Faculty Target-Based Engagement Assessment Statistical Model for Enhancing Performance and Education Quality

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Abstract

There is a worldwide interest in developing quantitative faculty members' activity evaluation models. However, implementing a fair and reliable model is challenging. Without capable and high-quality faculty members, no education improvement effort subsequently can succeed. Based on the gap analysis of the literature, lack of a quantitative faculty member assessment model might affect teaching and scholarly performance and lead to undesirable effects. Therefore, most of the existing metrics assessment models do not capture the full range of activities that support and transmit knowledge to students.

The main objective of the current research is to develop a practical, comprehensive and flexible statistical Target-Based Engagement assessment model of faculty members that considers both the specific faculty needs and the academic unit management concerns. A mathematical relationship between one or more random and additional non-random variables was used to develop the model. Descriptive and inferential statistical methods were applied in the data analysis. The Target-Based Engagement model has seven interconnected aspects and three subsequent modules. It is a robust statistical framework for automatic faculty assessment.

The results of this model are beneficial for faculty assessment in addition to having well-aligned key performance indicators inside the different levels of the institution. The model helps in supporting different strategic decision-making of the institution and is considered as a long-term improvement method in the academic profession. Creating a vision for future faculty assessment statistical models will improve the faculty performance and enhance the performance of all higher education stakeholders.

Keywords: target-based engagement, statistical model, quality of engineering education, self-assessment, faculty member assessment

Faculty evaluation is a complex process that encompasses various interconnected activities and actions, all of which are related to a specific purpose. Furthermore, it plays a vital role in education and helping faculty identify areas of strength and weakness in their educational skills. Without capable and high-quality faculty members, no education improvement effort subsequently can succeed. Hence, without high-quality evaluation systems, enhancing faculty members' performance cannot proceed.

A few studies attempt to evaluate the overall activity of academic staff. Based on the gap analysis of the literature, lack of quantitative faculty member assessment models might affect teaching and scholarly performance and lead to undesirable effects. Therefore, most of the existing metrics assessment models do not capture the full range of activities that support and transmit knowledge to students. Significant flaws in both substance and process are present in most of them (Elmore, 2008).

Higher Education institutions are facing the challenge of enhancing the quality of academics. They are usually using student teaching evaluation surveys as a tool to assess the quality of education. These surveys can afford useful information to the management about insights on their strengths and weaknesses, but evaluating faculty performance requires different parameters in different criteria to forecast the performance. Using faculty performance assessment criteria such as teaching and instruction standards, scholarly activity standards, community service standards and exceptional development standards will lead to better efficiency and accuracy.

A quantitative assessment of faculty performance aims to identify strengths and weaknesses in order to provide acceptable professional education enhancement. Accordingly, there are numerous important challenges in developing a comprehensive and supportive faculty member evaluation model. The model should:

- be based on methodologically sound procedures;
- be capable of reflecting differences between academic faculty;
- take into account the university/department strategic plans;
- help to enhance the performance of faculty members;
- be applicable to all faculty members; and
- be appropriate as a metric for continuous improvement, promotion and incentives.

Literature Review

There is a worldwide interest in developing quantitative faculty member's activity evaluation models (Mitchell & Leachman, 2015). However, implementing a fair and reliable model is challenging. Evaluation of faculty member performance plays an essential role in engineering education, helping faculty identify areas of strength and weakness in their educational skills. Lately, numerous state governments of the United States have obviously reduced the investment in public education (Mitchell & Leachman, 2015), and some states have acknowledged performance-based distribution to improve state universities regarding faculty development (Dougherty & Natow, 2015; Ellis & Bowden, 2014; Miao, 2012; O'Shaughnessy, 2013; Umbricht, Fernandez, & Ortagus, 2017). Numerous US public universities exposed to performance-based financing are currently getting reduced funding from their state legislatures. Some universities are increasingly having to self-fund some of their programs by raising tuition, focusing on funding research, and requiring some service fees from their students (Hillman, Tandberg, & Fryer, 2015). In such cases, the burden of searching for additional funds to support university programs is carried by the university administrators (chancellors, provosts, deans and

chairs) (Agbetsiafa, 2010). Accordingly, applying diverse techniques for evaluating the quality of education and faculty members is highly desired.

In reference to the survey data analysis gathered from more than 2,000 American college administrators, the National Institute for Learning Outcomes Assessment 2009 report (Kuh & Ikenberry, 2009) specifies that faculty engagement is an essential challenge for the assessment task at higher education institutions. The reason for this engagement is to determine and inspect empirically the factors that affect faculty members' engagement in learning outcomes-based assessment. Particularly, it is expected to investigate personal internal factors (e.g., values, perceptions, attitudes and knowledge) and external factors (e.g., institutional culture, policies and resources) on their commitment and actual involvement in assessment. As researchers state that "little is known about faculty and students' attitudes regarding different aspects of assessment that have wide-ranging implications for policy and practice in tertiary institutions" (Fletcher, Meyer, Anderson, Johnston, & Rees, 2012, p.119), the conclusions from this faculty Target Based Engagement (TBE) model will provide a much needed statistical conceptual framework about faculty's engagement in assessment to develop a quantitative means for measuring the performance of faculty members. A review of the literature (Banta and Associates., 2002; Grunwald & Peterson, 2003; Havnes & McDowell, 2008; Maki, 2010; and Palomba & Banta, 2015) discloses investigations of factors that impact faculty members' engagement in assessment activities, such as (a) time condition; (b) workload; (c) absence of assessment knowledge and resources; (d) uncertainty about the requirement of assessment; (e) concern of connecting assessment outcomes with faculty evaluation; and (f) fear of assessment intervening academic self-determination. However, most of the discussions rely on subjective methods.

Outstanding faculty members are playing the primary role in the assurance and improvement of teaching and research quality. To support the faculty member assessment system, the university administration has to provide faculty by methodology and application where used evaluation models with a scientific background. There are numerous existing different evaluation models for faculty members. The most known models include the Objective model, the Four levels of the evaluation model, the CIPP model, Provus's Discrepancy model, the CIRO model, and the Goal-free evaluation model (Stufflebeam, 2003).

Nowadays, data is at the center of researchers' work, regardless of whether they deal with science, industry or education (Chang, Kaufmann, & Kwan, 2014; Provost & Fawcett, 2013). The availability of such data makes it essential for them to be analyzed and evaluated adequately, which clarifies the current development of a new field named data science (Hardin et al., 2015; Emmert-Streib, Moutari, & Dehmer, 2016; Emmert-Streib & Dehmer, 2019; Dehmer & Emmet-Streib, 2017). For the analysis of faculty evaluation models, such as regression or classification methods (Emmert-Streib & Dehmer, 2019), permitting to estimate a forecast faculty model selection and model assessment are the main concepts for finding the best model for a given data set. Interestingly, concerning the description of the best model, there are two opposite approaches with a different fundamental philosophy (Ding, Tarokh, & Yang, 2018; Forster, 2000). One is defining the best model as predictiveness of a model, and the other as descriptiveness. The latter approach aims at identifying the accurate model, whose interpretation leads to a deeper understanding of the generated data and the underlying processes that created the data.

Regardless of the importance of all these model concepts, there are insufficient literature reviews available on the intermediate level that frame the objectives and approaches of faculty model selection and model assessment in a limited means. For illustration, innovative literature reviews

presented by Ding et al. (2018), Arlot and Celisse (2010) and Wit, van der Heuvel, and Romeijn (2012) are comprehensive presentations without much detail. Moreover, there are basic outlines to some models, such as by Aho, Derryberry, and Peterson (2014) and Zucchini (2000). These models focus only on a minor subsection of the main concepts, making it difficult to distinguish the broader image of faculty model selection and model assessment.

In addition to the above evaluation models, there are several existing theoretical models for the evaluation of teaching performance presented by Apodaca and Grad (2005), Chen and Hoshower (2003), Mittal and Gera (2013), Seidel and Shavelson (2007), and Scheerens and Bosker (1997). Apodaca and Grad argued for the theory of teaching effectiveness from a student learning methodology, in particular, the learning theory. Chen Hoshower applied the expectancy theory, initially advanced by Vroom, in their exploration of faculty members and student evaluation of teaching. Mittal and Gera included in their research the teaching effectiveness and charisma features on student evaluation of teaching effectiveness in higher education. Seidel and Shavelson and Scheerens and Bosker reviewed a few faculty effectiveness models that focused on teaching progression elements and process product models, which positively influenced student learning aftermaths.

In contrast, the focus of this paper is different in the following ways. First, the general conceptual ideas behind the model development, model assessment and their interconnections are presented. For this, theoretical details are accessible as far as they are helpful for a deeper understanding. Second, practical methods for the engagement of the faculty and the strategic objectives of the department/university are available as examples of the model inputs. It allows closing the gap between theoretical understanding and unbiased, practical assessment application. Third, the clarifications aim at an intermediate level of the reader by providing related information commonly omitted in advanced texts and forms that should ensure the paper benefits for a wide-ranging distribution with an overall interest in data science. Finally, some information about the practical application and validation of the model by using the MatLab R2019a statistical programming are existing. MatLab is used in the statistical assessment because it is a widely used program, which is freely available and forms the gold standard of the literature on statistics.

Research Paradigm and Hypothesis

This paper does not describe the findings of the research study in detail, but rather, it is representing the design, development, and potential application of the new faculty assessment model. Consequently, the application gives lesser importance as compared to the model development due to implementation time limitation that requires collecting data for five years. Based on the gap analysis of the literature, the study focuses more on model design innovation and concept orientation and does not necessarily require detailed theoretical or experimental development and analysis.

Hypotheses to be considered when structuring this faculty evaluation model include:

- How to design a model indicating the strategic objectives of the department/university and useful for enhancing faculty performance?
- How to define a clear set of evaluation criteria projecting, in the various areas of academic activity, stakeholders' values and concerns about academic careers and institutional policies?
- How to describe, as objectively and explicitly as possible, the performance of each one of the criteria, considering integrating its quantitative and qualitative dimensions?

Purpose of the Research

The primary purpose of the research is to develop a Target-Based Engagement (TBE) assessment statistical model of faculty members for enhancing the performance and quality of education. On the one hand, faculty evaluation has a formative purpose that the results are used to help faculty development, self-improvement and growth. Moreover, faculty evaluation has a summative purpose that the results are used to make personnel decisions on faculty promotion and incentives. Secondary objectives are to assess:

- Faculty teaching performance with improved specificity of feedback and alignment of assessments with the students' assessment survey.
- Faculty self-awareness of their skill level to guide them in targeted teaching skill acquisition and improvement.
- Institutional teaching competency considering self-evaluations and learner assessment data are combined to guide programming for faculty development.

Research Methodology

Conceptual Framework of Target-Based Engagement Statistical Model

Figure 1 provides the TBE statistical model conceptual framework summarizing the aspects involved and the way they interconnect. The main objective is to assure that faculty evaluation contributes to the improvement of the education quality and student outcomes through enhanced teaching performance and practice. The framework has seven interconnected aspects.

Persons assessed: Who? Faculty member evaluation is to be analyzed as the vital part of an evaluation and assessment framework of the TBE statistical model, which includes other components such as program/department assessment, teaching/scholarly/service/creativity assessment, continuous learning evaluation, strengths and weaknesses review, training needs analysis and strategic plan updating.

Aspects assessed: Which? The model measures the performance of the faculty's contribution each year that declared in the Faculty Improvement Plan (FIP). The FIP is synchronized with the Department's Strategic Plan (DSP). A target variable was constructed based on the engagement of the faculty in selecting the appropriate target activities from the original numeric department's Activity Performance Standard Database (APSD) during a specific period. The APSD has four distinct criteria, as shown in Tables 1-4: teaching and instruction standards, scholarly activity standards, community service standards, and exceptional development standards. All criterion items are prepared by faculty in his/her Faculty Improvement Plan and will be compared later with the actual achievements. The institution has minimum yearly required points per faculty, based on its strategic plan. Each criterion item has a different nature of contribution determined by the institution and based on the degree of importance in the strategic plan. It is classified as excellent, superior and good.

Furthermore, each criterion is classified into three value categories –superior, excellent, and good with different activities worth as follows (Table 5):

1. Each activity in the superior category is worth 3-point values,
2. Each activity in the excellent category is worth 2-point values, and
3. Each activity in the good category is worth a 1-point value.

Evaluation technology: How? This aspect refers to the methodology and procedures of a given approach to faculty evaluation, which is the mix of tools and criteria and standards used in the TBE faculty evaluation model. Faculty evaluation may be based on a combination of tools such as self-evaluation, classroom observation, department evaluation, performance indicators, satisfaction surveys, and external evaluation. It is undertaken concerning criteria and standards for the teaching profession, such as students learning outcomes, references, and performance. A statistical analysis model was used for faculty evaluation by applying MatLab.

Capabilities to evaluate and use response: By whom? This aspect concerns the arrangement to assess, to be evaluated and to use the results of the evaluation. It includes evaluators, such as faculty, peers, department chair, students and mentors to perform the assessment; and users for feedback, such as faculty, institution leaders, administrators, policymakers, etc.

Agents involved: With whom? This aspect generally deals with the application aspects of both faculty and institution evaluation procedures. Thus, it relates to the participation of a range of stakeholders such as students, faculty, institution leaders, educational administrators, policymakers, parents, communities, unions and education professionals.

Aspects gained: What? The main benefits of implementing this model are described in three criteria groups: faculty assessment, institution evaluation and strategic/decision-making.

Purposes: For what? It includes the objectives of the TBE evaluation model and the mechanisms designed to assure that the evaluation results are used in a way such goals are reached. Moreover, the purposes of a faculty evaluation model typically consist of improvement and accountability. Examples of mechanisms to use evaluation results feedback include performance feedback, professional development plans, financial and other rewards, Information/Publication of results and Policy adjustments/development.

Algorithm of Target-Based Engagement Statistical Model

The research set out to develop a TBE assessment model of faculty members. The algorithm of the TBE statistical analysis module consists of the following modules (Figure 2):

1. Model Inputs: Faculty Member Activity Plan
   1.1. Category Level:

Equation (1) represents an example of the planned assessment points of a superior category (teaching standards criterion) that worth 3-points per activity.

$$Teaching\ Superior\ Category\ Planned\ Points = \sum_{i=1}^{n} 3.TSi \qquad (1)$$

Where;
T_{Si} = Teaching superior category planned activities (T_{S1}, T_{S2}, ……., T_{Sn}),
3 = Worth points for each activity included in the superior category, and
n = Number of selected activities

Equation (2) represents an example of the planned assessment points of an excellent category (scholarly activity standards criterion) that worth 2-points.

$$Scholarly\ Excellent\ Category\ Planned\ Points = \sum_{j=1}^{n} 2.SEj \qquad (2)$$

Where;
S_{Ej} = Scholarly excellent category planned activities (S_{E1}, S_{E2}, ……., S_{En}),

2 = Worth points for each activity included in the excellent category, and
n = Number of selected activities

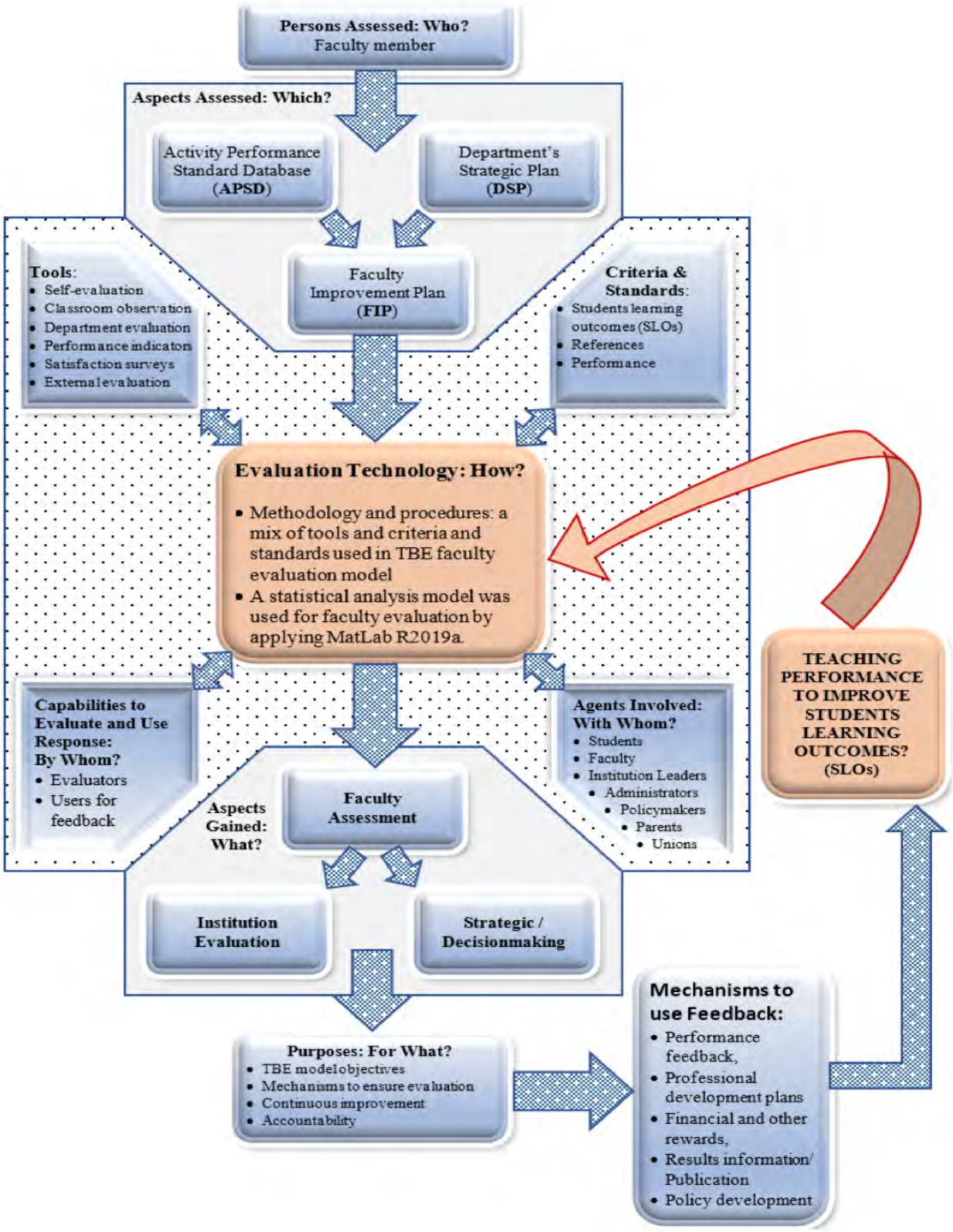

Figure 1: The Conceptual Framework for TBE Faculty Evaluation Model

Table 1: Faculty teaching activities plan

Engineering & Technology Dept. **Faculty Activities Plan** Faculty Name: ABC									
Plan Activities		**Proposed Plan**		**Actual Achievement**			**Final Adjusted Points**	**Assessment Progress, %**
		Activities	**Points**	**Activities**	**Points**	**Quality**		
1. Teaching (Superior Performance = 18 Points, Excellent performance = 14 Points, Good Performance = 10, Unacceptable Performance = 4)								
1.A. Superior Value (3 points) "Direct Evaluation"			**15.00**				**10.20**	**68%**
1.A.1	Review teaching evaluations based on department standard and implement a research-based change (required each year)	**1**	3.00	1	3.00	**75%**	**2.25**	**75%**
1.A.2	Attend a half-day CETL workshop and implement a research-based teaching change	**1**	3.00	1	3.00	**90%**	**2.70**	**90%**
1.A.3	Attend a CETL teaching circle that meets multiple days and implement a research-based change	**1**	3.00	1	3.00	**85%**	**2.55**	**85%**
1.A.4	Complete a significant formative assessment of student learning and implement a research-based change	**1**	3.00		-		**-**	**0%**
1.A.5	New preparation for a three-hour course	**1**	3.00	1	3.00	**90%**	**2.70**	**90%**
1.A.6	Teaching Effectiveness and ability		-		-		**-**	**0%**
1.A.7	Course visiting/observations of classroom presentation, teaching style and instructional methods and tools		-		-		**-**	**0%**
1.A.8	Syllabi, course objectives, course scope, depth and sequence of course material		-		-		**-**	**0%**
1.A.9	Teaching and examination methodology, material and using Canvas		-		-		**-**	**0%**
1.A.10	Student Learning Outcomes		-		-		**-**	**0%**
1.B. Excellent Value (2 points) "Reports" at least 1 / semester			**4.00**				**3.40**	**85%**
1.B.1	Professional Knowledge - understanding curriculum, subject content, and student needs		-		-		**-**	**0%**
1.B.2	Instructional Planning - using SUU curricula and standards, effective strategies, and resources, to address student needs	1	2.00	1	2.00	**90%**	**1.80**	**90%**
1.B.3	Instructional Strategies - engaging students in active learning to facilitate the students' acquisition of vital knowledge and skills		-		-		**-**	**0%**
1.B.4	Differentiated Instruction - challenging student's learning by providing appropriate content which addresses individual learning differences	1	2.00	1	2.00	**80%**	**1.60**	**80%**
1.B.5	Assessment Strategies - choosing a variety of diagnostic, formative, and summative assessment strategies that are valid and appropriate for the content		-		-		**-**	**0%**
1.B.6	Assessment Uses - measuring student progress, to inform instructional content and delivery methods		-		-		**-**	**0%**
1.B.7	Positive Learning Environment - providing a well-managed, safe, and orderly environment that is conducive to learning		-		-		**-**	**0%**
1.B.8	Academically Challenging Environment - creating a student-centered, academic environment in which teaching and learning occur at high levels and students are self-directed learners		-		-		**-**	**0%**
1.B.9	Professionalism - exhibiting a commitment to professional ethics and the department's mission and participating in professional growth opportunities to support student learning		-		-		**-**	**0%**
1.B.10	Other report/activity deemed (by the Department Chair) to be of similar caliber		-		-		**-**	**0%**
1.C. Good Value (1 point) "Any other Pieces of evidence"			**2.00**				**2.00**	**100%**
1.C.1	Attend a half-day CETL workshop without implementing a change		-		-		**-**	**0%**
1.C.2	Mentor a senior design group		-		-		**-**	**0%**
1.C.3	Review one teaching-related conference or journal paper	1	1.00	1	1.00	**100%**	**1.00**	**100%**
1.C.4	Assess the impact of a continuous improvement item using an appropriate methodology		-		-		**-**	**0%**
1.C.5	Evidence of creation of an organized learning environment (syllabi, course outlines, learning objectives, study guides, etc.)	1	1.00	1	1.00	**100%**	**1.00**	**100%**
1.C.6	Evidence of creative, thoughtful and thorough methods and materials (electronic media, unique field experiences, lab experiences, classroom activities, projects, etc.)		-		-		**-**	**0%**
1.C.7	Evidence of seeking and receiving feedback from students and others about teaching performance (student scores and comments, peer evaluations of classroom and/or materials)		-		-		**-**	**0%**
1.C.8	Evidence of thoughtful reflection about the feedback (analysis of quantitative and qualitative data, summary, overviews, etc.)		-		-		**-**	**0%**
1.C.9	Evidence of adjustments made (comments about what worked and didn't work and thoughts of why)		-		-		**-**	**0%**
1.C.10	Other evidence/activity deemed (by the Department Chair) to be of similar caliber		-		-			**0%**
Sub-Total (Teaching)			**21.00**				**15.60**	**74%**

Table 2: Faculty scholarly activities plan

Engineering & Technology Dept.	**Faculty Activities Plan**					Faculty Name: ABC		
Plan Activities		**Proposed Plan**		**Actual Achievement**			**Final Adjusted Points**	**Assessment Progress, %**
		Activities	**Points**	**Activities**	**Points**	**Quality**		
2. Scholarly (Superior Performance = 12 Points, Excellent Performance = 9 Points, Good Performance = 5, Unacceptable Performance = 2)								
2.A. Superior Value (3 points)			**12.00**				**5.55**	**46%**
2.A.1	Publication in peer-reviewed venues (conference proceedings or journals)	1	3.00	1	3.00	**100%**	**3.00**	**100%**
2.A.2	Formal collaborative undergraduate research (faculty-student) that will result in dissemination		-		-		-	**0%**
2.A.3	Publication of a book or commercial lab manual	1	3.00		-		-	**0%**
2.A.4	Present an online short course in connection with a conference by invitation or request	1	3.00	1	3.00	**85%**	**2.55**	**85%**
2.A.5	Conducting a workshop or formal training for SUU faculties and staff		-		-		-	**0%**
2.A.6	Participation in projects that result in a Funded External Grant over $40,000 (Principal or Co-Principal Writer) OR Director of a multi-year project involving over $100,000 in funding		-		-		-	**0%**
2.A.7	Implementation results of faculty/student scholarly projects or activities		-		-		-	**0%**
2.A.8	Formal review of a college/department program by request	1	3.00		-		-	**0%**
2.A.9	Pedagogical research or work in a successful ABET accreditation (Principal Writer)		-		-		-	**0%**
2.A.10	Develop a course that results in distribution (presenting it at a conference, for example)		-		-		-	**0%**
2.B. Excellent Value (2 points)			**4.00**				**1.80**	**45%**
2.B.1	Poster or oral presentation at scholarly/professional venue		-		-		-	**0%**
2.B.2	Work with students who present a poster/ paper at professional meetings		-		-		-	**0%**
2.B.3	Publication of a book chapter or section		-		-		-	**0%**
2.B.4	On-line workshop or presentation		-		-		-	**0%**
2.B.5	Presentation at a national or international professional event or conference		-		-		-	**0%**
2.B.6	Participation in projects that result in a Funded External Grant over $20,000.00-$39,000 (Principal or Co-Principal Writer) OR Director of the multi-year project involving $40,000-$99,999 in funding		-		-		-	**0%**
2.B.7	Engaging in scholarly activity that gives rise to the improvement or development of curriculum	1	2.00		-		-	**0%**
2.B.8	Referee an article in an online venue or journal OR review a text or lab manual by request of the publisher		-		-		-	**0%**
2.B.9	Contributor for national accreditation or accreditation review		-		-		-	**0%**
2.B.10	Reviewing, creating, investigating, or applying software applications in new ways	1	2.00	1	2.00	**90%**	**1.80**	**90%**
2.C. Good Value (1 point)			**1.00**				**0.75**	**75%**
2.C.1	Published article in a non-refereed journal or other print or electronic medium		-		-		-	**0%**
2.C.2	Work with students who present a poster/paper at a non-refereed journal or other print or electronic medium		-		-		-	**0%**
2.C.3	Book review for the publishing company	1	1.00	1	1.00	**75%**	**0.75**	**75%**
2.C.4	On-line related-venue		-		-		-	**0%**
2.C.5	Conducting a formal training or workshop OR serving as a guest lecturer in a colleague's class		-		-		-	**0%**
2.C.6	Professional consultation report which is submitted in writing to a client that has local impact OR Co-PI of multi-year funded grant ($40,000-$99,999)		-		-		-	**0%**
2.C.7	Be nominated for a scholarly award		-		-		-	**0%**
2.C.8	Review an article or five abstracts in a journal, conference or online venue		-		-		-	**0%**
2.C.9	Develop pedagogy that results in dissemination (presenting at a conference, CARAT, etc.)		-		-		-	**0%**
2.C.10	Developing assessment criteria, methods or materials		-		-		-	**0%**
Sub-Total (Teaching)			**17.00**				**8.10**	**48%**

Table 3: Faculty service activities plan

Engineering & Technology Dept.	**Faculty Activities Plan**						Faculty Name: ABC	
Plan Activities		**Proposed Plan**		**Actual Achievement**			**Final Adjusted Points**	**Assessment Progress, %**
		Activities	**Points**	**Activities**	**Points**	**Quality**		
3. Service (Superior Performance = 10 Points, Excellent Performance = 6 Points, Good Performance = 3, Unacceptable Performance = 1)								
3.A. Superior Value (3 points)			**6.00**				**5.55**	**93%**
3.A.1	Chairing any Departmental, College, or University committee		-		-		-	**0%**
3.A.2	Serving on any hiring committee		-		-		-	**0%**
3.A.3	Working as Engineering Club advisor [due to the planning time commitment]	1	3.00	1	3.00	**85%**	**2.55**	**85%**
3.A.4	Working in an official position for a regional or national professional society, or a state entity (such as USHE or USOE)		-		-		-	**0%**
3.A.5	Accompanying students to regional, national or international conferences where students' original or collaborative work is presented		-		-		-	**0%**
3.A.6	Serving on the Faculty Senate		-		-		-	**0%**
3.A.7	Working on an LRT Committee (at any level)	1	3.00	1	3.00	**100%**	**3.00**	**100%**
3.A.8	Other achievements /activities deemed by the Department Chair to be of similar caliber		-		-		-	**0%**
3.B. Excellent Value (2 points)			**2.00**				**2.00**	**100%**
3.B.1	Serving on the Provost's Retention Committee		-		-		-	**0%**
3.B.2	Working on the College Recruitment and Retention Committee		-		-		-	**0%**
3.B.3	Working on the Departmental Recruitment and Retention Committee		-		-		-	**0%**
3.B.4	Serving on the Department Curriculum Committee	1	2.00	1	2.00	**100%**	**2.00**	**100%**
3.B.5	Serving on the Undergraduate Research Committee		-		-		-	**0%**
3.B.6	Working as a course coordinator for a Departmental course		-		-		-	**0%**
3.B.7	Service in the SUU community (including other committees)		-		-		-	**0%**
3.B.8	Service as a supervisor of an organization or student club		-		-		-	**0%**
3.B.9	Other achievements/activities deemed by the Department Chair to be of similar caliber		-		-		-	**0%**
3.C. Good Value (1 point)			**2.00**				**1.75**	**88%**
3.C.1	Membership in a professional organization (ASEE, AIAA, ASCE, ASME, ASM, ASTM, IEEE, etc.)		-		-		-	**0%**
3.C.2	Be designated for a service award or other professional recognition		-		-		-	**0%**
3.C.3	Work as a supervisor of a group preparing for a non-technical competition	1	1.00	1	1.00	**75%**	**0.75**	**75%**
3.C.4	Engineering-related service in the non-SUU community		-		-		-	**0%**
3.C.5	Serving as a Science Fair judge		-		-		-	**0%**
3.C.6	Serving on the University Finance Committee		-		-		-	**0%**
3.C.7	Serving on the University Honors Committee	1	1.00	1	1.00	**100%**	**1.00**	**100%**
3.C.8	Other achievements/activities deemed by the Department Chair to be of similar caliber		-		-		-	**0%**
Sub-Total (Service)			**10.00**				**9.30**	**93%**

Table 4: Faculty exceptional development activities plan

Engineering & Technology Dept.	**Faculty Activities Plan**	Faculty Name: ABC

Plan Activities		Proposed Plan		Actual Achievement			Final Adjusted Points	Assessment Progress, %
		Activities	Points	Activities	Points	Quality		
4. Exceptional Development (Superior Performance = 10 Points, Excellent Performance = 6 Points, Good Performance = 3, Unacceptable Performance = 1)								
4.A. Superior Value (3 points)			**6.00**				**5.25**	**88%**
4.A.1	External or university awards, honors or other recognition for intellectual contributions		-		-		-	**0%**
4.A.2	Processes used for and the development of the existing program; such as Canvas	1	3.00	1	3.00	**100%**	**3.00**	**100%**
4.A.3	Leading the process of setting, monitoring and achieving specific and challenging goals or strategies that reflect high expectations		-		-		-	**0%**
4.A.4	Leading an implemented departmental program/workshop shows the vision of continuous improvement	1	3.00	1	3.00	**75%**	**2.25**	**75%**
4.A.5	Building any data-tracking systems		-		-		-	**0%**
4.A.6	Leading a project that represents department improvement; such as (Strategic Plan)		-		-		-	**0%**
4.A.7	Service to professional organizations or publishing applicable papers, studies or projects to support the profession		-		-		-	**0%**
4.A.8	Leading a leadership team		-		-		-	**0%**
4.A.9	Leading a staff development program; such as the leader of an enhancing mechanism		-		-		-	**0%**
4.A.10	Other activities/achievements deemed by the Department Chair to be of similar caliber		-		-		-	**0%**
4.B. Excellent Value (2 points)			**4.00**				**1.50**	**38%**
4.B.1	Participating in an implemented departmental program/workshop shows the vision of continuous improvement		-		-		-	**0%**
4.B.2	Participating in a project that represents department improvement; such as (Strategic Plan)		-		-		-	**0%**
4.B.3	Participating in a leadership team		-		-		-	**0%**
4.B.4	Participating in a staff development program; such as a member of an enhancing mechanism	1	2.00	1	2.00	**75%**	**1.50**	**75%**
4.B.5	Sharing in analysis and revision of curriculum, instruction, assessments and allocation of resources to ensure alignment of courses with SUU standards		-		-		-	**0%**
4.B.6	Build group conversations– topics and agendas		-		-		-	**0%**
4.B.7	Sharing in analysis work of measuring Value-Added to students at the end of any semester	1	2.00		-		-	**0%**
4.B.8	Participating in any lessons learning workshops		-		-		-	**0%**
4.B.9	Sharing in activities related to a shared vision of continuous improvement		-		-		-	**0%**
4.B.10	Other activities/achievements deemed by the Department Chair to be of similar caliber		-		-		-	**0%**
4.C. Good Value (1 point)			**2.00**				**0.75**	**38%**
4.C.1	Professional development for self and staff – notes, agendas, minutes		-		-		-	**0%**
4.C.2	Any documentation processes for the department activities to be used later in any continuous development work		-		-		-	**0%**
4.C.3	Scheduling site visits from education associations or industry (at least 2/year)	1	1.00	1	1.00	**75%**	**0.75**	**75%**
4.C.4	Allocate resources, including technology, to assist student and staff learning		-		-		-	**0%**
4.C.5	Create a collaborative learning culture		-		-		-	**0%**
4.C.6	Staff meeting observations for problem-solving		-		-		-	**0%**
4.C.7	Following-up department meeting minutes		-		-		-	**0%**
4.C.8	Booster club information	1	1.00		-		-	**0%**
4.C.9	Following-up programs that allow alumni to return and give back		-		-		-	**0%**
4.C.10	Other activities/achievements deemed by the Department Chair to be of similar caliber		-		-		-	**0%**
Sub-Total (Creativity)			**12.00**				**7.50**	**63%**
Total Assessment, based on Faculty Plan			**60.00**				**40.50**	**68%**
Total Assessment, based on Required			**50.00**				**40.50**	**81%**

Table 5: Relative weights of the department's activity performance standard database module

Model Relative Weights						
Assessment Category	Superior		Excellent		Good	
	Score	%age	Score	%age	Score	%age
Teaching	18	36%	14	39%	10	48%
Scholarly	12	24%	9	25%	5	24%
Service	10	20%	6	17%	3	14%
Exceptional Development	10	20%	7	19%	3	14%
Total	50	100%	36	100%	21	100%

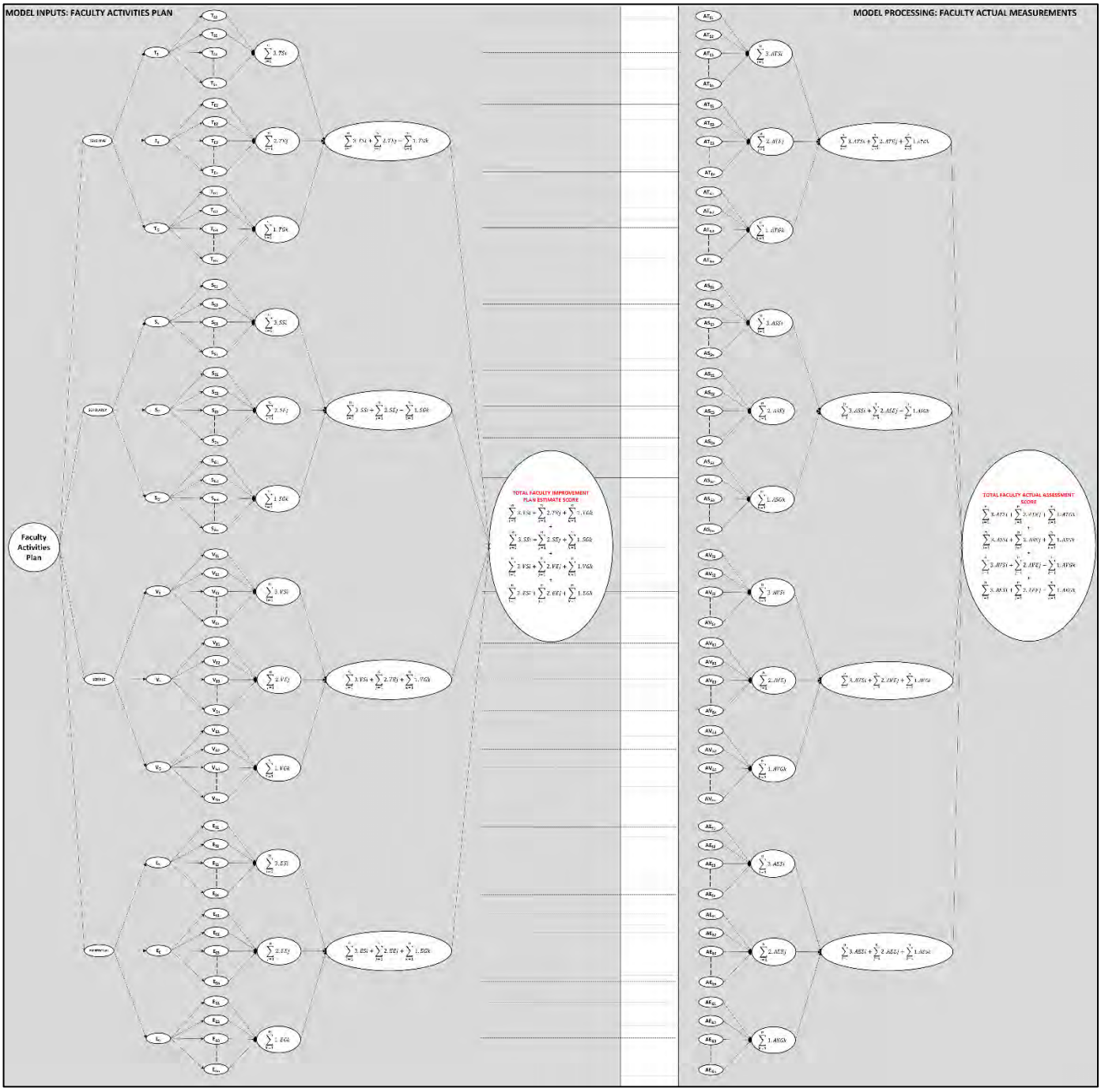

Figure 2: Engagement assessment statistical model of faculty members

Equation (3) represents an example of the planned assessment points of a good category (service activity standards criterion) that worth 1-point per activity.

$$Service\ Good\ Category\ Planned\ Points = \sum_{k=1}^{n} 1.VGk \quad (3)$$

Where;
V_{Gk}= Service good category planned activities (V_{G1}, V_{G2}, ……., V_{Gn}),
1 = Worth points for each activity included in the good category, and
n = Number of selected activities

1.2. Criteria Level:
Equation (4) represents an example of the planned assessment points of a criteria level (case of teaching activity standards criterion).

$$Teaching\ Planned\ Points = \sum_{i=1}^{n} 3.TSi + \sum_{j=1}^{n} 2.TEj + \sum_{k=1}^{n} 1.TGk \quad (4)$$

Where;
T_{Si}= Teaching superior category planned activities (T_{S1}, T_{S2}, ……., T_{Sn}),
T_{Ej}= Teaching excellent category Planned Activities (T_{E1}, T_{E2}, ……., T_{En}),
T_{Gk}= Teaching good category planned activities (T_{G1}, T_{G2}, ……., T_{Gn}),
3 = Worth points for each activity included in the superior category,
2 = Worth points for each activity included in the excellent category,
1 = Worth points for each activity included in the good category, and
n = Number of selected activities

1.3. Faculty Improvement Plan Level:
Equation (5) represents the total planned assessment points of the faculty member improvement plan.

$$\begin{aligned} Total\ Planned\ Points = & \sum_{i=1}^{n} 3.TSi + \sum_{j=1}^{n} 2.TEj + \sum_{k=1}^{n} 1.TGk + \\ & \sum_{i=1}^{n} 3.SSi + \sum_{j=1}^{n} 2.SEj + \sum_{k=1}^{n} 1.SGk + \\ & \sum_{i=1}^{n} 3.VSi + \sum_{j=1}^{n} 2.VEj + \sum_{k=1}^{n} 1.VGk + \\ & \sum_{i=1}^{n} 3.ESi + \sum_{j=1}^{n} 2.EEj + \sum_{k=1}^{n} 1.EGk \end{aligned} \quad (5)$$

2. Model Processing: Faculty Member Actual Measurements
The statistical model was used to represent, frequently in the significantly idealized form, the data-generating process. The model was specified as a mathematical relationship between one or more random variables and additional non-random variables. Two main statistical methods were used in the data analysis: descriptive statistics, which summarized data from a sample using indices such as the mean or standard deviation, and inferential statistics, which concluded from the data that were subject to random variation. The actual points of the yearly FIP were compared with the planned ones to create a score by using the above formulas. The value categories were automatically

awarded and calculated for all different levels of the university, department, and faculty by using MatLab R2019a. The model calculates the total faculty actual performance in three levels:

2.1. Category Level.

2.2. Criteria Level.

2.3. Faculty Improvement Plan Level:

Equation (6) represents the total actual assessment points of the faculty member.

$$Total\ Actual\ Points = \sum_{i=1}^{n} 3.ATSi + \sum_{j=1}^{n} 2.ATEj + \sum_{k=1}^{n} 1.ATGk + \sum_{i=1}^{n} 3.ASSi + \sum_{j=1}^{n} 2.ASEj + \sum_{k=1}^{n} 1.ASGk + \sum_{i=1}^{n} 3.AVSi + \sum_{j=1}^{n} 2.AVEj + \sum_{k=1}^{n} 1.AVGk + \sum_{i=1}^{n} 3.AESi + \sum_{j=1}^{n} 2.AEEj + \sum_{k=1}^{n} 1.AEGk \quad (6)$$

3. Model Outputs: Statistical Analysis of Faculty Assessment

The TBE model outputs were figured based on the statistical experiments that can be summarized in the following:

1. Direct outputs: Dashboard of faculty performance indicators (Figures 3-14). They are those outputs that calculated and developed directly in the model.
2. Indirect Outputs: Dashboard of the institution's performance and strategic decision-making indicators. They are outputs that need more processing and calculation to figure out the indicators.

TBE Analysis and Implementation

The TBE model is a robust statistical framework for automatic faculty assessment. It is a simplified, mathematically-formalized way and optionally to make predictions from this approximation to analyze the performance measurements and help in the institutional development decision-making. It measures the performance of the faculty's contribution in a given year. The data were collected from the faculty activity development plan in the Engineering and Technology Department at Southern Utah University in the year of 2018-2019. For ethical consideration and confidentiality, all collected data were without compromising the identities of their respondents.

Table (1) shows that the total proposed faculty teaching activities plan was 21.00 points, while the final adjusted points were 15.60, with achievement progress of 74%. Table (2) shows that the total proposed faculty scholarly activities plan was 17.00 points, while the final adjusted points were 8.10, with achievement progress of 48%. Table (3) shows that the total proposed faculty service activities plan was 10.00 points, while the final adjusted points were 9.30, with achievement progress of 93%. Table (4) shows that the total proposed faculty exceptional development activities plan was 12.00 points, while the final adjusted points were 7.50, with achievement progress of 63%. The total assessment was 60 points, based on the proposed plan, while the total final adjusted points were 40.50, with total achievement progress of 68%. The

total assessment was 50 points, based on the required achievements from the institution, while the total final adjusted points were 40.50, with total achievement progress of 81%.

Based on the institution's strategic plan, table (5) shows that the model teaching score designed for 'superior' as 18, 'excellent' as 14, and 'good' as 10. The model scholarly score designed for 'superior' as 12, 'excellent' as 9, and 'good' as 5. The model service score designed for 'superior' as 10, 'excellent' as 6, and 'good' is 3. The model exceptional development score designed for 'superior' as 10, 'excellent' as 7, and 'good' as 3.

The engagement of the faculty in achieving the activity performance of the institution was given emphasis on all the Tables from 1-4, while the engagement of the institution was given emphasis on table 5 and the minimum yearly required points per faculty. The evaluation conducted focused on both the engagement of each faculty and the required achievement of the institution's target plans.

Figure (3) shows the different rates of performance assessment for each criterion. They vary in teaching and instruction standards from 36% to 48%, scholarly activity standards from 24% to 25%, community service standards from 24% to 25%, and exceptional development standards from 14% to 20%. Figures from (4-7) show the yearly faculty plan assessment for each category (superior, excellent and good) and the total average assessment. The highest evaluation of the faculty was in community service standards, while the lowest one was in scholarly activity standards. Figure (8) shows the yearly faculty plan total Assessment for each criterion and the total average assessment. Figures (9-123) show the annual faculty member's qualitative and quantitative performance per each category and criterion (overall faculty average was 68%). The quantitative performance represents the faculty member degree of commitment, which reflects the FIP achievement degree (faculty average is 78%), while the qualitative performance represents the faculty member's degree of excellence, which reflects the work quality degree (faculty average is 87%), as calculated in Tables 1-4. Figure (13) shows the total yearly faculty member's qualitative and quantitative performance. Figure (14) shows the faculty member's continuous development in 5-years per each criterion and category.

Implementing the TBE Model equations will help the quality dimensions of the institutional higher education as follows:

Faculty Members

From the analysis of the model, faculty evaluation has a formative purpose that the results are used to help faculty development, self-improvement and growth, and personnel decisions on promotion and incentives.

Teaching Quality

From the statistical analysis module, faculty teaching performance will be improved specificity of feedback and alignment of assessments with the students' assessment survey. As mentioned in the activities plan of teaching and scholarly, faculty take advantage of the new technological tools to enhance student-to-faculty interaction and to better assess student progress. They connect with advanced teaching practices to improve their teaching materials and methods. Faculty take the opportunity to reflect on their own actions and role in the enhancement of teaching quality, obtaining a commitment to reflective practice and causing adaptation and innovation.

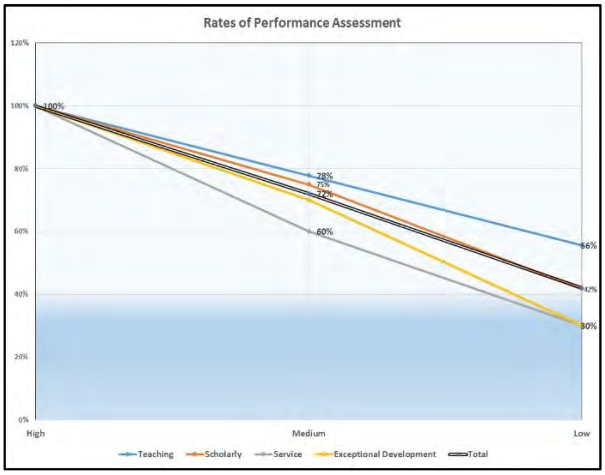

Figure 3: Rates of performance assessment

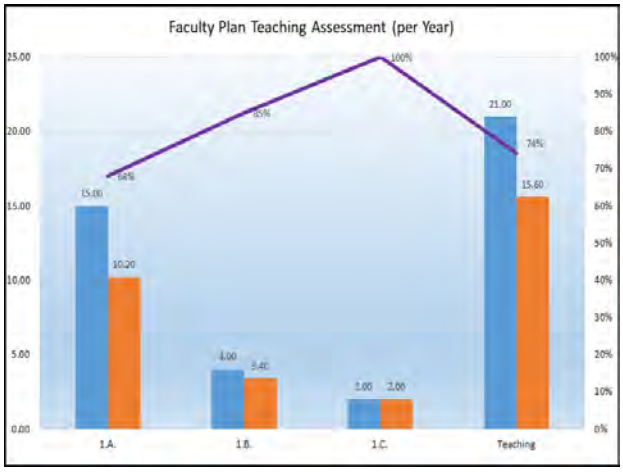

Figure 4: Faculty plan teaching assessment (per year)

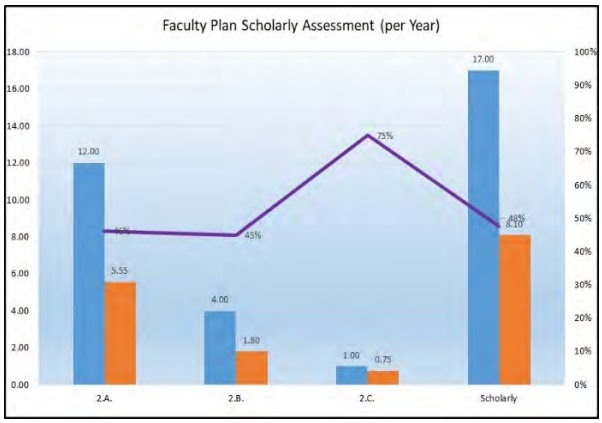

Figure 5: Faculty plan scholarly assessment (per year)

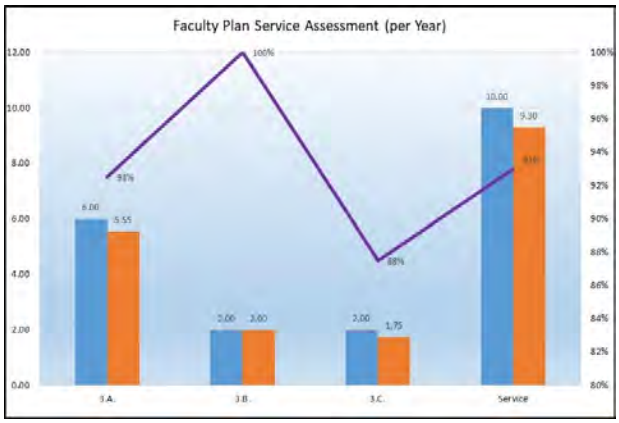

Figure 6: Faculty plan service assessment (per year)

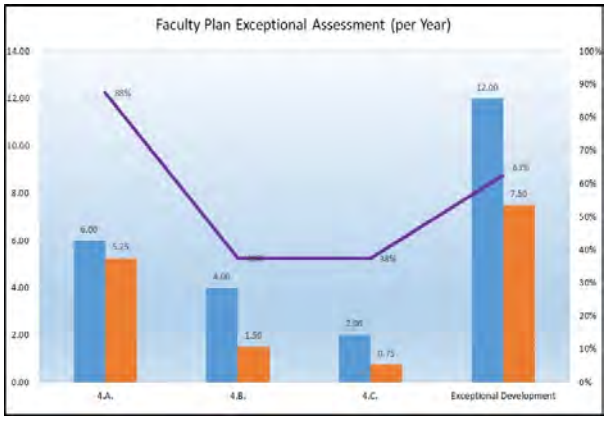

Figure 7: Faculty plan exceptional assessment (per year)

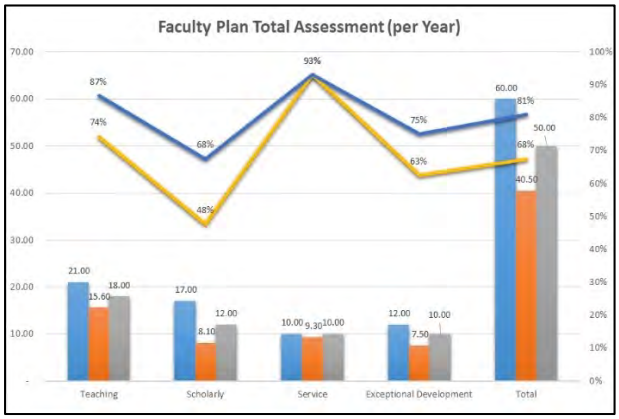

Figure 8: Faculty plan total assessment (per year)

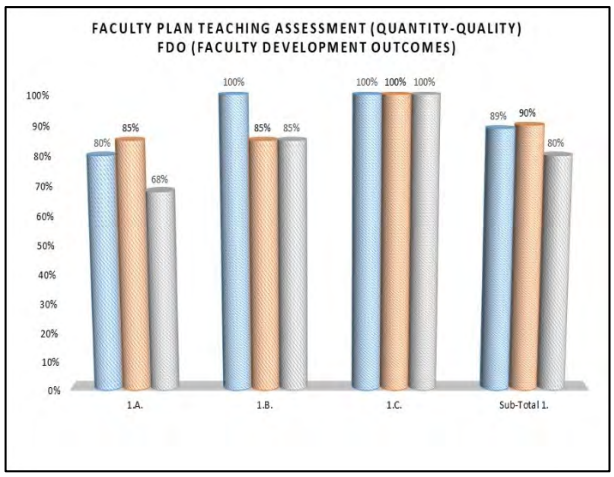

Figure 9: Faculty plan teaching assessment (quantity-quality)

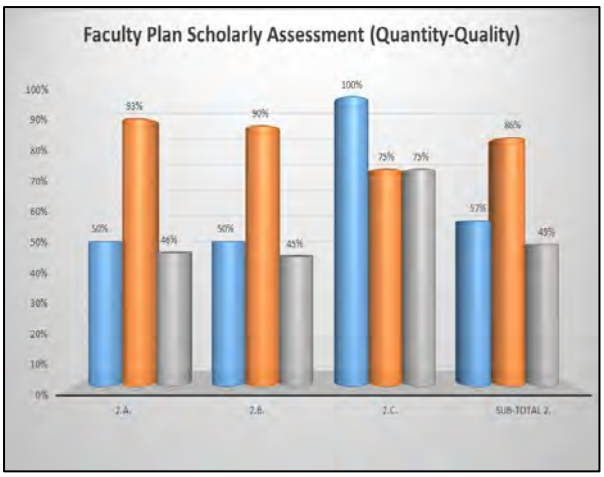

Figure 10: Faculty plan scholarly assessment (quantity-quality)

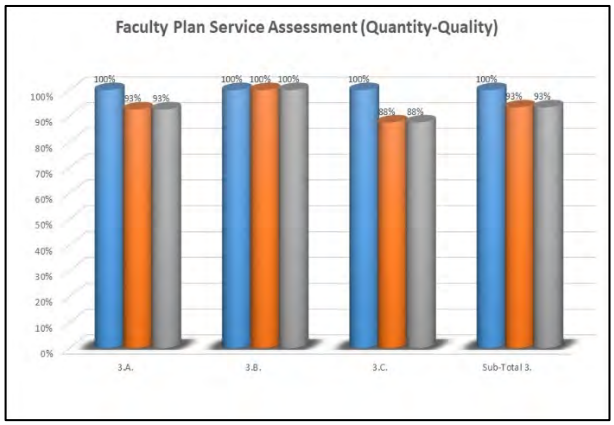

Figure 11: Faculty plan service assessment (quantity-quality)

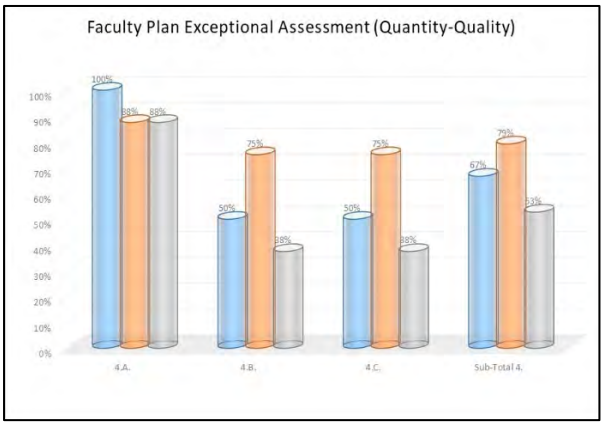

Figure 12: Faculty plan exceptional assessment (quantity-quality)

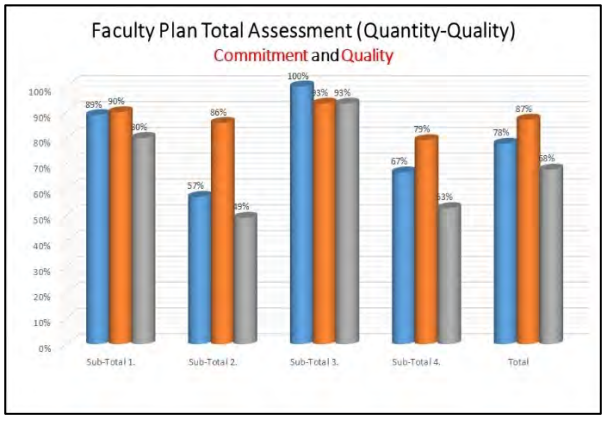

Figure 13: Faculty plan total assessment (quantity-quality)

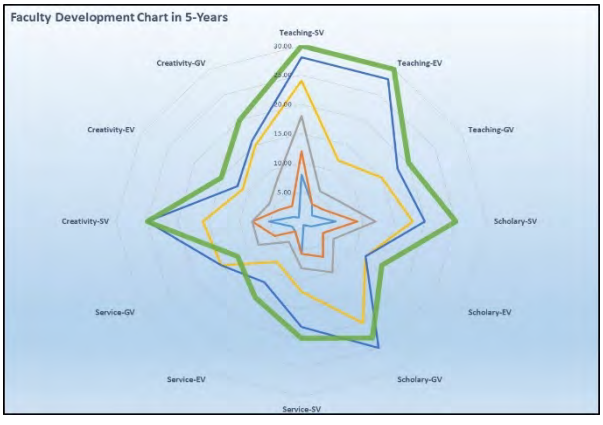

Figure 14: Faculty plan development chart in 5-Years (just for verification)

Teaching Competency Criteria

In addition to the faculty evaluation criteria by comparing equations (5) and (6), the model helps in having well-aligned information inside the different levels of the institution (university, department and faculty). The institutional teaching competency considering self-evaluations and learner assessment data are combined to guide programming for faculty development, which will help to improve the higher education performance in figuring out the following different criteria:

- Average program/department assessment
- Assessment comparison of all programs
- Average assessment for all department
- Top 5-faculty in the program/department
- Best program in the department
- Faculty/program/department continuous learning over time
- Institution development outcomes progress over time
- Average teaching/scholarly/service/creativity assessment per program/department
- Average teaching/scholarly/service/creativity continuous learning over time per program/department

Institution Strategic Decision-Making

Over the above, the model helps in supporting the following strategic decision-making of the institution:

- Strengths and weaknesses of program/department
- Faculty training needs analysis
- Institution strategic plan updating
- Faculty workload matrix
- Potentials for improvement plans
- Faculty promotion plans
- Building mechanisms to support faculty
- Continuous improvement quality circles

Students

Applying the TBE Model will help the students to collaborate actively with faculty in the definition of the initiative and of the quality of the teaching concept itself. The model will assist in keeping the interaction active and increasing concerns about teaching, learning environments, quality of content and faculty attitudes.

Conclusions

There is a worldwide interest in developing quantitative faculty member's activity evaluation models (Mitchell & Leachman, 2015). However, implementing a fair and reliable model is challenging. There are numerous existing different evaluation models for faculty members. The main objective of the current research is to propose a practical, comprehensive and flexible statistical Target-Based Engagement (TBE) assessment model of faculty members. The model considers both the specific faculty needs through selecting the matching activities in the faculty member's plan and the academic unit management concerns through providing a list of activities' references compatible with the unit strategic plan. The model involves several sequential phases and has a significant impact on enhancing faculty performance and institutional quality. The TBE model processing reliability was developed in the Department of Engineering and Technology at Southern Utah University. The statistical model helps improving faculty

performance and is considered a long-term improvement method in the academic profession. The consequences of this model will enhance the performance of higher education stakeholders.

The main components of TBE are:

1. Department strategic plan.
2. Department's Activity Performance Standard Database (APSD) classified into four main criteria: teaching and instruction standards, scholarly activity standards, community service standards, and exceptional development standards. Each criterion has three value categories (superior, excellent and good) with different activities worth.
3. Measurement Module (MM) that includes different methods for evaluating the faculty member's performance from various sources, such as department chair, self-assessment, students, peers, mentors, etc.
4. Faculty Improvement Plan (FIP) coordinated with the department's strategic plan.
5. Statistical Analysis Module (SAM) that automatically calculates all different levels of the university, department, and faculty by using MatLab R2019a.

Recommendations

The current research focuses on the determination of the reliability and validity of the suggested TBE model. Based on the gap analysis of the literature, the model does not describe the findings of the research study in detail, but rather it is representing the model design innovation, development, concept orientation and potential application of a new faculty assessment model. The application gives lesser importance as compared to the model development due to the implementation time limitation that requires collecting data for five years to establish the whole list of the statistical analysis aspects that the model could provide. In this paper, the implementation of the model was based on one year of collected data. Subsequent studies must include a more extended implementation period in order to determine the generalizability of the model.

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