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AN INTEGRATED PDCA QUALITY MANAGEMENT MODEL FOR TECHNICAL UNIVERSITIES IN UZBEKISTAN

Munojot M. Gafurova
Doctoral Researcher, Tashkent State Transport University,
Tashkent, Uzbekistan
E-mail: gafurovamunojotó@gmail.com

Abstract

Technical universities require quality management systems that connect institutional assurance with the day-to-day improvement of teaching, laboratory learning, digital engagement, and industry relevance. This study develops and evaluates an integrated quality management model combining four blocks: goals, content, mechanisms, and outcomes. Its conceptual basis synthesizes Uzbek research on contextualized institutional management and sociological monitoring, the CIS tradition of educational qualimetry and competency assessment, and international quality-assurance standards. The mechanism block operationalizes the Plan–Do–Check–Act cycle through departmental quality teams, monthly data reviews, learning analytics, targeted student support, and structured cooperation with employers. A non-randomized pre-test/post-test study was conducted during the 2022–2023 academic year at two technical universities in Uzbekistan. The intervention group comprised 185 students at Tashkent State Transport University, while 172 students at Tashkent State Technical University formed the comparison group. Baseline integrated competency scores were statistically comparable. At post-test, the intervention group achieved a mean integrated score of 70.9 compared with 55.3 in the comparison group, $t(355)=19.92$, $p<0.001$, Cohen's $d=2.11$. The standardized difference in gain scores was 1.83. The share of students in the highest reported attainment band increased from 6.5% to 35.1% in the intervention group, whereas the comparison group changed from 6.4% to 7.6%. The findings support the practical value of linking quality assurance to actionable feedback and human support. Because the intervention was implemented at one institution without random assignment, the results should be interpreted as strong quasi-experimental evidence rather than definitive causal proof.

Keywords: technical higher education, quality management, PDCA cycle, learning analytics, engineering education, industry partnership, Uzbekistan.

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Introduction

The quality of technical higher education is increasingly judged by whether graduates can solve complex engineering problems, work in multidisciplinary teams, use digital tools, and respond to rapidly changing industrial requirements. These expectations place technical universities in a difficult position. They must comply with national standards and external accreditation requirements, but they must also create internal systems capable of detecting learning problems early and improving educational practice continuously. A quality system that is limited to documentation and periodic inspection cannot meet this challenge.

Uzbekistan has established a policy basis for this transition. The Concept for the Development of the Higher Education System until 2030 prioritizes stronger links among education, science, and industry, wider institutional autonomy, digitalization, international recognition, and improved educational quality [1]. The Law on Education defines state educational standards, accreditation, transparency, and quality requirements, while subsequent amendments have expanded the legal basis for international accreditation [2]. These reforms increase the responsibility of universities to build credible internal quality assurance systems rather than depend exclusively on external control.

International frameworks point in the same direction. ISO 21001:2025 emphasizes learner-centred educational management, stakeholder needs, inclusion, evidence-based decisions, and continual improvement [3]. The Standards and Guidelines for Quality Assurance in the European Higher Education Area distinguish internal assurance, external assurance, and the work of quality agencies, while treating institutional responsibility for quality as the starting point [4]. The central research problem is therefore not whether technical universities should collect quality data, but how such data can be converted into timely pedagogical decisions.

The national research tradition adds an essential contextual requirement. Uzbek scholars have shown that educational quality cannot be managed as a mechanically imported set of indicators. Umarova conceptualizes higher-education quality monitoring as a continuous examination of the conditions, process, and results of education [10]. Alikarieva emphasizes that a workable model must reflect the pedagogical culture and management practices of the institution [11], while Bekmurodov draws attention to national and socio-cultural factors in contemporary

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management [12]. These positions make contextual adaptation a substantive part of quality management rather than a secondary implementation issue.

This article proposes an integrated PDCA-based model designed for technical universities and examines its implementation in Uzbekistan. The study asks three questions: How can quality assurance, learning analytics, industry participation, and targeted student support be combined in a single operational model? Does implementation coincide with measurable improvement in students' integrated competence? Which design features and limitations should be considered before wider institutional adoption?

LITERATURE REVIEW AND CONCEPTUAL BASIS

Quality in higher education is not a single measurable property. Harvey and Green distinguish quality as exceptional performance, consistency, fitness for purpose, value for money, and transformation [5]. The CIS school of educational quality research complements this plural understanding with a systemic and measurable perspective. Subetto's higher-school qualimetry treats quality as an integrated characteristic whose components must be defined, weighted, and interpreted within the purposes of professional preparation [6]. Selezneva further presents the quality of higher education as an object of systemic inquiry connected with societal expectations and the development of the individual [7]. Together, these views justify an assessment architecture that combines institutional conditions, educational processes, and graduate outcomes.

A management model also requires operational goals. Potashnik defines educational quality through the relationship between explicitly formulated goals and achieved results [8]. Bolotov and Efremova extend this logic by treating quality assessment as a system in which standards, educational achievements, and evaluation procedures must be methodologically aligned [9]. For technical universities, this means that laboratory performance, engineering problem solving, teamwork, and professional reflection should not be appended to a quality report after teaching has occurred; they must be specified as intended outcomes and measured throughout programme delivery.

Uzbek scholarship provides the contextual layer of this framework. Umarova's large-scale study of sociological monitoring in Uzbekistan separates the quality of educational conditions, the quality of the process, and the quality of outcomes, and

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stresses the need for continuous stakeholder-based observation [10]. Alikarieva's modelling research argues that a university quality system should connect management requirements with the institution's pedagogical culture and should involve academic staff consciously in implementation [11]. Bekmurodov's analysis of contemporary management shows why national mentality, organizational relations, and locally rooted professional practices affect the acceptance of managerial change [12]. In technical education, these insights support the preservation of mentoring traditions while digital monitoring and industry partnerships are expanded.

The competency approach connects these systemic and contextual arguments to student learning. Bolotov and Serikov explain that competence is not reducible to recalled knowledge; it emerges through the learner's experience of solving meaningful problems, reflecting on action, and integrating knowledge across fields [13]. This is especially relevant to engineering education, where the decisive question is not merely what a student knows but what the student can design, diagnose, justify, and improve. The ABET criteria similarly require documented student outcomes, systematic assessment, adequate laboratories and computing resources, and use of evaluation results for continuous improvement [14].

The management logic of the proposed model derives from continuous improvement. Deming argued that quality improves when organizations replace end-stage inspection with the systematic improvement of processes and leadership [15]. In a university, the PDCA cycle can be translated into four recurring actions: define learning outcomes and resources; implement teaching and practice; review evidence on student progress; and modify curriculum, instruction, or support. This logic is consistent with Potashnik's goal–result relationship [8] and Alikarieva's insistence that staff participation and local adaptation are preconditions of a sustainable institutional model [11].

Learning analytics can make the "Check" stage faster, but analytics is not an intervention by itself. Ferguson describes learning analytics as the interpretation of learner-related data for understanding and optimizing learning [16]. Foster and Siddle found that non-engagement alerts identified students at risk more efficiently than demographic indicators [17]. However, a randomized study by Hellings and Haelermans found that a dashboard changed online behaviour without producing an overall final-exam effect [18]. These findings support Umarova's monitoring perspective: data must be interpreted as part of a recurring social and managerial

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process [10]. The proposed model therefore treats digital monitoring as one component of a human decision cycle, not as an automated substitute for academic judgement.

Industry participation is the second context-specific requirement. Work-integrated learning has been associated with stronger engineering self-efficacy, lifelong-learning skills, and learning outcomes [19]. Evidence from engineering programmes also indicates that extended industry experience can improve later academic performance, although selection effects and programme differences must be considered [20]. For this reason, the model embeds industry representatives in curriculum design, practical modules, and expert assessment while retaining academic responsibility for standards.

THE INTEGRATED QUALITY MANAGEMENT MODEL

The model is a dynamic system of four connected blocks. Its architecture synthesizes three intellectual traditions: Uzbek studies of contextualized quality management and sociological monitoring [10–12], CIS research on qualimetry, systemic assessment, and competency development [6–9, 13], and international standards of continual improvement [3, 4, 14, 15]. It can be introduced initially at department level, expanded across a faculty, and then institutionalized across the university. Its distinct contribution is the closed feedback loop: evidence about learning is reviewed by a mixed quality team; the team identifies a pedagogical or organizational cause; a responsible actor implements a correction; and the next review tests whether the correction worked. This structure shifts attention from reporting completed activities to managing student development.

Table 1 Structure of the integrated quality management model

Block	Core elements	Operational function
Goals	Professional, social, and innovation competence	Defines the graduate capabilities expected by academic and industrial stakeholders
Content	Aligned curriculum, digital learning environment, virtual laboratories, and authentic industrial tasks	Connects theory, practice, and changing technological requirements
Mechanisms	PDCA cycle, departmental quality teams, learning analytics, tutoring, and employer participation	Turns monitoring evidence into documented and timely improvement decisions
Outcomes	Integrated competence, student progression, project quality, employability signals, and institutional performance	Evaluates learning, social value, and the sustainability of the quality system

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The model uses five implementation stages: diagnosis, design, pilot implementation, institutional scaling, and continuous evaluation. The staged design reflects Alikarieva's requirement that institutional models be adapted to local conditions and supported by the conscious participation of the academic community [11]. At the operational level, a department team reviews attendance, task completion, laboratory performance, and competency trends each month. When a risk is identified, the team records the likely cause and selects an intervention such as tutoring, a revised assignment, additional laboratory guidance, or referral to student support. The next PDCA review evaluates the response. This accountability chain clarifies which decisions belong to the student, instructor, department, faculty, and central administration.

MATERIALS AND METHODS

A non-randomized pre-test/post-test comparison design was used during the 2022–2023 academic year. Tashkent State Transport University served as the intervention institution and Tashkent State Technical University as the comparison institution. The participants were 357 third- and fourth-year students in engineering and information technology programmes: 185 in the intervention group and 172 in the comparison group. Participation was voluntary, the purpose of the study was explained, institutional permission was obtained, and individual data were anonymized. Because students were not randomly assigned and each condition corresponded to a different university, the design is quasi-experimental.

The intervention ran from November 2022 to April 2023 after baseline measurement in September–October. Twelve Moodle courses and three virtual laboratories were developed. Three practice modules and two joint laboratory sessions were designed with specialists from Uzbekistan Railways. Three departmental quality teams were established; each included two instructors, one administrator, and three student representatives. The teams conducted monthly PDCA reviews. A three-day professional-development programme supported instructors who experienced difficulty with digital assessment, while a tutor–curator arrangement provided targeted support for students identified through monitoring.

The main outcome was a 100-point integrated competency score based on four dimensions: motivational and meaning-oriented competence (16%), cognitive competence (40%), activity and practical competence (30%), and professional

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reflection (14%). Data sources included a 60-item assessment combining 30 knowledge items with 30 applied tasks and cases, a 24-item student motivation questionnaire, a faculty digital-readiness questionnaire, structured classroom observations, and project assessments by 12 industry experts. The reported internal consistency of the measurement set was Cronbach's $\alpha=0.87$.

Normality was checked with the Shapiro–Wilk test. Baseline comparability and post-test differences were examined with independent-samples t-tests. Cohen's d was calculated from pooled post-test standard deviations, following the principle that statistical significance should be accompanied by an interpretable effect size [21]. Attainment-band distributions were compared using the chi-square test, and Pearson coefficients were used to examine associations between model components and final scores. All t and d values in this article were recalculated from the reported group means, standard deviations, and sample sizes. The standardized gain index was computed as the difference between group gain scores divided by the pooled baseline standard deviation. This index is descriptive and is not presented as a substitute for a randomized treatment effect.

RESULTS

The groups were comparable on the baseline integrated score: 51.9±8.4 in the intervention group and 51.4±8.1 in the comparison group, $t(355)=0.57$, $p=0.568$, $d=0.06$. Normality tests did not reject normality for either group. At post-test, all four competency dimensions and the integrated score were higher in the intervention group. Recalculation from the reported summary statistics produced effect sizes from $d=1.46$ to $d=2.27$. These values are unusually large and should be read together with the design limitations described below.

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Table 2 Pre-test and post-test outcomes by study group

Outcome	Intervention pre	Intervention post	Comparison pre	Comparison post	t at post	Cohen's d
Motivational and meaning-oriented	54.3±8.2	68.7±8.1	53.8±7.9	57.1±7.8	13.78	1.46
Cognitive	52.1±9.1	72.4±7.4	51.7±8.8	55.9±7.1	21.50	2.27
Activity and practical	51.4±8.6	70.8±7.9	50.9±8.3	55.2±7.6	19.01	2.01
Professional reflection	49.8±7.4	65.3±8.3	49.3±7.1	52.8±8.0	14.49	1.53
Integrated competency score	51.9±8.4	70.9±7.6	51.4±8.1	55.3±7.2	19.92	2.11

The integrated score increased by 19.0 points in the intervention group and by 3.9 points in the comparison group. Their difference in gain was 15.1 points. Dividing this difference by the pooled baseline standard deviation of 8.26 produced a standardized gain index of 1.83. The attainment distribution also changed. The reported highest attainment band increased from 6.5% to 35.1% in the intervention group and from 6.4% to 7.6% in the comparison group. Based on the reported final counts, $\chi^2(2)=59.22$, $p<0.001$.

The strongest reported association with final performance was use of the digital learning environment ($r=0.62$, $p<0.001$), followed by participation in industry cooperation ($r=0.58$), responsiveness to PDCA monitoring ($r=0.54$), participation in targeted support ($r=0.47$), and improvement in instructors' digital competence ($r=0.43$); all reported p values were below 0.001. In addition, 89.3% of instructors in the intervention setting rated their use of digital technologies as successful or very successful. Industry experts scored intervention-group projects 18.7 points higher on a 100-point scale than comparison-group projects.

Implementation records identified three practical conditions. First, analytics generated actionable value only when a named instructor or tutor responded to an alert. Second, industry cooperation was strongest when agreements and assessment responsibilities were settled before the semester. Third, some instructors required short, task-focused digital training before dashboard data could become part of normal departmental decision-making.

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DISCUSSION

The results indicate that an integrated system can produce a stronger improvement signal than isolated quality instruments. The intervention did not simply add a dashboard. It connected curriculum alignment, authentic industrial tasks, monthly PDCA reviews, instructor development, and targeted student support. This helps explain why the findings differ from studies in which dashboards changed online behaviour but did not improve final examination performance [18]. Data became consequential because the model assigned responsibility for interpretation and follow-up.

The findings support the systemic position developed by Subetto and Selezneva: quality becomes meaningful when multiple dimensions are interpreted as parts of one educational system rather than as disconnected indicators [6, 7]. The four-component competency measure also follows the argument of Bolotov and Serikov that professional competence integrates knowledge, practical action, motivation, and reflection [13]. The strongest improvement in the cognitive and activity-practical dimensions therefore should not be read as test-score growth alone; it indicates better alignment between theoretical learning and engineering action.

The model also connects international compliance frameworks to national pedagogical practice. ISO 21001:2025 provides an organizational management architecture [3], the ESG establishes institutional responsibility and stakeholder participation [4], and ABET requires programmes to use outcome evidence for continuous improvement [14]. At the same time, Umarova's three-part monitoring logic—conditions, process, and outcomes—helps organize what should be reviewed [10], while Alikarieva and Bekmurodov explain why staff participation, mentoring relationships, and institutional culture influence whether a formal system becomes sustainable [11, 12]. The present model translates these expectations into a recurring department-level routine.

The findings also support a balanced interpretation of digitalization. The correlation between digital-environment use and final performance was the largest reported association, yet instructor competence and targeted support also remained significant. Technology therefore appears to amplify pedagogical capacity rather than replace it. This interpretation is consistent with research showing that learning analytics can identify risk effectively [17] while the educational consequences depend on how institutions respond to the information.

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For technical universities in Uzbekistan, implementation should begin with a small number of departments and a limited indicator set. The first dashboard should contain only measures that trigger feasible decisions: progress toward learning outcomes, completion of laboratory work, engagement, and unresolved support needs. Employer participation should be formalized through curriculum review, authentic tasks, project assessment, and feedback on graduate capabilities. Student representatives should participate in quality teams so that monitoring does not become a purely administrative exercise.

The study has four major limitations. First, assignment was not random and the intervention was confounded with institution, so differences may partly reflect university context, instructors, or programme composition. Second, the study covered one academic year and cannot establish the durability of the effects. Third, the summary data do not allow multilevel modelling of students within classes and departments. Fourth, longer-term outcomes such as employment quality and professional performance were not measured. Future research should use matched programmes across several universities, preserve anonymized student-level longitudinal data, preregister the analysis, and follow graduates for at least 12–24 months. These steps are necessary because unusually large effect sizes require replication and careful scrutiny.

CONCLUSION

This study presents a quality management model for technical universities in which goals, curriculum content, improvement mechanisms, and outcomes operate as a closed feedback system. The model is grounded not only in international standards but also in Uzbek research on institutional context and sociological monitoring and in CIS scholarship on educational qualimetry, systemic assessment, and competency development. Its central mechanism is a department-level PDCA cycle supported by learning analytics, industry participation, faculty development, and targeted student support. The model is designed to move quality assurance from periodic compliance to continuous pedagogical improvement.

In the quasi-experimental implementation, the intervention group showed substantially stronger gains in integrated competence than the comparison group. The post-test difference was statistically significant and educationally large, while the highest attainment band expanded markedly. The most important interpretation is not

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that digital tools alone caused improvement, but that data, human judgement, and responsibility were connected within the same management process.

The model can inform institutional quality assurance in Uzbekistan and comparable higher-education systems undergoing rapid expansion and digital transformation. Wider adoption should proceed through staged pilots, transparent data governance, independent evaluation, and replication across multiple technical universities. Under these conditions, quality management can become an educational capability that improves learning while also supporting accreditation, institutional accountability, and industry relevance.

REFERENCES

1. Decree of the President of the Republic of Uzbekistan No. PF-5847. Concept for the Development of the Higher Education System of the Republic of Uzbekistan until 2030. 8 October 2019. https://lex.uz/docs/-4545884
2. Republic of Uzbekistan. Law on Education No. O‘RQ-637. 23 September 2020, as amended. https://lex.uz/docs/-5013007
3. International Organization for Standardization. ISO 21001:2025 Educational organizations — Management systems for educational organizations — Requirements with guidance for use. Geneva: ISO; 2025. https://www.iso.org/standard/21001
4. European Association for Quality Assurance in Higher Education, European Students’ Union, European University Association, and European Association of Institutions in Higher Education. Standards and Guidelines for Quality Assurance in the European Higher Education Area. Brussels: EURASHE; 2015. https://www.enqa.eu/esg-standards-and-guidelines-for-quality-assurance-in-the-european-higher-education-area/
5. Harvey L, Green D. Defining quality. Assessment & Evaluation in Higher Education. 1993;18(1):9–34. https://doi.org/10.1080/0260293930180102
6. Subetto AI. Vvedenie v kvalimetriyu vysshey shkoly. Kniga 1: Obshchie osnovaniya kvalimetrii vysshey shkoly [Introduction to Higher School Qualimetry. Book 1: General Foundations]. Moscow: Research Centre of the USSR State Education Committee; 1991.

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7. Selezneva NA. Kachestvo vysshego obrazovaniya kak obekt sistemnogo issledovaniya [Quality of Higher Education as an Object of Systemic Research]. Moscow: Research Centre for Problems of Specialist Training Quality; 2001.
8. Potashnik MM, editor. Upravlenie kachestvom obrazovaniya [Managing the Quality of Education]. Moscow: Pedagogical Society of Russia; 2000.
9. Bolotov VA, Efremova NF. Sistemy otsenki kachestva obrazovaniya [Education Quality Assessment Systems]. Moscow: Logos; 2007.
10. Umarova D. Sociological Monitoring of the Quality of Higher Education in the Republic of Uzbekistan. Abstract of DSc dissertation in Sociology. Tashkent; 2022.
11. Alikarieva AN. Issues of Modelling the Quality Management System in Higher Education Institutions. Journal of Social Studies. 2022;5(2):4–13. https://tadqiqot.uz/index.php/soci/article/view/4900
12. Bekmurodov MB. Zamonaviy boshqaruv sotsiologiyasi [Contemporary Sociology of Management]. Tashkent: Yoshlar nashriyot uyi; 2020.
13. Bolotov VA, Serikov VV. Competency model: from the idea to an educational programme. Pedagogika. 2003;(10):8–14.
14. ABET. Criteria for Accrediting Engineering Programs, 2025–2026. Baltimore: ABET; 2025. https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2025-2026/
15. Deming WE. Out of the Crisis. Cambridge, MA: MIT Center for Advanced Engineering Study; 1986.
16. Ferguson R. Learning analytics: drivers, developments and challenges. International Journal of Technology Enhanced Learning. 2012;4(5/6):304–317. https://doi.org/10.1504/IJTEL.2012.051816
17. Foster E, Siddle R. The effectiveness of learning analytics for identifying at-risk students in higher education. Assessment & Evaluation in Higher Education. 2020;45(6):842–854. https://doi.org/10.1080/02602938.2019.1682118
18. Hellings J, Haelermans C. The effect of providing learning analytics on student behaviour and performance in programming: a randomised controlled experiment. Higher Education. 2022;83:1–18. https://doi.org/10.1007/s10734-020-00560-z
19. Khampirat B. The impact of work-integrated learning and learning strategies on engineering students' learning outcomes in Thailand. IEEE Access. 2021;9:111390–111406. https://doi.org/10.1109/ACCESS.2021.3055620

EduVision: Journal of Innovations in Pedagogy and Educational Advancements
Volume 2, Issue 4, April 2026
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20. Rolland SA, Jones JW, Bunting G. The impact of a year in industry on academic outcomes in higher education engineering. European Journal of Engineering Education. 2023;48(4):747–760. https://doi.org/10.1080/03043797.2023.2194244
21. Lakens D. Calculating and reporting effect sizes to facilitate cumulative science: a practical primer for t-tests and ANOVAs. Frontiers in Psychology. 2013;4:863. https://doi.org/10.3389/fpsyg.2013.00863