct validity if it succeeds measure theoretical structure has been developed. The question here is does the instrument tap the concept as theorised? This can be evaluated through convergent and discriminant validity.

B. Convergent Validity

Convergent validity is the degree to which multiple items used to measure the same concept are in agreement. This was assessed through composite reliability (CR), factor loadings and average variance extracted (AVE) [42]. The loadings for all items exceeded the recommended value of 0.5 [42]. Referring to Table II, all constructs have the value of CR more than 0.9, which beyond the recommended value of 0.7 [42]. The average variance extracted (AVE) measures the variance captured by the indicators relative to measurement error, and it should be greater than 0.5 to justify using a construct [42]. The average variance extracted, were in the range of 0.557 – 0.860.

TABLE II: MEASUREMENT MODEL

Construct	Item	Loading	Average Variance Extracted (AVE[a])	Composite Reliability (CR[a])
Key Performance Indicator of Polytechnic Transformation Plan	KPI1	0.580	0.557	0.917
	KPI10	0.766		
	KPI12	0.799		
	KPI13	0.805		
	KPI14	0.694		
	KPI6	0.520		
	KPI7	0.830		
	KPI8	0.827		
	KPI9	0.822		
Leadership in Organization and Human Resources Management	KPPE1a	0.745	0.659	0.955
	KPPE2a	0.806		
	KPPE4a	0.817		
	KPPE6a	0.796		
	OR1a	0.830		
	OR2a	0.809		
	OR3a	0.811		
	SM1a	0.822		
	SM2a	0.810		
	SM3a	0.765		
	SM4a	0.751		
	SM5a	0.820		
Operation and Maintenance Management	PENY1a	0.926	0.860	0.969
	PENY2a	0.903		
	PENY3a	0.937		
	PENY4a	0.931		
	PENY5a	0.940		
Services Management	PKD1a	0.864	0.633	0.951
	PKD2a	0.873		
	PKD3a	0.864		
	PKD4a	0.859		
	PR1a	0.747		
	PR2a	0.739		
	PR3a	0.861		
	PR4a	0.809		
	PR5a	0.792		
Working Environment and Resource Management	PRKER1a	0.761	0.691	0.945
	PRKER2a	0.785		
	PRKER3a	0.827		
	SUMB1a	0.833		
	SUMB2a	0.848		
	SUMB3a	0.861		
	SUMB4a	0.863		
	SUMB5a	0.820		
Law Management	KPPE1a	0.892	0.833	0.909
	KPPE6a	0.933		

Note: [a] Composite Reliability (CR) = (square of the summation of the factor loadings)/{(square of the summation of the factor loadings) + (square of the summation of the error variances)}
[b] Average Variance Extracted (AVE) = (summation of the square of the factor loadings)/{(summation of the square of the factor loadings) + (summation of the error variances)}

With the values obtained, it is shown that the use FMCQ convergent validity has allowed the literature and can be used for data collection.

C. Discriminant Validity

The discriminant validity of the measures (the degree to which items differentiate among constructs or measure

distinct concepts) was assessed by examining the correlations between the measures of potentially overlapping constructs. Items should load more strongly on their own constructs in the model, and the average variance shared between each construct and its measures should be greater than the variance shared between the construct and other constructs [43]. As shown in Table III, the squared correlations for each construct are less than the average variance extracted by the indicators measuring that construct indicating adequate discriminant validity. In total, the measurement model demonstrated adequate convergent validity and discriminant validity.

TABLE III: DISCRIMINANT VALIDITY

	Leadership in Organization and Human Resources Management	Key Performance Indicator of Polytechnic Transformation Plan	Operation and Maintenance Management	Services Management	Working Environment and Resource Management	Law Management
Leadership in Organization and Human Resources Management	0.799					
Key Performance Indicator of Polytechnic Transformation Plan	0.404	0.746				
Operation and Maintenance Management	0.608	0.377	0.928			
Services Management	0.699	0.403	0.760	0.827		
Working Environment and Resource Management	0.742	0.390	0.736	0.734	0.825	
Law Management	0.566	0.204	0.413	0.544	0.491	0.913

While Table IV shows the loadings and cross loading. The table shows that all items measuring the same construct loaded highly on that particular construct and loaded lower on other constructs indicating convergent and discriminant validity.

TABLE IV: OUTER MODEL LOADING AND CROSS LOADING

Item	Key Performance Indicator of Polytechnic Transformation Plan	Leadership in Organization and Human Resources Management	Operation and Maintenance Management	Services Management	Working Environment and Resource Management	Law Management
KPI1	0.580	0.397	0.379	0.379	0.386	0.207
KPI10	0.766	0.294	0.287	0.292	0.276	0.167
KPI12	0.799	0.347	0.286	0.274	0.309	0.155
KPI13	0.805	0.305	0.279	0.281	0.303	0.105
KPI14	0.694	0.255	0.227	0.241	0.234	0.072
KPI6	0.520	0.165	0.148	0.193	0.171	0.174
KPI7	0.830	0.290	0.283	0.331	0.310	0.177
KPI8	0.827	0.264	0.261	0.310	0.277	0.147
KPI9	0.822	0.285	0.275	0.321	0.253	0.145
KPPE1a	0.339	0.746	0.447	0.527	0.555	0.479
KPPE2a	0.332	0.806	0.453	0.510	0.563	0.509
KPPE5a	0.328	0.817	0.455	0.533	0.594	0.506
KPPE6a	0.294	0.798	0.468	0.541	0.592	0.516
OR1a	0.333	0.830	0.466	0.522	0.561	0.403
OR2a	0.327	0.809	0.427	0.465	0.547	0.397
OR3a	0.349	0.811	0.495	0.568	0.607	0.434
SM1a	0.316	0.822	0.509	0.599	0.626	0.473
SM2a	0.302	0.810	0.472	0.541	0.598	0.396
SM3a	0.313	0.766	0.567	0.632	0.624	0.434
SM4a	0.299	0.751	0.544	0.654	0.619	0.490
SM5a	0.342	0.820	0.535	0.622	0.638	0.399
PENY1a	0.356	0.571	0.926	0.712	0.694	0.380
PENY2a	0.345	0.570	0.903	0.716	0.694	0.407
PENY3a	0.351	0.557	0.937	0.695	0.677	0.353
PENY4a	0.333	0.566	0.931	0.706	0.674	0.393
PENY5a	0.362	0.557	0.940	0.697	0.685	0.382
PKD1a	0.351	0.584	0.664	0.864	0.610	0.381
PKD2a	0.381	0.570	0.659	0.873	0.645	0.490
PKD3a	0.333	0.550	0.672	0.864	0.627	0.457
PKD4a	0.315	0.583	0.695	0.869	0.644	0.459
PR1a	0.299	0.536	0.521	0.747	0.538	0.589
PR2a	0.272	0.473	0.545	0.758	0.522	0.462
PR3a	0.357	0.590	0.652	0.861	0.622	0.407
PR4a	0.360	0.703	0.619	0.809	0.644	0.416
PR5a	0.308	0.588	0.614	0.792	0.588	0.413
PRKER1a	0.270	0.579	0.543	0.614	0.761	0.402
PRKER2a	0.256	0.602	0.574	0.567	0.785	0.417
PRKER3a	0.310	0.607	0.556	0.583	0.827	0.360
SUMB1a	0.350	0.617	0.670	0.614	0.833	0.437
SUMB2a	0.346	0.640	0.630	0.617	0.848	0.471
SUMB3a	0.330	0.615	0.635	0.591	0.861	0.396
SUMB4a	0.342	0.636	0.644	0.633	0.863	0.401
SUMB6a	0.347	0.608	0.594	0.589	0.820	0.362
KPPE3a	0.163	0.435	0.332	0.459	0.389	0.892
KPPE4a	0.205	0.583	0.413	0.528	0.496	0.933

V. CONCLUSION

The result from the data analysis had to meet the criteria suggested by [16] for the reliability and validity FMCQ.

Accordingly, FMCQ particularly suitable for facility manager competencies information needed in polytechnics. Via these findings, the management of the polytechnic can make better planning for improvement in facilities management business. Generally, finding of the present study add to previous work on element of facility management competencies. The above findings hence contribute to our understanding of the basic competencies for facility manager. The limitation of the research derives, not involve all polytechnics in Malaysia. Thus the findings do not mean that it is suitable for all polytechnic, but the only polytechnic involved in that research. This research need to be continued in order to prove the element of competencies towards facility manager adoption. Therefore, it is suggested that further study is warranted in this area.

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