ABET Preparation and Review Process at Queensborough Community College

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Given sufficient time along with a methodical approach the ABET preparation process can provide valuable insights into the educational performance of engineering and technology programs. There are multiple approaches to the preparation for an ABET accreditation visit. We will focus on the process used at Queensborough Community College in the Engineering Technology Department. The department's ABET accredited Associate Degree programs include Electronic Engineering Technology, Computer Engineering Technology and Mechanical Engineering Technology.

Preparation for ABET accreditation begins well in advance of the actual visit. An institution must begin preparing for an upcoming visit immediately after the most recent visit. The Engineering or Technology Department will either create an assessment committee or recruit new members to the committee that already exists. The first task of the ABET Departmental Assessment Committee [DAC] is to examine the ABET evaluation report and propose a course of action to address any concerns or findings. The implementation can be a lengthy process and may require approval at a level above the department.

The DAC should use the current ABET "Criteria for Accrediting Engineering Technology Programs" [i] document as a guide for ABET preparation. This paper will focus on the details of the ABET Criterion 3 Student Outcomes and Criterion 4 Continuous Improvement.[i]

The DAC should categorize the required subsections of the ABET self-study report at least three years before the accreditation visit. These sub-sections include data that might include faculty information, facilities, classrooms, laboratory equipment, computer resources, guidance, maintenance and institutional support.

The aforementioned DAC should then prepare a set of ABET specific performance indicators based on the Criterion 3 Student Outcomes. The committee then chooses the courses that best align with the performance indicators. Each course instructor will then choose assignments and develop rubrics as a metric to assess the ABET specific performance indicators. The instructors then assess the extent to which those performance indicators are met in each of the courses they are teaching. To support the assessment process the instructors collect student work, assess the performance indicators based on the rubrics, and submit the student work samples.

The DAC then averages the assessment data collected by the instructors in the set of courses for which the performance indicators are evaluated. At the end of the academic year, the averages for each performance indicator are compared to the predetermined threshold value. If the average is below the threshold, an analysis is initiated to determine the possible root causes of the performance being below the required level. The DAC and the faculty jointly develop recommended courses of action to address any issues identified at the completion of the rubric and assessment review. This forms the basis of the Continuous Improvement Plan and addresses ABET Criterion 4.[i]

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Introduction

A strategic plan for the ABET preparation and review process should be developed and implemented well in advance of the ABET accreditation visit. The ABET "Criteria for Accrediting Engineering Technology Programs"[i] provides an excellent guideline while preparing the self-study report. This paper will focus on Criterion 3 and Criterion 4. An overview of the assessment process at Queenborough Community College (QCC) is shown in Figure 1, (next page) QCC Engineering Technology ABET Assessment Process.

Criterion 3 Student Outcomes

One of the first priorities of the DAC (Department Assessment Committee) is to examine the ABET Student Outcomes. According to ABET, "Student outcomes describe what students are expected to know and be able to do by the time of graduation."[i] The given ABET Student Outcomes are broadly defined, which prompted us to develop a set of Specific Performance Indicators (referred to as ABET Specific Performance Indicators), at a more granular level that are closely aligned to our particular program and can be assessed quantitatively in our courses. The DAC developed a set of specific Performance Indicators based on the ABET Criterion 3 Student Outcomes[i]. The DAC and the faculty examined the Engineering technology program and accompanying course outlines to determine which courses are appropriate to assess the performance indicators. It was decided that every performance indicator would be assessed in more than one course in order to obtain a representative data set. Some performance indicators are appropriate for lecture and some for lab, while others can be assessed in both lecture and lab. Considerable effort and thought must be put into developing specific performance indicators, as these form the basis of the assessment to be performed. The instructor examines the specific performance indicator and then chooses assignments which are appropriate to assess the performance indicator. The instructor also decides whether the performance indicator can be appropriately assessed in a lecture or laboratory section.

Outcome A, states that students should have "an ability to apply the knowledge, techniques, skills, and modern tools of the discipline to narrowly defined engineering technology activities."[i] This outcome encompasses such a wide range of skills, therefore it could only be assessed properly by evaluating it in hardware, software, and instrumentation oriented courses. One of the specific performance indicators designated as ETa1 and corresponding to Student Outcome A is an indicator to demonstrate that students can analyze electronic circuits and systems. We correlated the performance indicator ETa1 with a set of courses which are appropriate for this assessment. We deemed it to be appropriate to assess ETa1 in Electrical Circuit Analysis I, Electronics I and Electrical Control Systems. The strategy was to capture the students' performance in an early semester course such as Electrical Circuit Analysis I and to track the students' progress through the program, by then performing an assessment in a course such as Electronics I, which is approximately at the mid-point of the program. The assessment culminates in an upper level course such as Electrical Control Systems as shown in Figure 3.

We wanted to perform the assessment in a linear circuit course, electronic devices course and a system level course. By assessing the performance indicators at different intervals during the program we obtain a good indication of the students' progress through the program as they transition towards graduation.

We decided that various Student Outcomes must be performed in lab, while others are well suited to lecture sections of the courses. For example, assessment of the performance indicators corresponding to Student Outcome C, which states "an ability to conduct standard tests and measurements, and to conduct, analyze, and interpret experiments"[i] would be performed in the laboratory section of the courses. In contrast, Student Outcome E, which states "an ability to identify, analyze, and solve narrowly defined engineering technology problems"[i] would be assessed in lecture sections of the courses. For example, instructors choose assignments where students measure current in the laboratory and apply Kirchhoff's Laws in the lecture.

Student Outcome B, states that students should have "an ability to apply a knowledge of mathematics, science, engineering, and technology to engineering technology problems that require limited application of principles but extensive practical knowledge."[i] In our Computer Engineering Technology curriculum, programming represents an integral part of applications of the STEM discipline. Software skills should be assessed in a course which utilizes a high level programming language and a course which focuses on machine language microprocessor programming.

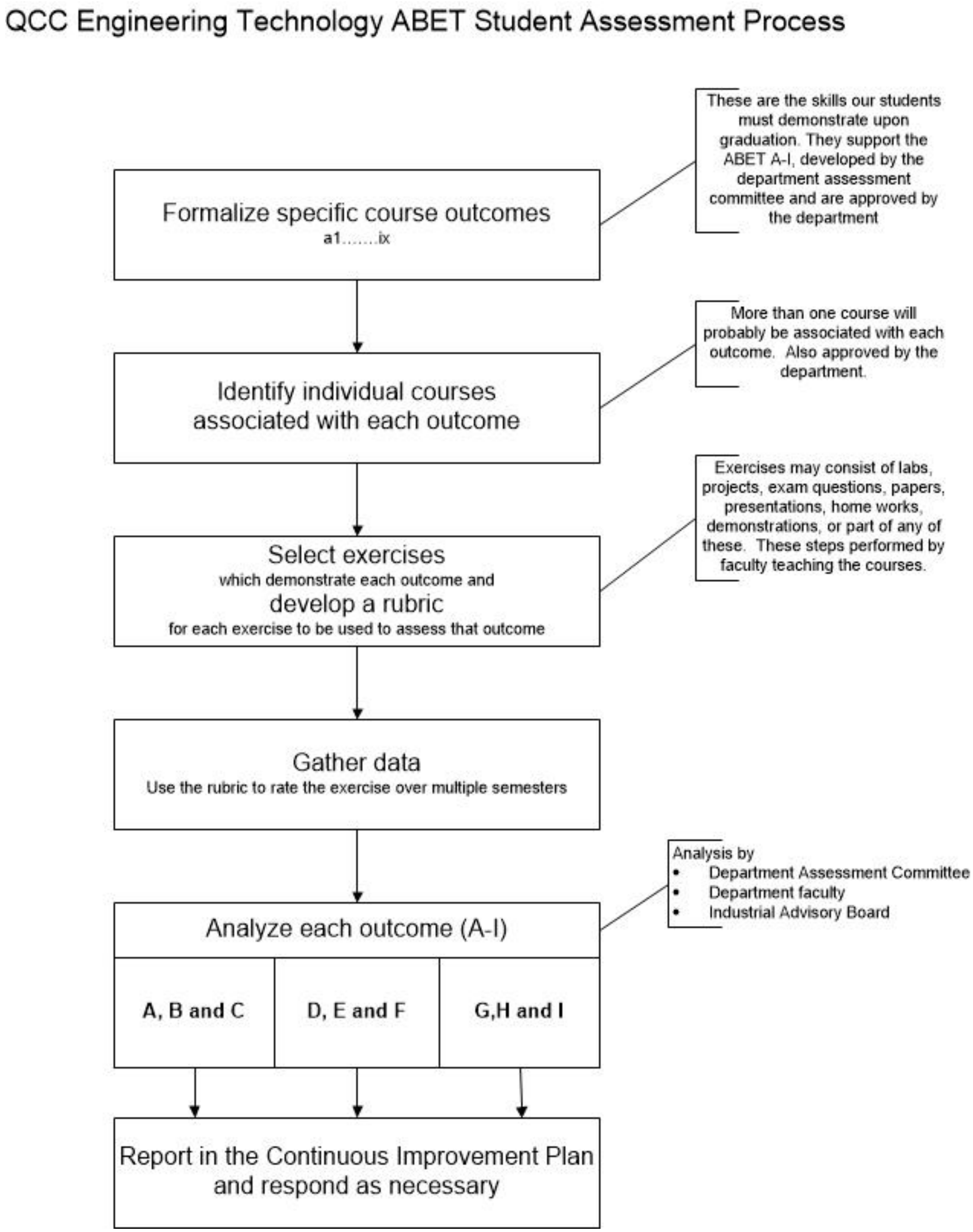

Figure 1. QCC Engineering Technology ABET Student Assessment Process [ii]

To evaluate Outcome D, which states "an ability to function effectively as a member of a technical team"[i] we choose a course containing an exercise that involves times constraints and an appropriate level of complexity that requires the squad to work as a team to accomplish the objective in the allotted time.

Student Outcome F, states that students should have "an ability to apply written, oral, and graphical communication in both technical and nontechnical environments; and an ability to identify and use appropriate technical literature."[i] Outcome F, is evaluated in laboratory courses where students are required to write lab reports, which convey measured data, compare measured and calculated results, and drawing conclusions based upon the comparisons.

Student Outcome G states that students should have "an understanding of the need for and an ability to engage in self-directed continuing professional development."[i] We assess this outcome in a course where students do research, analyze their findings, and present their findings to the class. Student Outcome G is also assessed in the clubs, which cover a wide variety of topics, where students are encouraged to participate and become involved in extracurricular activities, which align with their interests. In the curriculum, students are encouraged to perform research on both technical and nontechnical topics utilizing resources including books, internet and periodicals.

Student Outcome H states that students should have "an understanding of and a commitment to address professional and ethical responsibilities, including a respect for diversity."[i] At Queensborough Community College, we are fortunate to have a diverse population of students, which prompted us to develop an assignment where students reflect on and discuss their diverse backgrounds with their peers.

Student Outcome I states that students should have "a commitment to quality, timeliness, and continuous improvement."[i] The instructors assess this outcome in a course where the students' initial lab reports submission are graded and returned with comments. The students are encouraged to make revisions and resubmit the lab with improvements based on the instructors' feedback. Instructors can choose assignments which utilize a scaffolding approach where students can revise and resubmit their assignments with improvements. The choice of such assignments serves the dual purpose of assessing Student Outcome I in addition to other Student Outcomes. The students' resubmitted assignment submissions provide the instructor with the opportunity to look for improvements between the original and revised assignments.

In order to assess the performance indicators, the instructor chooses the assignments in such a way as to involve multiple concepts related to the applicable indicators. When considering an assessment exercise, the instructor considers factor such as time restraints on exams, as well as projects and homework in which the student have an opportunity to resubmit and improve their performance by utilizing the resources. In most cases, we found it to be an advantage when assessment occurs just beyond the midpoint of the semester in order to better assess the student learning and to give an instructor a chance to adjust their methodology and to give the student adequate time to comprehend the material.

The instructor develops the rubrics in order to reflect an increased level of mastery of the student outcome being assessed using each of the applicable performance indicators. The graded student work includes examinations, quizzes, laboratory reports, homework assignments, and projects. Specific exercises are identified in the courses that are used to assess associated performance indicators. For assessment purposes, the students' performance on each exercise is placed into Poor, Marginal, Good, or Excellent categories. The instructors examine the students completed work, categorize the performance according to the aforementioned rubrics, and tally the student headcount results for each category of the rubric. The headcount results are then inserted into the last row of the rubric for the associated performance indicator.

As an example, refer to Figure 2, where the instructor chooses the rubrics in such a manner that illustrates an increasing level of student performance between rubrics categories. Specifically, the marginal category infers that the students can write the time domain equations and take the Laplace Transform of the equations, while in the good category students can also solve the Laplace Transform domain equations. In order for students work to be included in the excellent category, the students build upon their previous steps by taking the Inverse Transform to find the time domain response.

Course number: ___________Section: _________ **Faculty name: __________________**

ABET Specific Performance Indicator –ETCTe4 **Year/semester of analysis:________**

ABET Student Outcome E - An ability to identify, analyze and solve narrowly defined engineering technical problems

Indicator & Exercise	Poor	Marginal	Good	Excellent
Performance Indicator e4 – Analyze and implement electronic and digital systems and circuits. **Exercise: <u>Quiz #2-Question 3</u>** Exercise description: Find current response i(t) in an R-C or R-L circuit by performing the following: Write the differential equation utilizing KVL, KCL, and the element equations. Then take the Laplace transform of the differential equation. Solve for the current I(s) in the Laplace transform domain. Convert the solution to the time domain response current i(t) by taking the inverse Laplace transform obtaining the transient and steady state response.	Students work on this assessment unable to reach the level considered as marginal.	1) The Students correctly wrote the Kirchhoff's Laws (KVL and KCL) and the element equations for the given circuit. 2) Students correctly identify the order of the system differential equation. 3) Students take the Laplace Transform of the differential equation to convert to the s-domain.	1) The Students correctly wrote the Kirchhoff's Laws (KVL and KCL) and the element equations for the given circuit. 2) Students correctly identify the order of the system differential equation. 3) Students take the Laplace Transform of the differential equation to convert to the s-domain. and: 4) Students correctly solved for the Laplace domain current I(s) and then expand into partial fractions.	1) The Students correctly wrote the Kirchhoff's Laws (KVL and KCL) and the element equations for the given circuit. 2) Students correctly identify the order of the system differential equation. 3) Students take the Laplace Transform of the differential equation to convert to the s-domain. 4) Students correctly solved for the Laplace domain current I(s) and then expand into partial fractions. and: 5) Students then find the inverse transform correctly in order to obtain the time domain solution for both the steady state and the transient response of the current.
Headcount (Number of students in each assessment category)				

Evaluation/Comments: The instructor feedback placed here, is useful in developing the recommendations contained in the continuous improvement plan.

Figure 2 Example of a Rubric corresponding to a Performance Indicator

Criterion 4. Continuous Improvement

Every semester the department collects all of the assessment data. The DAC (Department Assessment Committee) then analyzes the complete set of data based on student headcounts for each of the rubrics in all of our assessed courses. The student headcount data that would be recorded in each category shown in Figure-3, is based on the rubrics developed by the instructor in each class. The continuous improvement process begins with the DAC examining the weighted averages related to the head counts in each rubric category for every performance indicator submitted by the instructors in their courses every semester. This is a substantial amount of work performed by the instructors, DAC and administrative staff, and is a lengthy process. Therefore, institutions could choose to assess the performance indicators in a subset of the total course set and perform the assessment less frequently than every semester. The intent here is to have every performance indicator and their associated student outcomes examined at least twice in a six year ABET cycle.

In order to quantify the performance indicator assessment results, we calculate the *assessment* quality point average for each particular performance indicator as follows:

Average = {Σ (# of students in the pertinent category × assessment quality points for the pertinent category)} / (total # of students)

where the sum is taken over the Poor, Marginal, Good, and Excellent categories, and the categories are assigned the following number of assessment quality points:

- E (Excellent) receives four (4) quality points
- G (Good), receives three (3) quality points
- M (Marginal), receives two (2) quality point
- P (Poor), receives one (1) quality point

The *assessment* quality point average at Queensborough Community College is specifically calculated as follows:

$$\textbf{Average} = \frac{(S_P\times 1 + S_M\times 2 + S_G\times 3 + S_E\times 4)}{(S_P + S_M + S_G + S_E)}$$

Where : S_P = student headcount in the Poor assessment category

S_M = student headcount in the Marginal assessment category

S_G = student headcount in the Good assessment category

S_E = student headcount in the Excellent assessment category

As part of the continuous improvement process, the DAC examines the numerical *assessment* quality point average data to determine if the average for any performance indicator is below the predetermined threshold. If so, the DAC and the instructors work together to develop a suggested plan of action that will address the assessment results in the area of concern. The course of action is placed in the continuous improvement plan. The levels requiring action in response to the *assessment* quality point averages are defined as follows:

- Average ≥ 3.00: Performance Indicator assessment results are approaching the upper level of our expectations.
- 2.00 ≤ Average < 3.00: Performance Indicator assessment results are within the acceptable range, however improvements should be considered.
- Average < 2.00: Performance Indicator assessment results have reached an elevated level of concern and a course of action to address the concern must be included in the continuous improvement plan. For example, the Continuous Improvement Plan may contain an action plan item suggesting that the faculty should increase the time allotted to the topic associated with the concern raised by that performance indicator and then assign additional practice problems based on the topic.

The DAC created a departmental assessment website as part of the continuous improvement process. The website is used as a repository to disseminate the Engineering Technology Departmental ABET assessment data. This data includes the Technology Department's ABET Student Outcomes, Assessment Summary Reports for the "ABET Criterion 3 Student Outcomes A through I"[i], ABET Specific Performance Indicators, and the Continuous Improvement Plan. The Continuous Improvement Plan contains the assessment quality point averages for the departmentally developed ABET Specific Performance indicators in each course that is assessed. The DAC generates a set of Performance

Indicators Assessment Summary Reports for the courses assessed corresponding to the performance indicators.

An integral part of the continuous improvement process involves the review of the assessment data by the Industrial Advisory Board (IAB). [iii] The IAB consists of industry and business professionals throughout the New York Metropolitan area. The IAB members often employ graduates of our technology programs and also advise the faculty regarding the workplace environment. The IAB meeting with the faculty and the Department Assessment Committee (DAC) occurs once every semester, where one of the items on the agenda is to review three contiguous student outcomes such as outcomes (A,B and C), (D, E and F) and (G, H and I) . The IAB members provide a perspective based on industry experience, which complements the academic point of view of the faculty. The minutes, which are a record of the discussion and review process are retained and made available to both our faculty members and the visiting ABET accreditation accreditors. An additional part of the continuous improvement process is that both the faculty, who teach the pertinent courses, and the assigned DAC members review the course content and course outlines every year.

Conclusion

We would like to conclude this paper by providing a summary of our recommendations for the ABET preparation and review process. Each institution should develop and begin to implement a plan, which should lead to a successful ABET accreditation visit. The plan should include the formation of a Department Assessment Committee (DAC). The DAC should identify all of the sections that need to be included in the ABET Self-Study Report. The DAC uses the ABET Student Outcomes to develop a set of ABET Specific Performance Indicators. The faculty members in appropriate courses utilize the performance indicators, identify an assignment, and develop a rubric to assess the students' performance on the assignment. The instructor then performs the assessment and extrapolates the data based on the work submitted by the students. The DAC along with the faculty analyzes the assessment results and recommends the corrective courses of action as necessary. The suggested courses of action are placed in the continuous improvement plan. The totality of this data is utilized by the department chairperson to write the ABET Self-Study Report.

References

[i] http://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-technology-programs-2016-2017/

[ii] QCC Engineering Technology ABET Student Assessment Process Chart created by Dr. Belle Birchfield of the Queensborough Community College Engineering Technology Department

[iii] ETAC of ABET Self-Study Report for the Computer Engineering Technology Program at Queensborough Community College of The City University of New York and ETAC of ABET Self-Study Report for the Electrical Engineering Technology Program at Queensborough Community College of The City University of New York
by Chairperson Professor Stuart Asser

http://www.abet.org/accreditation/accreditation-criteria/

http://www.abet.org/accreditation/accreditation-criteria/accreditation-policy-and-procedure-manual-appm-2016-201

Queensborough Community College

Department of Engineering Technology

ET ABET Performance Indicator a1 Assessment Summary Report

Department	Engineering Technology							
	Engineering technology programs must demonstrate that their graduates have:							
Student Outcome A	An ability to apply the knowledge, techniques, skills, and modern tools of the discipline to narrowly defined engineering technology activities							
Performance Indicator a1:	Analyze electronic circuits and systems							
Semester								
Course #	Circuits I	Circuits I	Electronics I	Electronics I	Control Systems			
Section	Section A	Section B	Section C	Section D	Section E			
Instructor	Professor A	Professor B	Professor C	Professor D	Professor E			

Detailed Task	Section	E	G	M	P	Avg
Circuits I: Exam problem: Analyze series-parallel circuits with voltage and current sources using equivalent resistances, KVL, KCL, and Ohm's Law.	Section A	x	x	x	x	x
Circuits I: Exam problem: Analyze series-parallel circuits with voltage and current sources using equivalent resistances, KVL, KCL, and Ohm's Law.	Section B	x	x	x	x	x
Electronics I: Exam problem: Analyze a DC Power Supply that contains a contains a transformer, rectifier, filter, and regulator	Section C	x	x	x	x	x
Electronics I: Quiz problem– Determine common-emitter amplifier input and output impedances along with voltage gain from the circuit diagram and output voltage waveform.	Section D	x	x	x	x	x
Control Systems: Experiment Activity: Attached servo motor to a microcontroller and write a program which causes the wheels to rotate when the sensor detects no light.	Section E	x	x	x	x	x
Summary of ABET Performance Indicator a1		x	x	x	x	x

LEGEND

The spreadsheet measures and calculates quality point averages automatically for each item being considered.

- E (Excellent) receives four (4) quality points
- G (Good), receives three (3) quality points
- M (Marginal), receives two (2) quality point
- P (Poor), receives one (1) quality point

Instructor's Observations/Recommendations for Course Improvement

Legend: The spreadsheet measures and calculates quality point averages automatically for each item being considered.

- **E (Excellent) receives four (4) quality points**
- **G (Good), receives three (3) quality points**
- **M (Marginal), receives two (2) quality points**
- **P (Poor), receives one (1) quality points**

Figure 3 Performance Indicator Assessment Report