A knowledge management model for enhancing quality and performance of higher education institutions: insights from Oman

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Abstract: The quality and performance of higher education institutions (HEIs) are crucial to the success of HEIs in the short and long run. In this paper, a knowledge management (KM) model for HEIs is developed and proposed as an appraising mechanism that can be used to identify and monitor the quality and performance areas that are important to HEIs. The conceptualisation and operationalisation of the KM model is also articulated extensively in this paper and tested rigorously using a sample of HEIs in the form of College of Applied Sciences (CASs) in Oman. The findings from the study, which produces important implications for the Ministry of Higher Education (MoHE) as well as for HEIs, generally supports the KM model as an appraising mechanism for identifying and monitoring the quality and performance of HEIs.

Keywords: performance measurements; knowledge management; modelling; repeated measures.

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1 Introduction

Since early in the 21st century, the quality and performance of higher education institutions (HEIs) has become one of the societal issues and norms which are highly related and are representative of the main concern and attention of HEIs because of their

function in creation, acquisition, modification, storage, usage and dissemination of knowledge (Lyu et al., 2016; Kherbouche and Megnounif, 2016; Chiu and Chen, 2016; Plan, 2015).

Without any doubt the institutions are extremely and substantially engaged in knowledge management (KM), and thus have been recognised as knowledge-based organisations because of the role played by these institutions in interpretation, creation and dissemination of knowledge, and in their routine knowledge practices regarding students, academic staff, teaching and learning, research, …, etc. (Malik, 2005; Martina et al., 2007, 2012; Pinto, 2014; Chiu and Chen, 2016; Kherbouche and Megnounif, 2016; Gonzalez and Martins, 2017).

Institutions are supposed to manage knowledge, but because of the different types and levels of knowledge, they cannot fulfil this aim totally. In order to enhance the institutional performance and to achieve the institutional goals, the techniques of KM are applied to allow the institutions to manage the knowledge, related processes, and knowledge assets (Chiu and Chen, 2016).

Although it is very important to apply KM models in each institution for utilising the above benefits (ibid), there are many challenges/reasons why this is not always possible. Some of these challenges are: 'extended demand of students to higher education', 'the under-preparedness of students for entry into the labour force', 'the shortage of educational services and resources due to limited public funding', 'ineffective governance', 'dependence on tuition fees' (Al-Hemyari and Al-Sarmi, 2015). These challenges, which are faced by most institutions in developing countries, are the reasons for not implementing the KM techniques and thus preventing these institutions from attaining high achievement of quality and excellence.

In order to reduce the effect of the above dilemmas and improve the institutional performance and quality, HEIs as knowledge-based organisations need to manage their resources, processes and output, and propose a theoretical performance model to improve their quality which is to include any related activities (Lyu et al., 2016; Kherbouche and Megnounif, 2016; Chiu and Chen, 2016). In conclusion, it is necessary to reduce the effect of the above problems and essential to fill this gap by including all the activities and processes of HEIs in any framework/model, applied/proposed for institutional performance, because the activities and processes with other factors of any institution constitute the elements of its performance.

Despite the fact that the level of research done and the amount of money paid in improving the quality and performance of HEIs using KM techniques, and the good results which have been gained by such in developed countries, and despite there having been good efforts made by the national bodies of developing countries for HEIs, the corresponding results gained were still insignificant (Yih-Tong and Scott, 2003; Al-Khouri, 2014; Manatos et al., 2015; Ojo, 2016; Lyu et al., 2016). Thus, the gap of the KM modelling literature in HEIs of developing countries has to be filled, and one of the ways is by proposing integrated KM models which are to be implemented for assessing the institutional performance.

Furthermore, the literature in KM modelling of HEIs shows that the existing (practical and theoretical) frameworks/models of institutional performance in general and specifically in developing countries are few and ad hoc, and, not being comprehensive, fail to include robust indicators (Draper and Gittoes, 2004; Kaplan, 2010; Parmenter, 2007; Al-Sarmi and Al-Hemyari, 2014; Dickel and de Moura, 2016; Al-Hemyari and Al-Humairi, 2017).

In addition, the issue of implementing robust indicators in KM models "is not only important but also necessary for the methodology of constructing the indicators in order to make them be sound and applicable" [Al-Sarmi and Al-Hemyari, (2014), p.286]. Thus, aligning good indicators in KM categories, i.e., with good properties is required "for different reasons such as to assure that they measure the variables trustworthily, to estimate the unknown parameters efficiently, to be able to deal with any type of data actively, and finally to confirm that the behaviour of the measures is regular" (ibid).

Moreover, integrating KM models in HEIs will improve the environment and performance of HEIs and create successful national and international competitive positions (Robson et al., 2003; Shamizanjani et al., 2013; Malik, 2005; Ojo, 2016; Alosaim, 2018; Kumaravel and Vikkraman, 2018). On the other hand, the above gaps and deficiencies in the literature show the need for this research.

Thus, the general purpose of this paper is to fill the above gaps of KM modelling in the literature of HEIs by developing a KM guidance/model for measuring and enhancing the quality and performance of institutions by inclusion of most of the resources, processes and output of institutions and transforming these resources, processes and output into good indicators.

At the same time it is well recognised throughout the world that the issue of measuring the organisational performance is essential and has a pivotal role in KM as it can help the organisation by supplying forms of evidence in the evaluation and controlling of the processes of KM, and then it can help in the problem of how to improve the organisational performance (Al-Hemyari and Al-Sarmi, 2018; Oufkir et al., 2017; Kherbouche and Megnounif, 2016; Lyu et al., 2016; Kuah and Wong, 2011, Kok, 2007).

In addition, Dickel and de Moura (2016) have shared the above authors' opinions by their statement: "the process of performance measurement is considered one of the key elements of strategic management, being able to identify the gap between the current situation of an organization and the level of excellence to be considered, by proposing goals that are aligned with strategic planning and the use of indicators" (p.212).

To be more specific, and thus to concentrate on the Omani HEIs, and in order to develop the sector and achieve the goals of the sector and institutions, the limitations which preclude the achievement of the above purposes have to be addressed and treated. The Education Strategy – 2040 (2014) of the Education Council of Oman has explained several limitations of the sector and organised the limitations into five categories and so has developed policies and several recommendations for each category.

The strategy shows that the limitations regarding the requirements of applying effective KM practices are many, so for space considerations we will demonstrate only three of them in this section – they are as follows:

- the higher education sector should be oriented and based on strategical planning
- in order to propose and implement the efficient educational policies, they should be based on facts – the accurate information and statistical indicators (p.10)
- developing techniques, criteria and indicators to assess the performance of academic staff of institutions (p.12).

Thus, the importance of the topic of this paper comes from the national needs as well as international standpoints in regard to filling the gaps in KM modelling literature in higher

education. The paper is intended to provide a theoretical KM guide to HEIs on how to manage their activities and how to align good indicators to these activities and how they are to be implemented in order to achieve greater coherence in issues of accountability and transparency. It is also intended to contribute to the science of KM of HEIs, and to review the results of the proposed KM guidance.

The objectives of this paper are clarified as follows (to):

1 explain the importance of the research, give expression of need, and formulate the research questions

2 propose a KM guidance for developing and aligning the indicators in accordance to the topology of KM factors, KM functions, 'customer satisfaction' and the 'product direction'

3 explore the practical results of one of the KM practices of the College of Applied Sciences (CASs)

4 examine the significance of the results.

The scope of the research is restricted to the private HEIs and the governmental HEIs under the general guidance of the 'Ministry of Higher Education' (MoHE) – namely, the CASs. This article contains eight sections; the Section 1 is an introduction of the topic. Section 2 reviews the literature, and Sections 3 and 4 explain the research questions and the possible uses and purposes of indicators respectively. In Section 5, the KM development process, methodology and research methods are reviewed. Section 6 explains the application of the KM guidance. Sections 7 and 8 are assigned for the findings and conclusions respectively.

Table 1 Literature on KM streams (principles, models and indicators)

Author	*Streams*	*Subjects*
Kidwell et al. (2000)	Principles	Explained the differences between the types of explicit and implicit knowledge in HEIs.
Rowley (2000)	Principles	Proposed that HEIs have to use their KM activities to enhance their knowledge assets and intellectual capital.
Malik (2005)	Principles	Discussed how KM can help students to achieve their educational goals.
King (2009)	Principles	Concluded that KM aims to improve the various organisational behaviour and organisational performance.
Brewer and Brewer (2010)	KM models	Proposed a KM model which incorporated the human resource and knowledge learning for assessing goals.
Zaki and Zubairi (2012)	KM models	Developed a theoretical KM framework by incorporating some new quality indicators for Pakistani institutions.
Savitri et al. (2013)	KM models	Studied the level of implementing KM models in HEIs in the area of Bandung, Indonesia.
Pinto (2014)	KM models	Presented a framework to improve KM of institutions in Portugal.
Ojo (2016)	KM models	Proposed a theoretical KM model for implementation in institutions in Nigeria for improving their performance.
Lyu et al. (2016)	KM models	Studied the feasibility of the technique of balanced scorecard (BSC) in enterprises' performances.

Table 1 Literature on KM streams (principles, models and indicators) (continued)

Author	*Streams*	*Subjects*
Chiu and Chen (2016)	KM models	Studied the relationship between knowledge management and organisational effectiveness in Taiwan.
Kherbouche and Megnounif (2016)	KM models	Proposed a KM model based on inputs, a KM process and organisational performance. However, the empirical part of the model has not yet been published.
Gonzalez and Martins (2017)	KM models	Reviewed and classified 71 published papers from 25 different journals in terms of the processes of KM.
OECD (2002)	Indicators for the KM	Developed indicators for the KM practices for institutions uses.
Moor and Smits (2002)	Indicators for the KM	Proposed nine ad hoc indicators for different types of Knowledge.
Lee et al. (2005)	Indicators for the KM	Developed a new measure based on several types of knowledge processes.
Kok (2007)	Indicators for the KM	Proposed several ad hoc indicators for the KM initiatives in the HEIs of South Africa.
Minonne and Turner (2009)	Indicators for the KM	Achieved a model based on 12 known indicators, to evaluate the performance of KM in organisations.
Kuah and Wong (2011)	Indicators for the KM	Reviewed different studies and the indicators used on performance measurement of organisations.
Baban and Baban (2013)	Indicators for the KM	Identified five criteria for the KM performance measurement in a Romanian institution.
Dickel and de Moura (2016)	Indicators for the KM	Developed a model based on 17 indicators, in order to measure the organisational performance.

2 Review of literature

Several studies on KM streams (principles, model sand indicators) have been published in the last few decades. Examples of the literature of KM are given in Table 1.

3 Research questions

The purposes, aims and objectives of this paper will formulate the following main question:

How are and should robust indicators be aligned with KM categories in a proposed KM model/guidance, where the purpose of modelling is to assess the performance and quality of HEIs in Oman?

The above main research question and related bases tend to consider a number of secondary research questions. The secondary research questions are given below:

1 What are the possible uses of performance indicators in KM technique in the MoHE?

2 What are the problems and factors that impact on the development of the indicators for assessing HEIs in Oman?

3 How can they align with the topology of KM factors, KM functions, customer satisfaction and the product direction?

4 What are the results of the forms of implementation of the KM practices of the MoHE?

5 What is the level of significance of the results of the KM practices?

4 The possible uses and purposes of indicators in KM techniques

In order to answer the first secondary question which is related to the importance of the indicators in KM techniques, we need to restate and review further questions as to why the KM technique based on indicators is preferred over other models and what the possible uses of the indicators in any of the HEIs might be.

In order to compare between different institutions, to study the level of achieving institutional goals and to find the problems/obstacles which prevent the institutions from achieving their goals, and high performance and quality, studying methods and ways of evaluating the performance and quality of HEIs using efficient tools have to be developed.

Measuring the achievement and improvement of any institution is not an essay task. In addition, optimising and managing the intellectual resources is one of the main operators affecting the issue of creating the high levels of achievements and improvements. In order to signify and economise on the intellectual resources and to assess the level of achievement and improvement of any institution, a suitable approach/technique has to be identified – "specify exactly what the measurement models are, which the best are and which are appropriate for the organization to choose for measuring its assets in a proper way" (see Adenike, 2011; Gogan, 2014; Al-Sarmi and Al-Hemyari, 2014; Al-Hemyari and Al-Sarmi, 2016a; 2017, 2018).

The KM technique based on performance indicators is preferred over other approaches because "performance indicators provide objective evidence that an intended change is occurring" [Britan, (2010), p.2] and is intended to be followed.

In fact, the process of developing indicators of KM practice has several limitations and problems if the indicators are on an ad hoc basis. Contrariwise, if it is carefully and rationally developed and accurately measured by one of the most well-known of approaches that allow institutions to optimise and manage their intellectual resources and to measure their achievements and improvements efficiently, then the limitations will vanish, and the efficiency of the technique and the accuracy of the results will be increased (see Akiyoshi and Kaiser, 2003; Parmenter, 2007; Franceschini, et al., 2008; Al-Sarmi and Al-Hemyari, 2014 and Al-Hemyari and Al-Sarmi, 2016a, 2018).

The benefits of aligning the performance indicators in KM models and applying KM models for quality assessment in HEIs are many (Dickel and de Moura, 2016), and "it is well known that there are many purposes of quality assessment in HEIs. Some of them are: to improve the input, processes and the output of HEIs as well as to inform the society about the level of accomplishing their goals and objectives" (Al-Hemyari and Al-Sarmi, 2016a).

Numerous papers have studied this issue, proposed and implemented several indicators in institutions and highlighted the features and benefits of using them in HEIs. Indicators can be used for many purposes such as:

1 'providing reliable information to the stakeholders in respect of the nature of the HEIs and their performance'

2 'allowing comparisons to be made between individual universities/colleges of a similar nature'

3 'informing the government on the policy developments in higher education, marketing, and manpower planning'

4 'enabling universities/colleges to benchmark their own performance'

5 'providing students with the ability to choose their institution of preference based upon a flexibility in entry procedures and about the type of education they desire, i.e., full time/part time'

6 'enabling the institutions to provide the internal quality management'

7 'informing the industry, technology and research councils on how to distribute research funds' (ibid).

5 The KM development process/methodology and research methods

The purpose of this section is to study and treat the gaps and issues that emerged from the literature review of Sections 1 and 2, i.e., what the problems and challenges of developing accurate and useful indicators of the KM components of HEIs are and how to avoid them (which represent the content of secondary questions 2 and 3).

5.1 The methodology/indicators development process

In general, most of the KM models implemented in HEIs comprised the three main components – input, process and output (see Kherbouche and Megnounif, 2016; Dimitrios et al., 2015; Córcoles and Vanderdonckt, 2013; Pee and Kankanhalli, 2009). It is really remarkable that the proposed model of Kherbouche and Megnounif (2016), based on a systemic approach and extensive review of the literature, and comprising the same above components, are more suited to KM concepts, and, being so, provides very specific institutional terms of input, process and output.

In addition, the input (KM factors) is categorised to academic knowledge, organisational knowledge, external knowledge and technical knowledge. The processes (KM functions) are categorised to acquire knowledge, capitalise knowledge, diffuse knowledge and use knowledge. Finally, the third component is categorised to customer satisfaction (quality of services and quality of environment), organisational excellence and product direction (ibid, p.7). It may be useful to mention that in this paper the above classification input, process and output has to be followed.

On the basis of the concept of performance measurements in HEIs and their role and responsibility, the MoHE, has developed and implemented several practices of studying the performance and quality of HEIs through the proposed methodology of this paper of aligning the indicators to the KM components of HEIs.

The characteristics (clarity, validity, reliability, feasibility) and fundamental bases of developing the indicators (see Al-Hemyari and Al-Sarmi, 2018; Al-Sarmi and

Al-Hemyari, 2014; Britan, 2010) were followed and the process of developing and aligning the indicators to the KM components were outlined through a six main stage model whereby each main step was incorporated with several tasks.

Because of the limited national practices and the nature of the institutions in Oman, that of the KM guidance process tends to be a very long process and, as it is considered as academic research, was included in the six main stage, each stage involving in particular issues which were translated to several secondary steps: these steps are summarised in Table 2.

Table 2 The six main stage of the methodology

Stages	*Issues*	*Actions/tasks/sub stages*
1	Project requirements	Designating the project committee; determining the requirements and resources; approving the timeframe and examining the previous related national and international studies and practices; and plans and polices.
2	Responsibilities and operational action plan	Identifying the responsibilities of the MoHE which have to be categorised under the streams of KM and, translating the operational action plan into clear and measurable indicators under the streams of KM guidance.
3	Characteristics of streams/indicators	Developing the standards, studying the characteristics of importance, accuracy, … of the streams/indicators and revising the proposal.
4	Tools and methods	Designing the data collection tools, forms, surveys and data policies and proposing the statistical tests and measures.
5	Piloting the study	Piloting the proposal.
6	Implementation the KM guidance	Collecting, storing and editing the data and calculating, analysing, screening and reporting the results.

5.2 The research methods

In this section, the tools for the accuracy of collected data, measures to be used in analysing the data and methods of testing the final results are to be discussed.

In this paper, the ratios, maximum and minimum values, and the averages, are the measures used to analyse the data. The measures of Cronbach's alpha reliability, split-half reliability and Cronbach's alpha – if items deleted are to be used to study the consistency of data collection – are included. The one-sample t-test, two independent sample t-tests, correlation coefficient and several multivariate tests of repeated measures are to be applied to study the accuracy of the final results.

It may worth mentioning that several sets of indicators were refined, discussed, aligned with KM components and implemented in different projects with private and government institutions, where each project has been applied in different years and for different purposes and indicators. But these practices can be considered as special cases of the proposed methodology of this paper. Also, these practices along with the new one have also been applied and utilised in our routine work – i.e., in planning and decision making, in assessing employees, department and institutions (see Al-Hemyari and Al-Sarmi, 2015; 2016a; 2017, 2018).

6 Application

In order to answer the fourth and fifth secondary questions, the population and samples, data collecting and accuracy of collected data have to be discussed.

6.1 Population and sample

The total size of the population of the CASs is 5,723 (5,095 students and 628 academic staff). For the problem of implementing the surveys, a sample of a size of 960 units (748 students and 212 academic staff) were taken randomly and proportionally (about 17%) from each institution and given in Table 3.

Table 3 The distribution of the sample of each institution (CASs)

CASs	*Academic staff*	*Students*	*Total*	*Percentage*
1 Sohar	33	89	122	12.7%
2 Ibri	30	114	144	15%
3 Nizwa	40	153	193	20.2%
4 Rustaq	43	173	216	22.6%
5 Salalah	36	120	156	16.2%
6 Sur	30	99	129	13.4%
Total	212	748	960	16.8%

6.2 Consistency/stability of the surveys

In order to collect the data for the KM practice, i.e., the 32 indicators regarding operational excellence (excellence in teaching and learning), management excellence, opining excellence (internationalisation), partnership with the socio-economic world and the product direction, given in Table 6; the data forms and the surveys are to be used as tools to collect the data for the quantitative and qualitative indicators respectively. It may be noted here, that the data forms were designed and distributed to institutions; and the surveys were designed and studied by Al-Hemyari and Al-Sarmi (2015, 2016b) and applied for assessing the qualitative indicators of the CASs.

Table 4 Reliability (ρ) for some items (student survey)

Item	ρ	*Item*	ρ	*Item*	ρ	*Item*	ρ	*Item*	ρ
1	.952	9	.951	17	.954	25	.945	33	.954
2	.952	10	.955	18	.954	26	.943	34	.954
3	.947	11	.951	19	.953	27	.951	35	.943
4	.951	12	.958	20	.954	28	.953	36	.945
5	.951	13	.954	21	.952	29	.945	37	.945
6	.953	14	.954	22	.953	30	.956	38	.945
7	.958	15	.955	23	.951	31	.953	39	.946
8	.956	16	.957	24	.953	32	.952	40	.947

The data forms were distributed to the CASsto obtain the self-reported data, and the surveys which were also implemented online in the CASs were for the purposes of obtaining the data for the other qualitative indicators.

The surveys were developed and revised and several measures of the survey were applied and studied (for more details please refer to Al-Hemyari and Al-Sarmi, 2016b). The reliability measure (ρ) of the surveys for the student survey and the academic staff survey were 0.970 and 0.951 respectively. For space consideration, few of the measures for some items of the surveys are given in Tables 4 and 5.

Table 5 Reliability (ρ) for some items (academic staff survey)

Item	ρ	*Item*	ρ	*Item*	ρ	*Item*	ρ	*Item*	ρ
1	.879	9	.880	17	.862	25	.856	33	.864
2	.879	10	.879	18	.880	26	.859	34	.858
3	.871	11	.878	19	.890	27	.854	35	.862
4	.881	12	.879	20	.879	28	.855	36	.863
5	.876	13	.881	21	.868	29	.847	37	.856
6	.883	14	.880	22	.879	30	.865	38	.847
7	.872	15	.879	23	.855	31	.864	39	.856
8	.885	16	.874	24	.858	32	.864	40	.850

6.3 Accuracy of collected data

The data of this KM application is collected from CASs using the forms and surveys, and measured by applying several measures based on the Likert-type scale. In such circumstances, one should address and study the level of accuracy of data collected, which the efficiency of estimation of the indicators are completely based on.

The measure of Cronbach's alpha reliability is to be estimated, it is based on the ratio of the true variance to the total variance (or Pearson covariance matrix) (ibid) which is the plethora used for this purpose. The Cronbach's alpha, if the item is deleted, and Guttman split-half coefficient (to estimate the average correlation between the two parts of the data if the data can be portioned to two parts) are also to be estimated. The results of these measures are given in this section.

It is observed from the result of this test that the estimated Cronbach's alpha is equal to .924, which is very high and much closer to the theoretical standardised value (.930). These results show good levels of internal consistency. In order to find any non-significant data of any indicator, the measures of Cronbach's alpha would have to be taken into account, and if items which were deleted were estimated, then a greater level of consistency could be attained.

The estimated values of Cronbach's alpha, if the item is deleted, belong to .918 to .925 which shows a non-significant improvement in the case of any indicator having to be deleted. Therefore, no additional action is needed to be taken. The estimated values of correlation between forms and Guttman split-half coefficient are where both measures are high and equal to .932 and .952 respectively. It may be concluded that the collected data of the indicators has a high level of data accuracy.

Table 6 KM components (C), indicators and results of fifth practice (CASs)

KMC		*Codes/indicators*	*Max.*	*Min.*	*Ave*
Operational excellence/excellence in teaching and learning	1	Coursework	74%	61%	70%
	2	The level of student capability	79%	61%	72%
	3	The quality of teaching methods	87%	68%	74%
	4	The quality of assessment strategies	74%	64%	71%
	5	Perceived teaching quality	72%	51%	65%
	6	The quality of programs	78%	60%	69%
	7	Quality of academic departments	75%	53%	67%
	8	The average teaching load	15	10	12
	9	The average class size	35	15	22.3
	10	The student-instructor ratio	28	10	16.5
	11	The percentage of PhD holders	39.7%	13.8%	25.2%
	12	Percentage of professors and associate professors	5.3%	2.5%	3.8%
	13	Student satisfaction	79%	58%	69%
	14	Academic staff satisfaction	89%	62%	76%
	15	Student participation and engagement	65%	55%	63%
	16	Academic staff participation and engagement	78%	56%	69%
Operational excellence/management excellence	17	The quality of information and communication technologies	64%	56%	62%
	18	The quality of institutional facilities	74%	59%	67%
	19	The clarifying of institutional strategies	79%	75%	77.6%
	20	The professional developments/training programs for academic staff	89%	65%	80.24%
	21	The performance of executives	88%	81%	86%
	22	The performance of heads of academic departments	76%	59%	70%
	23	The performance of registrars/registration offices	72%	61%	66%
	24	The quality of academic advising	71%	48%	63%
	25	The level of communicating the rules and regulations	87%	58%	77.32%
	26	The level of interaction between students and academic staff	68%	60%	66%
Operational excellence/opining excellence/internationalisation	27	International conferences/workshops participated in by academic staff	40%	4.9%	2.47%
	28	The ratio of academic staff engagement in international professional associations and in editorial committees of international journals	33%	22%	28%
Operational excellence/partnership with socio-economic world	29	The level of participation in community activities	52%	41%	48%
The product direction	30	Research ratio	16.1%	2.9%	9.6%
	31	Research capability of executives	29%	23%	26%
	32	The level of gaining the skills and attributes of graduates	78%	64%	73%

7 Findings

In order to answer the fourth and fifth secondary questions, the results of the applications of KM in the MoHE and how they are effective and significant have to be explained in this section. In addition, several statistical tests were performed using the IBM SPSS software-23 to show the significance of the results obtained.

7.1 Actual results

In fact, the results of this KM application are given in Table 6, where the given indicators were applied in two past different projects of the MoHE. The results of the past practices of PHEIs were published in two papers (see Al-Hemyari and Al-Samri, 2015; 2017) and are to be compared with the results of the new practice, i.e., this paper regarding the CASs – and which are shown in Table 6. For space consideration, only the final results of the 27 qualitative and six quantitative indicators (based on self-reported data) are given in Table 6. The following results are obtained from Table 6 and to be compared with the results of the related practice of PHEIs (see Table A1).

1 The performance of the given indicators of the CASs could be arranged into four groups on the basis of the actual performance given in Table 6. The first category: {below average: indicators with sequences 27, 28, 30, 31}, the second category: {are average and above average: indicators with sequences 2, 3, 5–7, 9–12, 17–19, 23–26}, the third category: {good: indicators with sequences 1, 4, 16, 20, 22, 32} and the fourth category: {very good: indicators with sequences 8, 21}.

2 In general, the performance of most of the indicators of CASs is better than the performance of PHEIs with the same indicators except for the indicators 18, 21, 22 and 23.

Remark 1: The definitions of the indicators of Table 6 are given in Al-Hemyari and Al-Sarmi (2015, 2017). It may be remarked here that all the indicators of Table 6 were based on surveys and measured by Likert-type scales (see Al-Hemyari and Al-Sarmi, 2016b). In order to compare the results of CASs with results of PHEIs (Table A1), the original Likert scales which were given in the surveys, have to be transformed to equivalent Likert scales of percentages (except three scales) and developed in Table 7.

Table 7 Equivalent scales of the indicators

Codes	*Equivalent scales*
1	$\{1 < .55, .55 \leq 2 < .65, .65 \leq 3 < .75, .75 \leq 4 < .85, 5 \geq .85\}$
2	$\{1 < .50, .50 \leq 2 < .60, .60 \leq 3 < .70, .70 \leq 4 < .80, 5 \geq .80\}$
3	$\{1 < .55, .55 \leq 2 < .65, .65 \leq 3 < .75, .75 \leq 4 < .85, 5 \geq .85\}$
4	$\{1 < .55, .55 \leq 2 < .65, .65 \leq 3 < .75, .75 \leq 4 < .85, 5 \geq .85\}$
5	$\{1 < .50, .50 \leq 2 < .60, .60 \leq 3 < .70, .70 \leq 4 < .80, 5 \geq .80\}$
6	$\{1 < .55, .55 \leq 2 < .65, .65 \leq 3 < .75, .75 \leq 4 < .85, 5 \geq .85\}$
7	$\{1 < .55, .55 \leq 2 < .65, .65 \leq 3 < .75, .75 \leq 4 < .85, 5 \geq .85\}$
8	$\{1 > 21, 18 < 2 \leq 21, 15 < 3 \leq 18, 12 < 4 \leq 15, 5 \leq 12\}$
9	$\{1 \geq 51, 41 \leq 2 < 51, 31 \leq 3 < 41, 21 \leq 4 < 31, 5 \leq 20\}$

Table 7 Equivalent scales of the indicators (continued)

Codes	*Equivalent scales*
10	{1 ≥ 51, 41 ≤ 2 < 51, 31 ≤ 3 < 41, 21 ≤ 4 < 31, 5 ≤ 20}
11	{1 < .45, .45 ≤ 2 < .55, .55 ≤ 3 < .65, .65 ≤ 4 < .75, 5 ≥ .75}
12	{1 < .20, .20 ≤ 2 < .30, .30 ≤ 3 < .40, 40 ≤ 4 < .50, 5 ≥ .50}
13	{1 < .55, .55 ≤ 2 < .65, .65 ≤ 3 < .75, .75 ≤ 4 < .85, 5 ≥ .85}
14	{1 < .60, .60 ≤ 2 < .70, .70 ≤ 3 < .80, .80 ≤ 4 < .90, 5 ≥ .90}
15	{1 < .50, .50 ≤ 2 < .60, .60 ≤ 3 < .70, .70 ≤ 4 < .80, 5 ≥ .80}
16	{1 < .55, .55 ≤ 2 < .65, .65 ≤ 3 < .75, .75 ≤ 4 < .85, 5 ≥ .85}
17	{1 < .60, .60 ≤ 2 < .70, .70 ≤ 3 < .80, .80 ≤ 4 < .90, 5 ≥ .90}
18	{1 < .60, .60 ≤ 2 < .70, .70 ≤ 3 < .80, .80 ≤ 4 < .90, 5 ≥ .90}
19	{1 < .45, .45 ≤ 2 < .55, .55 ≤ 3 < .65, .65 ≤ 4 < .75, 5 ≥ .75}
20	{1 < .60, .60 ≤ 2 < .70, .70 ≤ 3 < .80, .80 ≤ 4 < .90, 5 ≥ .90}
21	{1 < .50, .50 ≤ 2 < .60, .60 ≤ 3 < .70, .70 ≤ 4 < .80, 5 ≥ .80}
22	{1 < .60, .60 ≤ 2 < .70, .70 ≤ 3 < .80, .80 ≤ 4 < .90, 5 ≥ .90}
23	{1 < .60, .60 ≤ 2 < .70, .70 ≤ 3 < .80, .80 ≤ 4 < .90, 5 ≥ .90}
24	{1 < .60, .60 ≤ 2 < .70, .70 ≤ 3 < .80, .80 ≤ 4 < .90, 5 ≥ .90}
25	{1 < .65, .65 ≤ 2 < .75, .75 ≤ 3 < .85, .85 ≤ 4 < .95, 5 ≥ .95}
26	{1 < .50, .50 ≤ 2 < .60, .60 ≤ 3 < .70, .70 ≤ 4 < .80, 5 ≥ .80}
27	{1 < .10, .10 ≤ 2 < .15, .15 ≤ 3 < .20, .20 ≤ 4 < .25, 5 ≥ .25}
28	{1 < .4, .4 ≤ 2 < .6, .6 ≤ 3 < .80, .8 ≤ 4 < .10, 5 ≥ .10}
29	{1 < .20, .20 ≤ 2 < .25, .25 ≤ 3 < .0, .30 ≤ 4 < .35, 5 ≤ .35}
30	{1 < .20, .20 ≤ 2 < .03, .30 ≤ 3 < .4, .4 ≤ 4 < .50, 5 ≥ .50}
31	{1 < .4, .4 ≤ 2 < .6, .6 ≤ 3 < .8, .8 ≤ 41 < .0, 51 ≥ .0}
32	{1 < .50, .50 ≤ 2 < .60, .60 ≤ 3 < .70, .70 ≤ 4 < .80, 5 ≥ .80}

7.2 The statistical tests

In this section, several statistical tests were developed using the IBM SPSS software-23 to show the significance of the results obtained.

1 T-test

For the problem of testing the significance of the results of each type of institution, the two-sided T-tests have to be performed and given by: H_0: $\mu_i = 0$ against H_1: $\mu_i \neq 0$ where $i = 1, 2$, μ_1 and μ_2 represents the means of first (CASs) and second (PHEIs) groups. The results of the significance values of two-sided t-tests for each variable (type of institution) are equal and equal to 0.000 which shows that there are significant differences between the results of each of the CASs.

2 Pearson correlation

The second important measure that needs to be performed is the Pearson correlation coefficient for estimating the correlation between the results of the two types of institution. The hypothesis for this measure is given by: H_0: $\rho = 0$ against H_1: $\rho \neq 0$. The result of this test is highly significant (significance value equals to 0.000) and strong linear relationship (.981) between the results of CASs and PHEIs.

3 The repeated measures ANOVA

In order to examine the practical results of Table 6, correct, simple and suitable tests need to be designed. In fact, the data of Table 6 is given in terms of average, maximum and minimum values of each indicator and for two types of institution. This means that the data is almost similar to the repeated measures designs under three different statuses (variables). In addition, the analyses should be concerned with testing the differences of the repeated measures.

In statistics, there are several well-known repeated measures designs which are powerful and accurate. Some of these are complex designs that can analyse the repeated measures, and others are simple, but all of them are equivalent and accurate. Throughout these designs, we will show preference for and application of the most well-known and simple design which is called the repeated measures ANOVA. In fact, this design is an extension to one-way ANOVA, but it is appropriate for the conditions of related but not independent treatments, and, at the same time, the power of this test is much more than other tests (see Field, 2013; Girden, 1992).

In repeated measures ANOVA, we need to perform a multivariate test to the hypothesis: H_0: $\mu_{1i} = \mu_{2i}$ against H_1: $\mu_{1i} \neq \mu_{2i}$, $i = 1, 2, 3$, where μ_{1i} and μ_{2i} represents the means of first (CASs) and second (PHEIs) groups. In terms of this test we have two variables, the first variable is called factor1 and is composed of three dependent variables (three statuses), and the second is denoted by var2 (with two values) and represents CASs and PHEIs. Running the repeated measures ANOVA test supplies the following results of four multivariate tests (Table 8).

It was important to clarify that the last column of Table 8 shows that the sig. (significance) values of all the four multivariate tests are less than 0.05, which means that there is statistical significance between factor1 and a statistical significant interaction between the three dependent variables (three statuses) and the types of institutions (var2).

In order to complete the analysis, the test of the homogeneity of variance assumption test needs to be employed for factor1 (the repeated-measures dependent variable) using the same software. Running Mauchly's test of sphericity to the same data provides the sig. value of the test as being 0.000, which means that there is significance, i.e., the assumption of the homogeneity of variance is not correct. This test shows that the four multivariate tests of Table 8 are not fitted for analysing this data and need to be appropriately adjusted on the basis of the Epsilon values of the same table. In this case, the revised test which is based on another four multivariate tests of within-subjects effects have to be run.

Table 8 The multivariate tests (repeated measures ANOVA)

Effect		*Value*	*F*	*df*	*Error df*	*Sig.*
factor1	Pillai's trace	.752	92.501	2.000	61.000	.000
	Wilks' lambda	.248	92.501	2.000	61.000	.000
	Hotelling's trace	3.033	92.501	2.000	61.000	.000
	Roy's largest root	3.033	92.501	2.000	61.000	.000
factor1 * var2	Pillai's trace	.131	4.592	2.000	61.000	.014
	Wilks' lambda	.869	4.592	2.000	61.000	.014
	Hotelling's trace	.151	4.592	2.000	61.000	.014
	Roy's largest root	.151	4.592	2.000	61.000	.014

Running the revised multivariate tests of within-subjects effects to the same data, provide the results of Table 9. Table 9 shows that the sig. (significance) values of all the four multivariate tests are less than 0.05, which means that there is statistical significance between factor1 and statistical significant interaction between the three dependent variables (three statuses) and the types of institutions (var2).

Tables 6 of the practical results have been accommodated to present the performance of CASs and provide a clear sighting to the level of quality of achieving the indicators and essential comparisons between CASs. In addition, the statistical tests of the practical results (Section 7.2) of the quality and performance indicate that they are true/significant and effective.

Table 9 The revised multivariate tests of within-subjects effects

Source		*Sum of squares*	*df*	*Mean square*	*F*	*Sig.*
factor1	Sphericity assumed	10,194.278	2	5,097.139	173.407	.000
	Greenhouse-Geisser	10,194.278	1.159	8,795.862	173.407	.000
	Huynh-Feldt	10,194.278	1.186	8,593.412	173.407	.000
	Lower-bound	10,194.278	1.000	10,194.278	173.407	.000
factor1 * var2	Sphericity assumed	499.549	2	249.774	8.497	.000
	Greenhouse-Geisser	499.549	1.159	431.022	8.497	.003
	Huynh-Feldt	499.549	1.186	421.102	8.497	.003
	Lower-bound	499.549	1.000	499.549	8.497	.005

8 Conclusions

8.1 Summary of the results

In this paper, a number of important problems, dilemmas and challenges affecting most of the developing countries including Oman were reviewed. Several gaps and deficiencies in the literature of KM modelling in HEIs were discussed, which constituted the goal of this paper. A detailed discussion of the purposes, aims and the scope of the research, objectives and major and secondary research questions, which addressed the issue of developing a KM model through aligning good indicators in KM categories was given. The methodology of developing a KM model is discussed and several practices of the model within the Ministry were summarised. The paper presents the results of a new practice of the ministry with several statistical tests having been subsequently performed to examine these results.

The main research question is divided into five secondary questions. The secondary research questions were examined and answered through different sections. The discussion shows that there are several important uses of indicators in KM practices in higher education. Among these benefits, the practices show that the results of indicators were used to compare between different institutions, to study the level of achieving institutional goals and to find the problems/obstacles which prevent the institutions from achieving their goals. These practices have also been applied and utilised in our routine work – i.e., in planning and decision making, in assessing employees, department and institutions.

Also, the literature shows that most of the indicators used in measuring the performance of institutions are ad hoc indicators and not aligned with KM categories; at the same time the proposed methodology was based on developing robust indicators in the sense of providing the desired statistical properties of the indicators; and aligning the indicators with KM categories through a six main stage.

The study reveals that the KM practices of the MoHE are important and accurate tools in monitoring and evaluating the institutional-wide critical streams of activity/responsibilities to be adhered to and fulfilled by HEIs of each institution.

The practical results of implementing the KM practice in six institutions were demonstrated, compared and examined. The practical results as presented in Section 7 show that the performance of CASs is comparable and generally better than that of private institutions. Moreover, the results of this paper ought to be taken seriously as they provide a clear overview of the performance of institutions regarding the given indicators and serve to assist the executives of institutions in creating an effective teaching environment.

Several statistical tests the Cronbach's alpha, Cronbach's alpha if the item is deleted, Guttman split-half coefficient, two-sided T-test, Pearson correlation coefficient and two tests of repeated measures (ANOVA) were performed to assess the accuracy of the process of data collection and to test the significance of the practical results. The results of these tests were given, and they show that the results are accurate and highly significant.

It may be worth mentioning that this study is an attempt to propose a useful KM model through several processes and KM guidance for evaluating the performance of HEIs and that this guidance is to be implemented in several government and private institutions. At the same time, and for the purposes of getting efficient measures for assessing the institutions, more research following the same direction needs to be undertaken.

8.2 Limitations

It is natural that any framework for the assessment and evaluation of institutions is not without limitations. In order to implement the KM guidance processes and practices proposed in this paper, several types of requirements need to be settled. The first is high levels of cooperation between the academic units of any institution, since the assessing and evaluating processes are multiple – concerning teaching and learning, research, environment, society involvement, internationalisation, …, etc. In addition, academic staff, executives and students are also included in the assessment. Thus, without a high degree of cooperation between academic units and academic staff, executives and students, the process may not be done efficiently.

In fact, there are other challenges that need to be made clear and addressed. The second of these is the need for the assessing and evaluating processes to achieve a greater maturity and improvement, with such processes being applied and their results implemented on an annual basis. In order to implement the assessing and evaluating processes on a yearly basis, the costs required for the implementation of the assessing and evaluating processes would be considerable – the sustainability issue related to the carrying out of these processes would need to be clearly addressed.

Hogg and Hogg (1995) based on vast personal experiences recommended and urged that the "statisticians should be well-acquainted with TQM ideas and philosophies and be

leaders in their worldwide implementation in higher education". Instead of acting upon this recommendation, statisticians have so far failed to assume their proper role in HEIs. That the above recommendation is not deemed as being valid by several institutions is something which is considered as being one of the challenges.

In addition, one of the most important issues that mitigate against the attaining of the institutional goals by the institutions, and thus the achievement of high levels of quality and performance, and the cause of the problem of the delays in supplying the self-reported data from some institutions, which create a long process of data editing, is the quality of employees in quality audit, data collection and analysis departments in institutions, as these employees are not only non-statisticians but people whose capacity to work is limited.

The results of the last KM practice of this paper utilised several qualitative/opinion indicators. For the problem of surveying the respondents accurately (of academic staff and students) in any institution, "the opinions of the respondents have to be neutral and fair, otherwise the responses will be subject to many types of error" (Al-Hemyari and Al-Sarmi, 2015). Otherwise, the results are not fair and sound and thus not trustworthy. This means that the time of applying the surveys should not affect the opinions, and other factors like the effect of institutions/executives; and the issues of confidentiality and privacy of the data should be controlled and addressed by the project executives before their implementation.

8.3 Future directions

The KM models and quality tools and techniques are decisive paths to take in order to achieve a high level of quality in HEIs and to reinforce their academic reputation and prestige. In order to achieve success in the above aims, the future research directions need to be identified. In fact, the future research directions of the KM techniques of HEIs are promising and modern and they have unlimited functions and applications.

Regarding this, the following points offer a few directions:

- HEIs of developing countries should stop running after rankings approaches; rather they should be optimising their resources and controlling their institutional processes.
- At the same time, we need to promote a culture of using KM approaches in input, processes, output and outcomes of institutions, i.e., we need to settle rules and regulations and justify the orientation of the present culture of higher education towards it becoming a culture of quality and standards.
- In order to strengthen the development and implementation of KM approaches in institutions, the impact of this process on the quality of HEIs needs to be studied.

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Appendix

Table A1 KM components (KMC), indicators and results of first practice (PHEIs)

KMC		*Codes/indicators*	*Max.*	*Min.*	*Ave*
Operational excellence/excellence in teaching and learning	1	Coursework	70.83%	57.78%	64.57%
	2	The level of student capability	79.47%	49.67%	64.81%
	3	The quality of teaching methods	80.39%	61.02%	72.73%
	4	The quality of assessment strategies	74%	64%	71%
	5	Perceived teaching quality	66.75%	50.18%	58.21%
	6	The quality of programs	78%	60%	69%
	7	Quality of academic departments	70.89%	42%	57.02%
	8	The average teaching load	20	12	18.5
	9	The average class size	37	18	29
	10	The student-instructor ratio	31	8	19.3
	11	The percentage of PhD holders	64%	0	30.1%
	12	Percentage of professors and associate professors	49%	0%	12%
	13	Student satisfaction	77%	46%	66%
	14	Academic staff satisfaction	88%	56%	74%
	15	Student participation and engagement	64.02%	49.25%	57.8%
	16	Academic staff participation and engagement	72.9%	60.67%	64.78%
Operational excellence/management excellence	17	The quality of information and communication technologies	67.18%	38.47%	53.15%
	18	The quality of institutional facilities	69.74%	51.01%	60.83%
	19	The clarifying of institutional strategies	84.62%	55.5%	73.06%
	20	The professional developments/training programs for academic staff	85.108%	56%	74.29%
	21	The performance of executives	86.57%	55.43%	72.46%
	22	The performance of heads of academic departments	83.19%	35.36%	68.52%
	23	The performance of registrars/registration offices	62.76%	33.06%	41.65%
	24	The quality of academic advising	70.81%	40.8%	59.49%
	25	The level of communicating the rules and regulations	86.57%	55.43%	71.46%
	26	The level of interaction between students and academic staff	63.75%	46.80%	59.14%
Operational excellence/opining excellence/internationalisation	27	International conferences/workshops participated in by academic staff	14%	4%	7%
	28	The ratio of academic staff engagement in international professional associations and in editorial committees of international journals	39%	11%	26%
Operational excellence/partnership with socio-economic world	29	The level of participation in community activities	54.34%	31.01%	44.29%
The product direction	30	Research ratio	70%	0%	18%
	31	Research capability of executives	25%	10%	17%
	32	The level of gaining the skills and attributes of graduates	82.66%	59.05%	68.02%