A Framework of Indicators for Measuring Performance of Higher Education Colleges

Abdulmajied Ali Balkach[*], Yazid Messaoud Mati
Management Information System Department
Qassim University
Buraidah, P.O. Box 6633, K.S.A
[*]Email: d.balkash [AT] gmail.com

Abstract—**This paper presents a methodological framework devised to allow colleges of higher education to control and monitor the performance of their critical activities, which are related to students, faculty and staff, teaching and learning, research and community services. For each activity, a set of appropriate indicators are presented leading to a total of one hundred thirty eight key indicators. The proposed framework is based on the input-transformation-output model that plays an important role in operations management to improve processes. An Excel-based dashboard to show and present these indicators is developed.**

Keywords: Higher education, performance measures, indicators, input-transformation-output model, dashboard.

I. INTRODUCTION

The increase of global competition in today's world forced the companies to improve their operations and processes to reach the goals and objectives of their business strategy. These objectives cannot be easily and quickly reached without a strong management that emphasizes on an efficient performance management system that uses metrics to measure and control the performance of the various activities.

Higher education is a complex system with multiple inputs and outputs, and where various activities and processes are performed. This complexity makes the control and improvement of higher education colleges more complex and suggests the need for appropriate measurement systems, especially for institutions with limited resources. Yet many countries especially developing ones interest in this measurement because policymakers have now undertaken various reforms to improve colleges, and understand the importance of this measurement to improve their operations. Further, the pressure of fulfilling national and international accreditation standards have strengthen the need of developing performance indicators for use at the institutional level.

The selection of indicators for measuring the performance of higher education colleges should be governed by the mission of the colleges. For instance, research-oriented colleges should more concentrate on deeply research indicators in contrast to teaching and research oriented colleges that are a mix of teaching and research activities. However, there is no perfect indicators for using in higher education since every indicator has some disadvantages. For example, using the student course evaluation to measure the effectiveness of teaching can sometimes be misleading as it reflects characteristics (e.g. student grades) that may not be related to teaching quality.

In the recent years, there is a movement toward the development of higher education performance indicators but most of the previous studies concentrate on a given activity such as teaching effectiveness (Berk, 2005), research (Al-Turki et al., 2015) or even on a specified component of an activity such as research impact (Penfield et al., 2013). This paper describes progress currently underway in the College of Business and Economics at Qassim University (Saudi Arabia) to achieve a reliable and valid system to measure the efficiency of its critical activities and processes. Such a system would create a more useful and more common standard for the use in various other colleges regardless the type and the environment.

The remainder of the paper is structured as follows. In the next section, the literature on performance indicators in higher education is reviewed. The third section describes the proposed framework of indicators. Section 4 describes the indicators for participants that are: Students, alumni, faculty and staff. The indicators for teaching and learning are given in Section 5. Section 6 provides the research indicators while Section 7 describes the community service indicators. Section 8 presents the various dashboards showing the proposed indicators, which are developed in Excel. The final section concludes the paper and gives some directions for future research.

II. INDICATORS IN HIGHER EDUCATION

The measurements employed in higher education are based on a set of metrics that reflect the processes being assessed. These metrics can be classified as follows: Indicators, performance indicators and key performance indicators. While there is no general agreement on a definition of these metrics, the Organization for Economic Co-operation and Development (OECD) defines an indicator as "a qualitative or quantitative

factor or variable that provides a simple and reliable means to measure achievement, to reflect changes connected to an intervention, or to help assess the performance of a development actor" (OECD, 2002). In management, an indicator is a measure that relates actual performance or results achieved to the desired objectives. A performance indicator is an indicator that is aligned with the business strategy. It embodies a strategic objective and measures performance against a goal. Performance indicators that are used to measure the core activities and processes are called Key Performance Indicators (KPIs). In this paper, the term indicator is employed to specify any type of measures regardless its alignment or not with the college's mission and strategy.

The main purpose of using indicators in higher education colleges is to control and monitor the performance of its activities and processes. These indicators provide adequate information to administrators and policy-makers to decide on the progress and achievements. The indicators are also used for benchmarking purpose by comparing the performance against similar institutions with the goal of improving the processes to compete with competitors . They are also used to give simple and accurate information for accreditation and audit agencies, and provide the various stakeholders with necessary information. They can also be used for marketing purpose to promote the colleges, to attract expected students and faculty, and to improve the current student satisfaction by providing them with necessary information.

The educational indicators are classified in the literature using several classifications among them the one that consists in decomposing the indicators into input, process and output (Chen, 2007). The input describes the human, financial and physical resources. The process describes the transformation activities that are used to deliver educational programs and services. The output reflects the quantity of outcomes produced. Another classification is proposed in Marques (2001) that consists in grouping indicators into four categories: Internal indicators (e.g. pass rate, graduate rate), operational indicators (e.g. student to professor ratio, size of the classes), external indicators (e.g. employability of the graduates, external stakeholders satisfaction) and research indicators (e.g. productivity, impact). Indicators are also grouped into input, process, output and outcomes (Borden and Bottrill, 1994). They can be decomposed as well in quantitative and qualitative.

A number of indicators have been developed for assessing activities and processes in higher education. A list of indicators that are used in institutions across the United State is described in Terkla et al. (2012) where the indicators are grouped into eleven categories ordered by frequency of use. Another list of indicators that are used by thirty four accredited colleges and universities in the United State, is identified and analyzed in Terkla (2011). A complete list of indicators for different kind of institutions in particular educational ones, are described in Baroudi (2016). Some previous studies focus on developing indicators of a given activity. For instance, a set of

indicators used in Australia for assessing teaching and learning processes has been provided in Chalmers and Thomson (2008). Twelve indicators to measure teaching effectiveness are presented in Berk (2005). The research activity is frequently assessed in the literature through the productivity (Lariviere, 2012), the quality (Abbasi and Jaafari, 2013) and the impact (Penfield et al., 2013).

In the next section we will develop a generic framework of indicators for assessing critical activities of higher education colleges. These indicators are easy to compute making them likely to be adopted by a large scale of colleges. They are organized in a way that uses blocks of indicators each of which tracks the performance of a given activity.

III. THE PROPOSED FRAMEWORK

The creation of goods and services in any type of organizations involves a set of operations that transform inputs to outputs. These operations can be described by the input-transformation-output model, which plays an important role in operations management to improve processes (Slack et al., 2016). In this model, the outputs of products and services are obtained from a set of input resources that are utilized to convert something, or are converted themselves. The various operations of higher education colleges conform to this model but differ in the nature of their inputs and outputs. Figure 1 describes the input-transformation-output model for higher education where various inputs are needed and multiple outputs are provided.
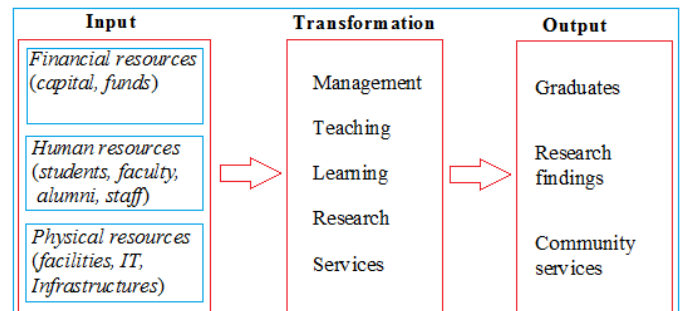

Figure 1: Input-transformation-output model in higher education

The inputs of higher education colleges can be decomposed to human resources (students, alumni, faculty, staff) that participate in the different activities of the colleges, financial resources (capital, funds) and physical resources (information technology, facilities, infrastructure). The outputs can be decomposed into three core components: Graduates, research findings and community services. The transformation processes refer to the work activities that convert inputs into outputs through value-added actions. These activities are management, teaching, learning, research and services. For instance, the teaching activity uses the transforming resources (e.g. faculty, facilities) to transform students to qualified graduates.

The framework of indicators proposed in this paper follows the above input-transformation output model by

designing a set of generic indicators that take into account the strengths and limitations of indicators as well as their reliability for the various types of colleges. However, as there are several activities involved in higher education, we will only focus in this paper on teaching, learning, research and community services, which constitute the basic components of the college's mission.

IV. KPIs FOR PARTICIPANTS

The participants are the people of the college who are involved in their different activities and who actively interact to achieve the college's mission. Four types of participants are considered in our framework: Students, alumni, faculty and staff members. The proposed indicators for each of them are described below.

4.1. Students: Students are one of the driving force in colleges since they are involved in all teaching, research and community services activities. The college must ensure that admission and registration activities are consistent to obtain a variety of high quality students who will contribute to the success of the college. Students follows different steps from their application until the exit from the college. These steps, that constitute the basis of the proposed indicators of Table 1, are: Application, admission, enrollment, retention and satisfaction.

Table 1: Student indicators

Code	Indicator
$Ps1$	Number and variety of applicants
$Ps2$	Applicants growth
$Ps3$	Number of transfers to the college
$Ps4$	Transfer students' GPA
$Ps5$	Admission scores
$Ps6$	Admission scores growth
$Ps7$	Admission variety
$Ps8$	Number of enrolled students
$Ps9$	Yield = enrolled/admitted
$Ps10$	Yield growth
$Ps11$	Freshman retention rate
$Ps12$	Fall-to-fall retention
$Ps13$	Student satisfaction

The first four indicators relate to student application where Ps1 tracks the number and variety of students (e.g. gender, region, nationality), and Ps2 measures the growth of applications over the last year. The indicators Ps3 and Ps4 reflect respectively the degree of attrition of the college and the quality of the transferred students. The three next indicators describe the admission process where Ps5 measures the quality of the admitted students, Ps6 gives the growth of admission scores over the last year, and Ps7 tracks the admission variety (e.g. region, gender, nationality). The enrollment process is gauged by the number of enrolled students Ps8, the yield Ps9 that is defined as a percentage of enrolled to admitted students, and the yield growth Ps10 over the last five years. Indicators Ps11 and Ps12 determine respectively the retention rate for the new enrolled students and from year to year. Finally, indicator Ps13 calculates the student satisfaction on the admission and registration activities of the college.

4.2. Alumni: Alumni are group of people who have graduated from the college. A strong relation between the college and its alumni is needed and would be important for both sides. Alumni contribute to the mission of the college in different ways such as providing insight into the future directions of the market, assisting current students in career planning and donating. The college provides a number of benefits and services to alumni that include access to college resources such as library, career service and online resources. Table 2 proposes the retained indicators to measure the efficiency of the alumni relation.

Table 2: Alumni relation indicators

Code	Indicator
$Pa1$	Number and variety of alumni
$Pa2$	Number of services and benefits provided to alumni
$Pa3$	Number of events organized for alumni
$Pa4$	Alumni satisfaction
$Pa5$	Percent of connected alumni
$Pa6$	Percent of active alumni
$Pa7$	Percent of engaged alumni

The first indicator $Pa1$ gives an idea on the number and variety of alumni (gender, nationality, employment location). The three next indicators track the sufficiency of services provided to alumni where $Pa2$ tracks the number of services (e.g. access to library, sport center, social club), $Pa3$ measures the number of activities organized for alumni (e.g. alumni day, career workshop), and $Pa4$ calculates the alumni satisfaction. The remaining three indicators concern the alumni commitment to the college activities. An alumni is said connected if it follows the college news through the college website subscription and the social media. An active alumni is the one who provides a service to the college such as participating to an event in the college. An engaged alumni constantly serves the college by giving donation and providing mentoring to current students.

4.3. Faculty: Faculty members are the second driving force of the college as they are the main responsible of providing the various activities of the college. We classify the faculty indicators into four categories that describe the sufficiency, variety, qualification and retention. These indicators are described in Table 3. The indicators Pf1 and Pf2 can help get a feel for the academic environment at the college including class-size and how much attention students will receive. Indicator Pf3 describes the variety of faculty members in term of gender, nationality, age and academic rank. The qualification indicators measure the quality of faculty members where Pf4 concerns newly faculty, and the existing faculty are tackled using Pf5 and Pf6. The remaining indicators measure how successful the college is in keeping the current faculty.

Table 3: Faculty member indicators

Code	Indicator

$P_{f}1$	Student to faculty ratio
$P_{f}2$	Percent of full-time faculty
$P_{f}3$	Faculty variety
$P_{f}4$	Evaluation of newly hired faculty members
$P_{f}5$	Percent of faculty with doctorate degree
$P_{f}6$	Percent of senior faculty
$P_{f}7$	Retention rate
$P_{f}8$	Average working years
$P_{f}9$	Faculty satisfaction

4.4. Staff: Professional staff support faculty members and students by providing services that enhance the quality of the various activities of the college including student admissions, career advising, alumni relations, etc. The staff indicators that measure the sufficiency and qualification are described in Table 3.

The indicators Ps1 and Ps2 are used to gauge the number of staff a college provides to ensure sufficient services for its students. The indicator Ps3 measures the variety of staff in term of gender and age. The qualification of staff are measured by indicators Ps4 and Ps5 that consist respectively in evaluating the quality of hiring and development processes. The next three indicators measure the adequacy of working climate at the college. Indicators Ps6 and Ps7 measure how successful the college is in keeping the current staff. Finally, indicators Ps9.

Table 4: Staff indicators

Code	Indicator
$P_{s}1$	Student to staff ratio
$P_{s}2$	Percent of full-time staff
$P_{s}3$	Staff variety
$P_{s}4$	Evaluation of newly hired staff
$P_{s}5$	Percent of staff attending a training course
$P_{s}6$	Retention rate
$P_{s}7$	Average working years
$P_{s}8$	Staff satisfaction
$P_{s}9$	Student satisfaction
$P_{s}10$	Administration satisfaction

and Ps10 measure the student and administration satisfactions on the sufficiency of staff and the appropriateness of their services.

V. KPIs FOR TEACHING AND LEARNING

Teaching and learning activities constitute the most important strategic goal of higher education colleges, and also the most challenging task because of the various factors that impact these activities. They are considered by accreditation and audit agencies as the most salient pillar for attributing the accreditation to colleges of higher education. These activities can be expressed by the input-transformation-output model as a set of activities that effectively use input resources such as faculty members and financial resources, to transform students to well qualified and competitive graduates with up-to-date knowledge and skills.

A great number of studies were conducted to address quality and effectiveness issues in teaching and learning, which lead to propose several policies and best practices (Henard and Roseveare, 2012), to develop framework (Danielson, 2013), and to suggest indicators for measuring the colleges commitment to teaching quality (Pouyioutas, 2014). In this section, we propose a set of indicators that involve input, process and output indicators.

5.1. Input indicators: The input involved in teaching and learning activities are students, faculty and financial resources. A set of indicators describing the salient characteristics of students and faculty members are introduced in Section 4. In this section, we propose new indicators that directly impact the teaching and learning activities. These indicators are presented in Table 5.

Table 5: Input indicators for teaching and learning

Code	Indicator
$T_{i}1$	Student entrance score
$T_{i}2$	Average student load per semester
$T_{i}3$	Student to faculty ratio
$T_{i}4$	Average faculty teaching workload
$T_{i}5$	Average number of courses per faculty
$T_{i}6$	Average class size
$T_{i}7$	Expenditure per full-time student
$T_{i}8$	Student to computer ratio
$T_{i}9$	Student satisfaction index
$T_{i}10$	Faculty member satisfaction index

The indicator $T_{i}1$ measures the academic abilities of students before they enter the college, which generally has an impact on teaching and learning activities. The indicator $T_{i}2$ tracks the number of credit hours registered by full-time-equivalent students per semester, which determines the expected time to invest by students inside and outside the classroom. The three next indicators, which have an effect on quality of teaching and learning activities, are dedicated to faculty members: $T_{i}3$ is generally used in ranking colleges and it is assumed that the lower the ratio the more contact a student will have with faculty members, $T_{i}4$ calculates the number of credit hours thought by faculty members in each semester, and $T_{i}5$ tracks the number of different courses assigned to each faculty member. The indicator $T_{i}6$ is a determinant of teaching strategies employed in classrooms, and a small size class would lead to better student learning outcomes. $T_{i}7$ is the amount of expenditure per full-time student while $T_{i}8$ that relates to the effective use of computers within the college, is calculated by dividing the number of students by the number of computers. The last two indicators $T_{i}9$ and $T_{i}10$ are obtained through surveys that measure student and faculty members satisfaction on input resources allotted to teaching and learning activities.

5.2. Process indicators: Teaching and learning process encompasses various activities that range from strategic (e.g. design of the program structure) to operational activities (e.g. evaluating the class teaching). The assessment of teaching and

learning activities has been addressed in the literature in different ways depending on the classification of its issues. To facilitate the monitoring and control of these activities, we classify the issues of teaching and learning into four classes: Curriculum design, teaching effectiveness, teaching engagement, and support services.

The curriculum design relates to the structure of the components of a curriculum, and a most widely accepted definition is developed in Taba (1962) who defines the curriculum design as: "A statement which identifies the elements of the curriculum, states what their relationships are to each other, and indicates the principals of organization and the requirements of that organization for the administrative conditions for which it is to operate. A design of course needs to be supported with and to make explicit a curriculum theory which establishes the sources to consider and the principals to apply". Accordingly, we decompose the curriculum design into two parts: Program specification that includes the definition of aims, learning outcomes, and program structure or content; and the course design that encompasses course content, teaching strategies and ways of assessments. The proposed indicators of curriculum design are described in Table 6.

Table 6: Curriculum design indicators

Code	Indicator
T_c1	Total credit hours of each program
T_c2	Peer review of program specification
T_c3	Year of last update
T_c4	Practitioners' review of program learning outcomes
T_c5	Number of courses supporting program learning outcomes
T_c6	Degree of consistency of program learning outcomes
T_c7	Alumni satisfaction on program specifications
T_c8	Peer review of course specifications
T_c9	Percent of courses assessed per year

Teaching effectiveness refers to the interaction that occurs in a classroom between teachers and students. Monitoring teaching effectiveness reflects the institutions commitment to continual improvement. The teaching effectiveness can be evaluated by measuring the input, process and output. Table 7 describes the retained indicators to measure the effectiveness of teaching, which make use of diversified sources to increase their validity and reliability.

The indicator T_e1 and T_e2 are based on the evidence that as more faculty are qualified in the subject they are teaching as more they are effective (e.g. see Carrell and West, 2010) especially in graduate level. The indicator T_e3 corresponds to students evaluation that is commonly used in higher education (Marsh, 1987). Student ratings are now the most widely used source of information on teaching effectiveness (Selden, 1999). The indicator T_e5 is used for administrative decision such as promotion, bonus where the

department chair constitutes the most important one (Selden, 1984).

Table 7: Teaching effectiveness indicators

Code	Indicator
T_e1	Percent of senior faculty
T_e2	Percent of faculty having publications in the field they teach
T_e3	Student course evaluation
T_e4	Peer review evaluation
T_e5	Administration evaluation
T_e6	Percent of courses with student-centered approach
T_e7	Variety of assessment

Teaching engagement is defined, based on the work engagement definition of Kahn (1990), as the harnessing of students and faculty's selve to their teaching and learning roles. Several studies were dedicated to faculty engagement among them the work of Barman and Saikat (2011) who develop a definition as well as a survey to measure the faculty engagement. The student engagement in university classes is measured and analyzed in Ahlfeldta *et al.* (2005). The proposed indicators for measuring the teaching engagement are described in Table 8, where indicators T_g4 - T_g6 can be calculated through surveys that includes several elements such as absenteeism, preparation, motivation and availability.

Table 8: Teaching engagement

Code	Indicator
T_g1	Percent of students attended a support course
T_g2	Percent of absenteeism per course
T_g3	Percent of students participating to program course development
T_g4	Faculty satisfaction on student engagement
T_g5	Administration satisfaction on faculty engagement
T_g6	Student satisfaction on faculty engagement

The support services refer to the activities provided by the college to students and faculty in order to fit its learning and teaching activities. These services influence the quality of teaching and student learning outputs (Chalmers, 2007). Table 9 gives the proposed indicators that track the budget spent on these services and how this budget is allocated. The first indicator T_s1 quantifies the budget allocated to teaching and learning. T_s2 tracks the amount of resources available to each student such as library resources, books and computers. T_s3 measures the sufficiency of books in the library, and T_s4 gives an idea on the support courses provided to students including training and e-learning courses. Indicator T_s5 represents the teaching and learning awards used to distinguish the faculty members. The last two indicators T_s6 and T_s7 measure respectively the students and faculty satisfaction on support services.

Table 9: Support services indicators

Code	Indicator
T_s1	Percentage of budget allotted to teaching and learning
T_s2	Resource to student ratio

T_s3	Availability of books in library
T_s4	Number of support courses for students
T_s5	Number of awards in teaching and learning
T_s6	Student satisfaction index
T_s7	Faculty satisfaction index

5.3. Output indicators: The output indicators reflect the quantity and to some extents quality of what teaching and learning activities produce during one reporting period. The retained indicators that relate to currents students and alumni are given respectively in Table 10 and Table 11.

Table 10: Current student related output indicators

Code	Indicator
T_o1	Retention rate
T_o2	Progress rate
T_o3	Percent of student who fail in one course
T_o4	Capstone exam pass rate
T_o5	National exam qualification pass rate
T_o6	Graduation rate
T_o7	Percent of students completing their degree on time
T_o8	GPA distribution of graduates
T_o9	Student satisfaction

The retention rate T_o1 specifies the percentage of students enrolled in the current year, and continue to be enrolled in the next year. It can be important to calculate this indicator for the freshman students. The progress rate T_o2 indicates the percentage of student load passed. Indicator T_o3 can be calculated for a range of course types. The indicators T_o4 and T_o5 (e.g. SOCPA for accounting students) are used to check the quality of outputs. The indicator T_o6 is obtained by dividing the number of graduates by the number of enrolled students, and T_o7 gives an idea on the number of years a student remains in the college. The indicator T_o8 is a measure of quality of the output as it track the distribution of GPA of graduates. The indicator T_o9 is calculated through surveys relative to the educational experience at the college.

Table 11: Alumni related output indicators

Code	Indicator
T_o1	Employment rate
T_o2	Distribution of job type
T_o3	Distribution of employment location
T_o4	Number of months to find a job
T_o5	Number of alumni awarded a distinguished prize
T_o6	Percent of alumni working in their field of study
T_o7	Average starting salary
T_o8	Percent of alumni pursuing a postgraduate degree
T_o9	Alumni satisfaction
T_o10	Employee satisfaction

Employment rate T_o1 is the proportion of employed graduates (for instance after three, six and twelve months) while T_o2 and T_o3 give information on the employment jobs of graduates (e.g. public or private sector, location). Indicators T_o4-T_o7 measure the quality of graduates. The indicator T_o8 refers to the graduates' motivation for further education and

learning. Finally, T_o9 and T_o10 refers to the satisfaction of alumni and employees on knowledge and skills.

VI. KPIs FOR RESEARCH

The second central function of higher education colleges is the research activity that aims to produce, disseminate and apply new knowledge which include theories, principles and methods. We define the research activity, on the basis of the input-transformation-output model, as a production process that uses faculty members' knowledge and experience, tools and materials to obtain tangible (e.g. publications, systems) and intangible (e.g. tacit knowledge, consulting) outputs.

The majority of indicators of the literature are devoted to measure the research output. In our framework, we employ two groups of indicators that describe the inputs and outputs of the research activity. Note again that the aim is not to list all possible indicators but rather to propose the most useful, generic yet simple to compute and track.

6.1. Input indicators: The input indicators aim to measure the availability of resources that have an effect on research outputs. These resources are: Time, financial resources, and human resources that include faculty members and graduate students. The proposed input measures are summarized in Table 12.

Table 12: Input indicators for research

Code	Indicator
R_i1	Percent of time devoted to research
R_i2	Research funds
R_i3	Percent of faculty members receiving an internal grant
R_i4	Percent of senior academics
R_i5	Percent of research fellow
R_i6	PhD students to faculty members ratio
R_i7	Research motivation index
R_i8	Faculty research satisfaction index

The indicator Ri1 emphasizes the type of the college because a research-oriented college is more productive than a teaching-based college in which faculty members have limited time to perform research. The indicator Ri2 measures the amount of funds allotted to faculty members, especially the young ones, for participating in conferences, collaborating with other institutions, etc. The indicator Ri3 is used since grants seem to have a positive effect on research productivity (Langfeldt et al., 2015). The use of indicator Ri4 is justified by the claim that faculty with higher academic positions are the most productive (Rorstad and Aksnes, 2015). The indicator Ri5 is suggested because (senior) research fellow demonstrate greater productivity. The indicator Ri6 is a determinant of the research productivity since PhD students contribute to a high percentage of publications of colleges (Lariviere, 2012). The indicator Ri7 tracks the research motivation of faculty members, while the indicator Ri8 is introduced to assess the

faculty satisfaction on the organizational context. The two last indicators can be computed through surveys.

6.2. Output indicators: The research output indicators commonly used in the literature can be classified into three dimensions: Productivity, quality and impact. Even though the three dimensions are interrelated the motivation of separating them is mainly due to the fact that the measures of each dimensions are different in meaning but also to capture the nature of colleges. For instance, a research-oriented college may concentrate more on the quality and impact dimensions while a teaching-oriented college may only need to focus on the productivity dimension.

The productivity is an index that measures how efficiently the research activity runs and how effectively it uses resources. It is defined as the ratio of outputs, described by the number of publications in various channels, to inputs that are used to create those outputs. The proposed measures of productivity are described in Table 13.

Table 13: Research productivity measures

Code	Indicator
$Rp1$	Ratio of publications to faculty numbers
$Rp2$	Average number of authors per paper
$Rp3$	Percent of papers with a faculty member in the first position
$Rp4$	Rate of publications
$Rp5$	Percent of interdisciplinary publications
$Rp6$	Ratio of publications to PhD thesis
$Rp7$	Average number of years to finish the Phd thesis
$Rp8$	Percent of internal grants leading to k journal papers
$Rp9$	Productivity growth

The first four measures concern the partial productivity of faculty members. The indicator $Rp1$ that is computed by dividing the total number of publications by the number of faculty members, gives an idea of how well faculty members are productive. The indicator $Rp2$, which is used in some colleges for tenure and promotion purposes, gives an indication of the extent to which faculty members publish alone or in collaboration with others (Abramoa *et al.*, 2013). It is calculated by the sum of the author counts divided by the number of papers. The indicator $Rp3$ is justified by the fact that the first position is traditionally attributed to the one who contributes more to the paper. The indicator $Rp4$, which is defined as a ratio of the sum of papers to the number of years to publish them, is most convenient for young researchers. The indicator $Rp5$ gives an idea on the degree of collaboration between two or more disciplines, which is motivated by the belief that interdisciplinary works have a positive effect on productivity and also on research impact. The indicator $Rp6$ is a partial productivity of PhD thesis, which is calculated by the total number of publications issued from thesis divided by the number of defended thesis. The indicator $Rp7$ relates to how fast students finish their PhD thesis. The indicator $Rp8$ is a partial productivity of grants. Finally, $Rp9$ concerns the

productivity growth that is the increase of productivity from the previous year to the current year relative to the productivity of the previous year.

The research quality dimension indicates the ability of the results of research to meet or exceed the expectations of scientific community within the discipline. Eight indicators are proposed in Table 14 to measure the research quality, where the first fifth indicators correspond to the quality of journals in which faculty members publish. These journals are classified into three classes *A;B* and *C* according to the mission of the college. For instance, in a teaching-research college the class *A* may consist of journals with impact factors, class *B* contains journals published in well known publishers (e.g. sciencedirect, kluwers) but without impact factors, and class *C* contains the remaining journals.

Table 14: Research quality measures

Code	Indicator
$Rq1$	Percent of A class papers
$Rq2$	Weighted score of publications
$Rq3$	Percent of faculty members with more than k papers in class A
$Rq4$	Percent of PhD thesis leading to an A or B paper
$Rq5$	Growth in A class papers
$Rq6$	Number of international coauthored papers
$Rq7$	Number of external grants
$Rq8$	Percent of faculty members with an Esteem

The indicator $Rq1$ is calculated by the formula:

$$\frac{|A|}{|A \cup B \cup C|}$$

The indicator $Rq2$, which is used by some accreditation associations, calculates a weighted sum of publications by giving a weight to each class. The weights are fixed arbitrary but a suitable weight might be 4 for the class *A*, 2 for the class *B* and 1 for the class *C*. The indicator $Rq3$ allows obtaining high quality faculty whereas $Rq4$ gives an idea about the quality of works performed by PhD students. The indicator $Rq5$ tracks the evolution of *A* class papers from one year to another. The use of $Rq6$ is motivated by the fact that collaboration with other institutions would generally lead to quality papers (Abbasi and Jaafari, 2013) and also because research funding agencies encourage this type of works (Sonnenwald, 2007). The idea behind $Rq7$ is that the quality of research is an important factor to attribute external grants. Finally, $Rq8$ calculates the percentage of faculty members having an esteem that refers to the overall research reputation (e.g. receiving an award/prize, invitation to speak as conference keynote).

The third type of measures to assess the research output concerns the research impact that became an important dimension during the last few years particularly for accreditation associations (see for instance AACSB, 2012). While there is no unified definition of research impact (Penfield *et al.*, 2013), we approach it as how the research outputs effect the academic, practice and society. The

academic impact corresponds to publishing new research that make a significant contribution to knowledge, practice impact means developing new products and systems that improve economic performance, and society impact relate   s to public engagement by addressing real-life challenges (e.g. healthcare, environment). The proposed measures selected for research impact are summarized in Table 15.

Table 15: Research impact measures

Code	Indicator
$Rm1$	h-index
$Rm2$	g-index
$Rm3$	h-index (g-index) growth
$Rm4$	i10 Google Scholar index
$Rm5$	Average impact factor by faculty member
$Rm6$	Number of licenses granted
$Rm7$	Number of patents and copyrights awarded
$Rm8$	Number of products/systems developed and used by community
$Rm9$	Society satisfaction

The first five indicators are selected to assess the academic impact. The indicator $Rm1$ corresponds to the *h*-index developed by Hirsch (2005) who consider that "a faculty member has an *h*-index if *h* of his or her published papers have been cited at least *h* times, and the remaining papers have *h* or less citations each". The second indicator *g*-index improves the *h*-index by measuring the global citation performance of papers. It is defined in (Egghe, 2006) as "the largest number of first *g* papers that have together at least *g*2 citations". Note that to calculate this indicator the papers are first sorted in decreasing order of their number of citations. The indicator $Rm3$, which traces the change of *h*-index and *g*-index from one year to the next, is useful for measuring the research impact of young researchers as it reduce the effect of career length. It is suitable to compute the three above measures in multiple databases (e.g. Scopus, Google Scholar, Web of Science) to have a thorough analysis. The indicator $Rm4$ is the *i*10 index of Google Scholar that tracks the number of papers with at least 10 citations. The indicator $Rm5$ is calculated by the sum of impact factors of published papers divided by the number of faculty members. Notice that the selected indicators do not consider the academic social site indicators (e.g. Research Gate, Academia) since we estimate that the corresponding bibliometric are already included in the proposed fifth indicators, and the social measurements (e.g. followers) and usage metrics (e.g. pages views, downloads) do not objectively assess the research impact. The next three indicators measure the practice impact by considering the number of licenses, patents, products and systems developed. The last indicator $Rm9$, which is calculated through surveys, measures the society impact.

To make all the above proposed indicators worthwhile, it is suitable to calculate them by type of publications (i.e. journal, conference), gender, faculty academic rank and discipline, to have a good understanding of the research performance in the college.

VII.   COMMUNITY SERVICE

Community service which is part of the community engagement is the third core component of the mission of higher education colleges. It refers to service activities performed for the benefit of the local community with the aim of linking the college with the external world to help the community while promote students and faculty members development.

The performance of community service is assessed by the indicators of Table 16 that describe the productivity and impact of activities provided by the college to the community.

Table 16: Performance indicators for community service

Code	Indicator
$C1$	Number of services provided by students
$C2$	Number of services provided by faculty members
$C3$	Percentage of engaged students
$C4$	Percentage of engaged faculty members
$C5$	Number of requests for services
$C6$	Number of requests for membership
$C7$	Community satisfaction index

The first two indicators $C1$ and $C2$ focus on the partial productivity of students and faculty members while $C3$ and $C4$ determine the proportion of engaged students and faculty members. A student is said engaged if it participates to a social, cultural or voluntary activity, whereas an engaged faculty member must provide services (e.g. consultations, training courses, writing implementing grants) or must be a membership within a professional organization such as board of directors, leadership committees or editorial board of a professional journals. The indicators $C3$ and $C4$ are necessary to reduce the effect of the size of the colleges. The impact is gauged by the number of requests from the local community to use faculty expertise. Two types of expertises are considered which are the provision of services expressed in $C5$ and the membership in a leadership committee calculated in $C6$. Finally, the indicator $C7$ determines the satisfaction of the community on the provided services using global surveys.

VIII.   DASHBOARD DEVELOPMENT

The various indicators proposed in the previous sections were integrated in a dashboard using the Excel software, which visually displays the indicators in a simple and organized way. The main screen of the dashboard is depicted in Figure 2 that contains the indicators of the five activities described in the previous sections.

By clicking on a selected activity, the proposed indicators will be displayed using different types of graphics. Figure 3 shows the various screens of the students and alumni dashboard. For instance, by pressing the button "admission and registration" we obtain the indicators related to the admission and registration activities.
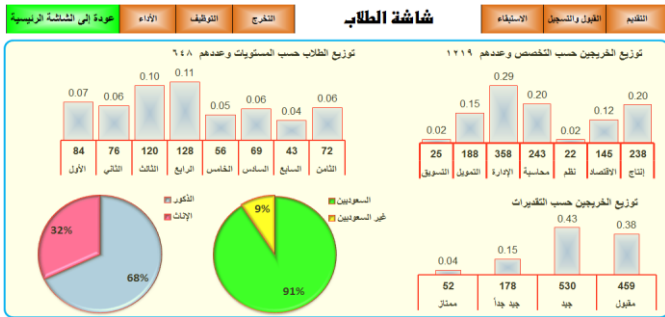
Figure 2: Main screen of the dashboard

Figure 3: Student screen

The main screen of the faculty and staff indicators is displayed in Figure 4. By clicking on the button "staff" we obtain all indicators related to staff that are shown in Figure 5.
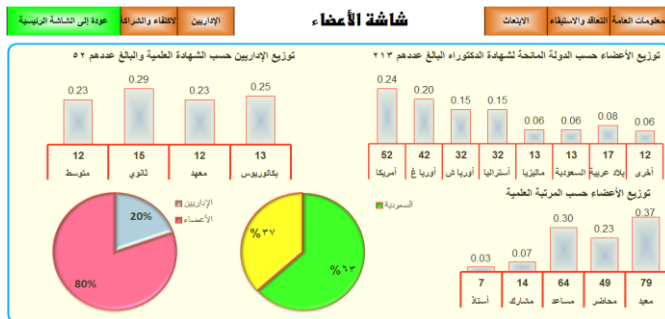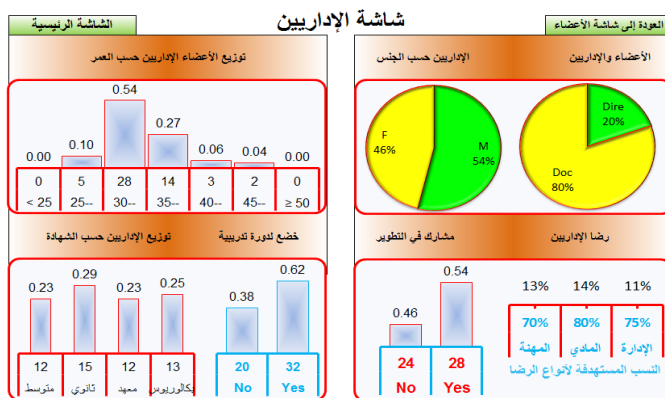

Figure 4: Faculty screen

Figure 5: Staff screen

In addition, Figure 6 shows the research indicators that contain productivity, quality and impact. Clicking for example

on the productivity button will display the indicators related to research productivity that are shown in Figure 7.
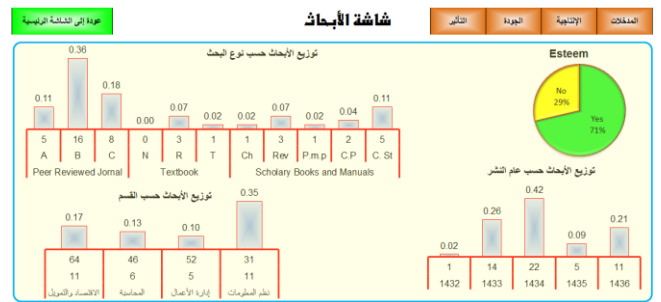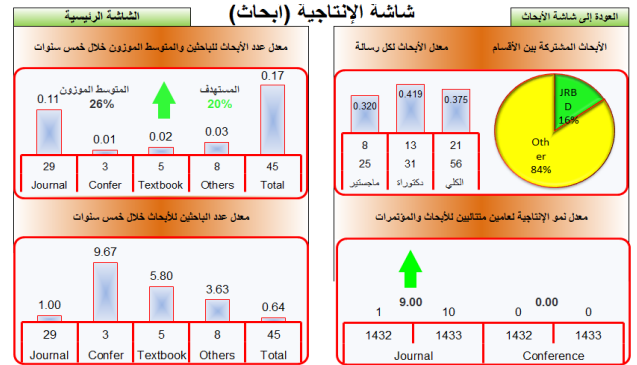

Figure 6: Research screen

Figure 7: Productivity screen

In Figure 8, the main screen related to teaching and learning activity is shown, and Figure 9 presents the indicators of the community service.
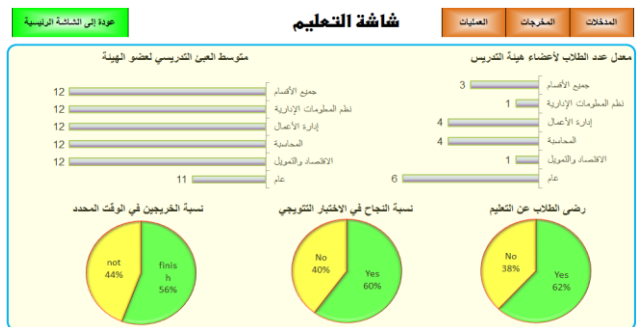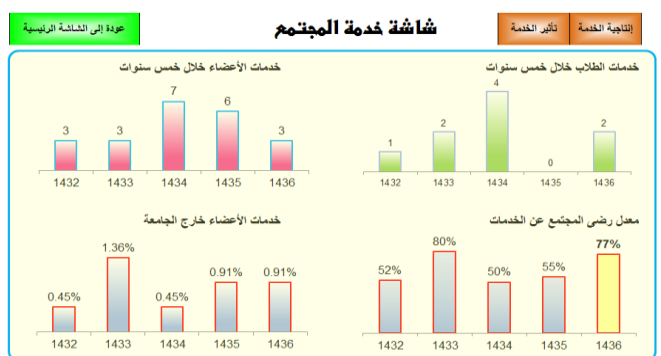

Figure 8: Teaching and learning screen

Figure 9: Community service screen

IX. CONCLUSION

In this paper, a set of most suitable indicators for controlling and monitoring the performance of critical activities of higher education colleges is proposed. We focused on four activities that are related to participants (i.e. student, faculty, staff, alumni), teaching and learning, research and community services. One hundred thirty eight indicators are proposed, which capture the salient features of the four activities by using the input-transformation-output model. An Excel-based dashboard is developed to display the proposed indicators to policy-makers. As future research, we will first develop questionnaires and surveys that are used to evaluate the various types of satisfaction indices. Then, we will develop indicators for other activities such as financial activity. It is also suitable to develop a web-based application that shows the proposed indicators in more compact form.

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