Available at e-Journal Universitas Sultan Ageng Tirtayasa

JOURNAL INDUSTRIAL SERVICESS

journal homepage: http://jurnal.untirta.ac.id/index.php/jiss

eISSN 2461-0631

Case study article

Integration of SERVQUAL and Six Sigma for enhancing academic service quality in departments and laboratories: A case study

Maria Ulfah [a*], Faula Arina [b], Yusraini Muharni [a], Atia Sonda [b], Shanti Kirana Anggraini [a], Akbar Gunawan [a], Ade Irman Saeful Mutaqin [a]

[a] *Department of Industrial Engineering, Universitas Sultan Ageng Tirtayasa, Jl. Jend. Sudirman KM3, Cielgon 42435, Banten, Indonesia*
[b] *Department of Statistics, Universitas Sultan Ageng Tirtayasa, Jl. Jend. Sudirman KM3, Cielgon 42435, Banten, Indonesia*

ARTICLE INFO

Article history:
Received 21 October 2024
Received in revised form 22 May 2025
Accepted 24 May 2025
Published online 24 May 2025

Keywords:
academic service
laboratory service
ServQual
Six Sigma
5W+1H

Editor:
Andreas Tri Panudju

Publisher's note:
The publisher remains neutral concerning jurisdictional claims in published maps and institutional affiliations.

ABSTRACT

Academic services are super important for shaping how students experience their education and feel about their school. The quality of these services, whether in academic departments or laboratories, affects how well students perform, how engaged they are, and what they think of their institution. This study sets out to figure out the lowest gap value, calculate the sigma value and satisfaction level, and suggest ways to improve the academic services in the Department and Laboratory. We used Servqual and Six Sigma methods to dig into this. The results showed that all service attributes, for both the department and the lab, had negative gap values. For department services, the total sigma value was 2.205 with an average satisfaction level of 76.2%. For lab services, it was a sigma of 2.274 and a satisfaction level of 78.04%. The biggest issue for both was the same: the comfort of the study room in the department and the practicum room in the lab, which were rated as super important but had the lowest satisfaction. Using the 5W + 1H method, we came up with practical suggestions to fix what's making students unhappy.

1. Introduction

Quality is all about making customers happy or meeting their needs and expectations [1]. When we talk about customer satisfaction, it's about how well a product or service matches what someone hoped for when they bought it. The reality of what they get determines how satisfied they feel [2]. Services are things one person does for another—like a seller helping a buyer. They're intangible, meaning you can't touch them or own them, and they're not something you can see [3].

Colleges and universities must deliver top-notch educational services to stay competitive. In today's world, schools need to keep adapting and come up with new ideas to thrive. As education providers, universities must focus on satisfying their students by meeting their needs. A service happens when people interact directly or when someone uses an object, leading to a happy customer.Public services are what the government or state-owned companies do to meet people's needs and follow the law [4].

When setting academic quality standards for colleges, policies are guided by laws like Law No. 20 of 2003 on the National Education System, Government Regulation No. 60 of 1999 on Higher Education, and Government Regulation No. 19 of 2005 on National Education Standards. These policies also consider goals, principles, resources, the skills of the people making them, strategies, and the current situation [4].

Keeping students happy with academic services is super important. It makes them feel safe and comfortable, encourages them to spread the word about their school, attracts others to keep studying there, and boosts the school's reputation. Since students are the main "customers," their satisfaction with educational services matters a lot. In this study, we define student satisfaction as how well academic services match what students expect.

Things that can make students unhappy include a curriculum that doesn't meet their needs, poorly presented or evaluated material, and facilities that

*Corresponding author:
Email: maria67_ulfah@yahoo.com

http://dx.doi.org/10.62870/jiss.v11i1.29226

aren't up to scratch. The quality of these services directly affects how satisfied students are [5].

This research aims to measure student satisfaction with academic services provided by a higher education institution. The study employs the Servqual framework by Parasuraman et al. [6] to evaluate academic services based on student feedback and Six Sigma to enhance these services. It covers five categories: Tangibles (physical facilities), Reliability (dependability), Responsiveness (promptness and helpfulness), Assurance (building trust), and Empathy (showing care). These categories guide the creation of questionnaires to identify factors influencing student satisfaction [7]. Service quality refers to how well a service meets customer expectations by fulfilling their needs and delivering accurately [8].

Six Sigma is a system focused on maximizing user satisfaction by achieving a high Sigma Quality Level. It utilizes the DMAIC process: Define, Measure, Analyze, Improve, and Control [9]. This framework helps identify issues, measure performance, analyze causes, implement improvements, and maintain control to achieve near-perfect results (zero defects) [4].

In the Define stage, the Importance Performance Analysis (IPA) model is used to link student satisfaction with priorities for improving academic services in the Industrial Engineering department and laboratories [10]. In the Measure stage, Defects Per Million Opportunities (DPMO) and quality levels are calculated for each Servqual category, determining the sigma value for the department and labs [10]. In the Analyze stage, a fishbone diagram is created to investigate key issues requiring improvement. This helps identify root causes, facilitating solution development by mapping the process [11]. In the Improvement stage, solutions are proposed using the 5W+1H method to enhance academic service quality [12].

This study seeks to identify service aspects needing improvement and propose solutions for top priorities. Other studies have explored similar concepts, such as improving service quality for master's students using Servqual and IPA [13], enhancing delivery services with Servqual [14], analyzing gaps between consumer expectations and perceptions of service, price, and product quality [15], and evaluating how service quality and facilities impact customer satisfaction at Yuta Hotel in Manado [16].

While previous studies have applied Servqual and IPA to assess service quality in contexts like higher education [13] and logistics [14], none have integrated Servqual with Six Sigma's DMAIC framework to specifically evaluate and improve academic services. This study addresses this gap by combining these methods to not only measure student satisfaction but also provide a structured approach to identify and resolve specific issues in departmental and laboratory services, using tools like fishbone diagrams and the 5W+1H method for actionable improvements. This research can be used by decision-makers in higher education institutions to improve academic services and enhance student satisfaction.

The remainder of this paper is organized as follows: Section 2 describes the materials and methods. Section 3 presents the results and discussion. Finally, Section 4 concludes the research.

2. Material and method

In this study, the research design is quantitative descriptive research. The descriptive method is implemented through survey techniques, case studies, comparative studies, and documentary analysis. Specifically, this study employs the case study method. The subjects are students from the 2019 and 2020 Industrial Engineering classes at Universitas Sultan Ageng Tirtayasa, Indoneses, selected because they have experienced extended services and utilized all facilities and services in both the academic department and the Industrial Engineering laboratory.

Data processing in this study involves two methods: the Servqual method and the Six Sigma method. Servqual (Service Quality) and Six Sigma are techniques for assessing and improving service quality [17].

2.1. *Servqual (Service Quality)*

The initial stage involved preparing a questionnaire on academic services, covering both departmental and laboratory services, based on the five Servqual dimensions: Tangibles, Reliability, Responsiveness, Assurance, and Empathy. The questionnaire uses a five-point rating scale. The expectation questionnaire employs a scale of (1) Very Unimportant, (2) Unimportant, (3) Neutral, (4) Important, and (5) Very Important. The evaluation and customer satisfaction questionnaire uses a scale of (1) Very Dissatisfied, (2) Dissatisfied, (3) Neutral, (4) Satisfied, and (5) Very Satisfied. The questionnaire was distributed to 30 respondents to test validity and reliability.

In the second stage, after confirming the validity and reliability of all questionnaire statements, a data adequacy test was conducted to determine the sample size representing the entire population (students) based on the selected subjects.

In the third stage, questionnaires were distributed via Google Forms to the number of respondents determined by the data adequacy test. The collected data were analyzed to assess student satisfaction and expectations regarding the academic services of the Industrial Engineering Department and Laboratory.

In the fourth stage, Servqual GAP calculations were performed for both departmental and laboratory services using the collected questionnaire data.

2.2. *Six Sigma*

The Six Sigma method consists of five stages, collectively known as DMAIC (Define, Measure, Analyze, Improve, and Control). In this study, only the stages up to Improve are implemented, excluding the Control stage.

Table 1
Validity test of satisfaction in the academic section

Dimension	Statement	Calculated R	Critical R	Validity
Tangible	Study Room Comfort	0.740	0.3061	Valid
	Lecturer Attendance and Discipline	0.559		Valid
	Quantity and Quality of teaching materials	0.666		Valid
Reliability	Method/method of delivery applied to students	0.612	0.3061	Valid
	Transparency of the assessment used	0.417		Valid
	Skills/abilities in using tools (Software and the like)	0.681		Valid
Responsiveness	Response in response to student questions	0.720	0.3061	Valid
	Lecturers respond to questions or complaints	0.634		Valid
	Respond to student questions appropriately and quickly	0.611		Valid
Assurance	Learning according to RPS/courses	0.491	0.3061	Valid
	Exams/Assignments according to RPS/Courses	0.604		Valid
	Reliability and experience of lecturers according to their scientific field	0.584		Valid
Empathy	Communication inside and outside the classroom (face to face and online)	0.622	0.3061	Valid
	Friendly and respectful towards students	0.565		Valid
	Feedback/corrections/improvements to work are given to students	0.707		Valid

The Six Sigma methodology, using the DMAIC framework, is applied to the learning process to achieve high-quality outcomes, specifically enabling school institutions to meet national education standards. Strategies for improving quality through Six Sigma can be implemented using the DMAIC method [18]. This approach aims to reduce variation to near perfection (zero defects) [4]. In education, Six Sigma correlates with efforts to enhance and elevate educational quality [19].

2.2.1. *Define stage*

The quality attributes of educational services are identified using the five Servqual dimensions: Tangibles, Reliability, Responsiveness, Assurance, and Empathy. Using the Servqual method, the gap between expectation and satisfaction scores for departmental and laboratory services is calculated based on questionnaire data. The results are then analyzed and presented in a report [20].

2.2.2. *Measure stage*

At this stage, the Defects Per Million Opportunities (DPMO) and sigma values are calculated for both departmental and laboratory services.

2.2.3. *Analyze stage*

The analysis begins with a Cartesian diagram to evaluate the attributes most important to consumers in detail. Subsequently, a fishbone diagram (also known as a cause-and-effect diagram) is constructed to identify the root causes of dissatisfaction for the attribute with the highest discrepancy value [21]. The fishbone diagram is an effective graphical tool for analyzing significant factors influencing the quality characteristics of outcomes [22].

2.2.4. *Improve stage*

This stage involves developing improvement proposals using the 5W+1H method. These proposals aim to address identified issues and enhance the quality of academic services [12].

3. Results and discussions

3.1. *Servqual*

The initial stage involved developing a questionnaire based on the five Servqual dimensions (Tangibles, Reliability, Responsiveness, Assurance, and Empathy) to assess the academic services of the Industrial Engineering Department and its laboratory. The questionnaire was distributed to a sample of 30 respondents to conduct validity and reliability tests.

The sample for this study was determined using purposive random sampling, a technique that involves selecting participants based on specific criteria. The criteria are as follows [23]:

- Students from the 2019 and 2020 batches who have completed all compulsory Industrial Engineering courses.
- Students from the 2019 and 2020 batches who have completed all Industrial Engineering practicums.

The number of samples was determined using the Slovin formula with a 5% margin of error. Based on this formula, from a population of 206 students from the 2019 and 2020 intakes, a sample of 136 students was selected to participate as respondents in this study.

3.1.1. *Validity test*

The results of the satisfaction validity test for the Industrial Engineering major, as shown in Table 1 and obtained using SPSS software, indicated a significance value of 0.000. Since this value is below the critical p-value of 0.05, the data is considered valid. Similarly, the expectation validity test results, presented in Table 2, showed a significance value of 0.043. As this value is also below the 0.05 threshold, the data is likewise considered valid.

Table 2
Validity test of expectations in the academic section

Dimension	Statement	Calculated R	Critical R	Validity
Tangible	Study Room Comfort	0.372	0.3061	Valid
	Lecturer Attendance and Discipline	0.758		Valid
	Quantity and Quality of teaching materials	0.610		Valid
Reliability	Method/method of delivery applied to students	0.604	0.3061	Valid
	Transparency of the assessment used	0.441		Valid
	Skills/abilities in using tools (Software and the like)	0.746		Valid
Responsiveness	Response in response to student questions	0.726	0.3061	Valid
	Lecturers respond to questions or complaints	0.765		Valid
	Respond to student questions appropriately and quickly	0.819		Valid
Assurance	Learning according to RPS/courses	0.699	0.3061	Valid
	Exams/Assignments according to RPS/Courses	0.730		Valid
	Reliability and experience of lecturers according to their scientific field	0.812		Valid
Empathy	Communication inside and outside the classroom (face to face and online)	0.723	0.3061	Valid
	Friendly and respectful towards students	0.770		Valid
	Feedback/corrections/improvements to work are given to students	0.816		Valid

Table 3
Validity test of satisfaction with laboratory services

Dimension	Statement	Calculated R	Critical R	Validity
Tangible	Study Room Comfort	0.732	0.3061	Valid
	Lecturer Attendance and Discipline	0.726		Valid
	Quantity and Quality of teaching materials	0.747		Valid
Reliability	Method/method of delivery applied to students	0.697	0.3061	Valid
	Transparency of the assessment used	0.622		Valid
	Skills/abilities in using tools (Software and the like)	0.390		Valid
Responsiveness	Response in response to student questions	0.643	0.3061	Valid
	Lecturers respond to questions or complaints	0.651		Valid
	Respond to student questions appropriately and quickly	0.460		Valid
Assurance	Learning according to RPS/courses	0.626	0.3061	Valid
	Exams/Assignments according to RPS/Courses	0.568		Valid
	Reliability and experience of lecturers according to their scientific field	0.764		Valid
Empathy	Communication inside and outside the classroom (face to face and online)	0.735	0.3061	Valid
	Friendly and respectful towards students	0.612		Valid
	Feedback/corrections/improvements to work are given to students	0.787		Valid

Table 4
Validity test of expectations with laboratory services

Dimension	Statement	Calculated R	Critical R	Validity
Tangible	Study Room Comfort	0.537	0.3061	Valid
	Lecturer Attendance and Discipline	0.727		Valid
	Quantity and Quality of teaching materials	0.586		Valid
Reliability	Method/method of delivery applied to students	0.505	0.3061	Valid
	Transparency of the assessment used	0.630		Valid
	Skills/abilities in using tools (Software and the like)	0.804		Valid
Responsiveness	Response in response to student questions	0.815	0.3061	Valid
	Lecturers respond to questions or complaints	0.707		Valid
	Respond to student questions appropriately and quickly	0.601		Valid
Assurance	Learning according to RPS/courses	0.660	0.3061	Valid
	Exams/Assignments according to RPS/Courses	0.704		Valid
	Reliability and experience of lecturers according to their scientific field	0.591		Valid
Empathy	Communication inside and outside the classroom (face to face and online)	0,831	0.3061	Valid
	Friendly and respectful towards students	0.690		Valid
	Feedback/corrections/improvements to work are given to students	0.844		Valid

Validity tests were conducted on satisfaction questionnaires for both the department and the laboratory, as shown in Table 3. The results of the satisfaction validity test for the laboratory showed a significance value of 0.000. Since the p-value is less than the critical value of 0.05, the data is considered valid. The validity test results for the level of expectations in the laboratory are presented in Table 4. This test yielded a significance value of 0.002, which is also below the 0.05 threshold, indicating that the data is valid.

3.1.2. *Reliability test*

The results of the satisfaction reliability test for the department showed a reliability coefficient (Cronbach's alpha) of 0.880, indicating that the data has adequate reliability (in the range of 0.71–0.90) [26].

Table 5
Results of department gap calculation

Variable	Question	Satisfaction		Expectation		GAP
		Score	Average	Score	Average	
X1	Study Room Comfort	470	3.456	637	4.684	-1.23
X2	Lecturer Attendance and Discipline	518	3.809	605	4.449	-0.64
X3	Quantity and Quality of teaching materials	514	3.779	619	4.551	-0.77
X4	Method/method of delivery applied to students	490	3.603	624	4.588	-0.99
X5	Transparency of the assessment used	453	3.331	618	4.544	-1.21
X6	Skills/abilities in using tools (Software and the like)	525	3.860	617	4.537	-0.68
X7	Response/response in response to student questions	544	4	628	4.618	-0.62
X8	Lecturers respond to questions or complaints	492	3.618	614	4.515	-0.90
X9	Respond to student questions appropriately and quickly	506	3.721	620	4.559	-0.84
X10	Learning according to RPS/courses	551	4.051	625	4.60	-0.54
X11	Exams/Assignments according to RPS/Courses	527	3.875	612	4.50	-0.63
X12	Reliability and experience of lecturers according to their scientific field	589	4.331	632	4.65	-0.32
X13	Communication inside and outside the classroom (face to face and online)	509	3.743	617	4.537	-0.79
X14	Friendly and respectful towards students	550	4.044	620	4.559	-0.51
X15	Feedback/corrections/improvements to work are given to students	509	3.743	612	4.5	-0.76

Table 6
Results of laboratory gap calculation

Variable	Question	Satisfaction		Expectation		GAP
		Score	Average	Score	Average	
X1	Study Room Comfort	490	3.603	633	4.323	-1.05
X2	Lecturer Attendance and Discipline	545	4.007	630	4.632	-0.63
X3	Quantity and Quality of teaching materials	512	3.765	629	4.625	-0.86
X4	Method/method of delivery applied to students	512	3.765	634	4.662	-0.90
X5	Transparency of the assessment used	483	3.551	614	4.515	-0.96
X6	Skills/abilities in using tools (Software and the like)	529	3.890	627	4.610	-0.72
X7	Response/response in response to student questions	530	3.897	627	4.610	-0.71
X8	Lecturers respond to questions or complaints	531	3.904	616	4.529	-0.63
X9	Respond to student questions appropriately and quickly	523	3.846	616	4.529	-0.68
X10	Learning according to RPS/courses	553	4.066	620	4.559	-0.49
X11	Exams/Assignments according to RPS/Courses	541	3.978	608	4.471	-0.49
X12	Reliability and experience of lecturers according to their scientific field	526	3.868	617	4.537	-0.67
X13	Communication inside and outside the classroom (face to face and online)	565	4.154	621	4.566	-0.41
X14	Friendly and respectful towards students	579	4.257	626	4.603	-0.35
X15	Feedback/corrections/improvements to work are given to students	543	3.993	619	4.551	-0.56

3.1.3. Gap measurement

The results of the gap value calculation for the department's academic service questionnaire are shown in Table 5. The largest gap value was in the reliability dimension (−0.96), while the smallest was in the assurance dimension (−0.50). Among individual attributes, the largest gap value was in X1 (−1.23), and the smallest was in X12 (−0.32).

Similarly, the results for the laboratory service questionnaire (Table 6) show the largest gap value in the reliability dimension (−0.86) and the smallest in the empathy dimension (−0.44). For individual attributes, X1 had the largest gap value (−1.05), while X14 had the smallest (−0.35).

3.2. Six Sigma

Six Sigma is a straightforward management measurement tool used to assess the progress of businesses or institutions, including educational institutions, through systematic data collection and statistical analysis [27]. This study primarily adopts the DMAIC (Define, Measure, Analyze, Improve, Control) methodology [28], utilizing various DMAIC tools. After service improvements were implemented, customer satisfaction became the primary focus, measured through Servqual-based questionnaires [29]. The Servqual model evaluates service quality using five key dimensions [30].

In the Define phase, this study identified 15 Critical-to-Quality (CTQ) attributes derived from the five Servqual dimensions to measure student satisfaction with department and laboratory services. Questionnaires were distributed to 136 respondents (sample size determined using Slovin's formula), with responses undergoing validity and reliability testing consistent with the Servqual method.

Educational service attributes (CTQs) represent processes or activities that directly impact service quality. While higher education services typically include 22 CTQs based on Parasuraman's Servqual dimensions [31], this study focused on 15 attributes for simplicity and relevance, excluding those with minimal impact on educational service quality.

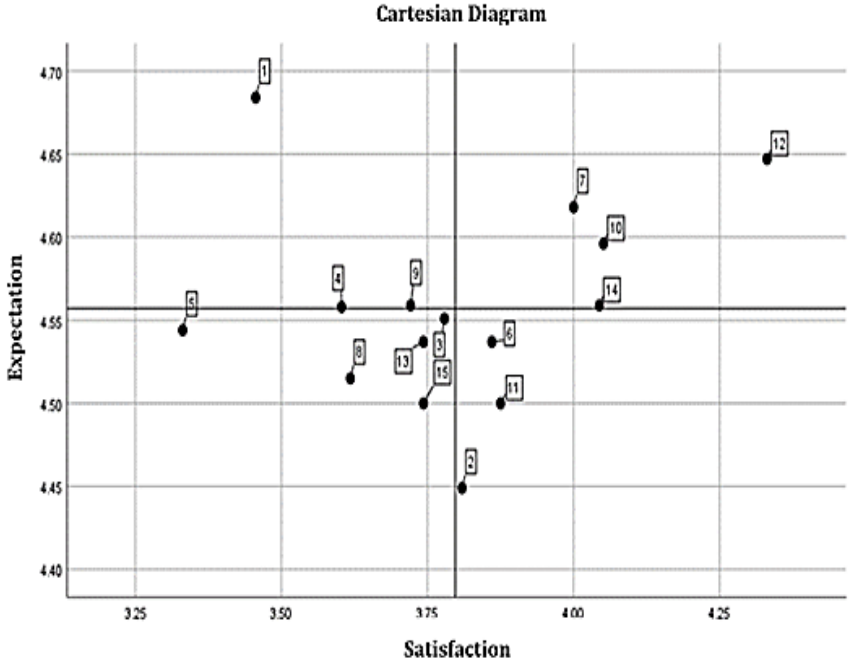

Fig. 1. Satisfaction indicators for department services

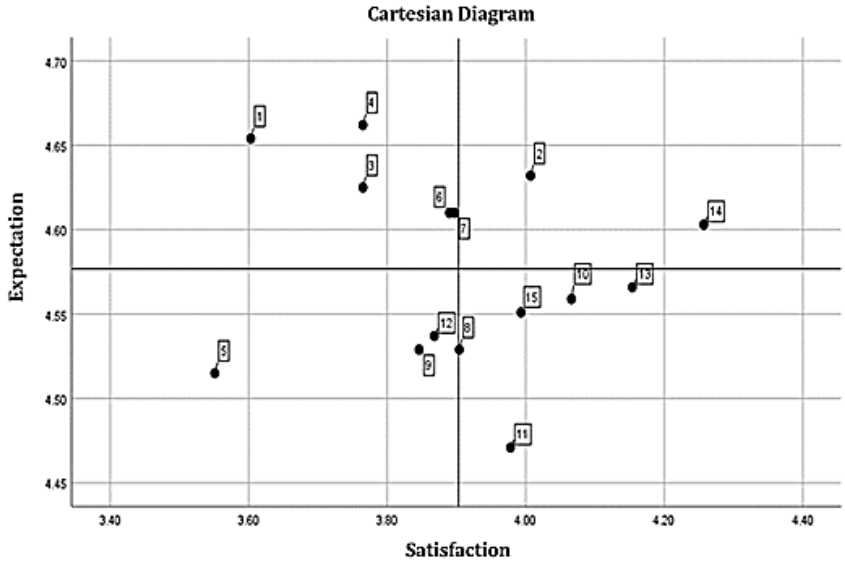

Fig. 2. Satisfaction indicators for laboratory services

Table 7
Six sigma of department services

Dimension	Score	Target	Level	DPMO	Sigma
Tangible	3.68	5	74%	264000	2.131
Reliability	3.6	5	72%	280000	2.083
Responsiveness	3.78	5	76%	244000	2.193
Assurance	4.09	5	82%	182000	2.408
Empathy	3.84	5	77%	232000	2.232

Table 8
Six sigma of laboratory services

Dimension	Score	Target	Level	DPMO	Sigma
Tangible	3.68	5	74%	264000	2.131
Reliability	3.6	5	72%	280000	2.083
Responsiveness	3.78	5	76%	244000	2.193
Assurance	4.09	5	82%	182000	2.408
Empathy	3.84	5	77%	232000	2.232

The next phase involved calculating DPMO (Defects Per Million Opportunities) and sigma levels for each Servqual dimension and attribute. Higher sigma values indicate better service quality, with process performance assessed through process capability, DPMO, and sigma level metrics [32].

For department services (Table 7), the highest DPMO was in the Reliability dimension (280,000), while the highest sigma value was in the Assurance dimension (2.408), with an overall department service sigma of 2.209. For laboratory services (Table 8), the highest DPMO was similarly in Reliability (252,000), with the highest sigma in the Empathy dimension (2.438) and an overall laboratory service sigma of 2.277.

The analysis employed two key diagrams: the Cartesian diagram (Importance-Performance Analysis/IPA) and fishbone diagram. The IPA identified important but underperforming attributes,

while the fishbone diagram helped determine root causes of dissatisfaction for attributes with the most negative gap values. Improvement priorities were established through Importance-Performance Analysis (IPA), evaluating student satisfaction with Industrial Engineering academic and laboratory services. Expectation-satisfaction analysis for department service attributes is presented in Fig. 1, while laboratory service attributes are shown in Fig. 2.

The fourth stage of the Six Sigma DMAIC methodology is Improve. At this stage, identified problems are addressed through root cause solutions based on previous analysis. The improvement design is developed from the fishbone diagram analysis conducted in earlier stages.

For proposing improvements, this study employs the 5W+1H framework (What, Why, Where, When, Who, and How) to systematically plan corrective actions and gather necessary implementation data. The recommended corrective actions and proposed improvements are presented in Table A1 and Table A2 (see Appendices).

4. Conclusions

All attributes in both academic and laboratory services of the Industrial Engineering Department show negative gap values, indicating student satisfaction consistently falls below expectations. The department's overall service quality scores a sigma value of 2.205 with 76.2% average satisfaction, while laboratory services achieve slightly higher at 2.274 sigma and 78.04% satisfaction. Notably, comfort in study rooms emerges as the most critical yet least satisfactory attribute for department services, mirroring laboratory services where comfort in practice rooms shows the same concerning pattern. Proposed improvements target nine key departmental issues including unregulated room capacity, poor time management, lack of technical training, inadequate maintenance of facilities (projectors, AC units, lighting), and insufficient ergonomic considerations. Laboratory services require ten corrective actions, adding specialized facility needs for large practicum rooms to the similar set of concerns. These findings highlight urgent areas requiring prioritized interventions to bridge the expectation-satisfaction gap through comprehensive service quality enhancements.

Declaration statement

Maria Ulfah: Conceptualization, Methodology, Supervision, Project administration. **Atia Sonda**: Software. **Faula Arina**: Resources, Formal analysis. **Santi K Anggraeni**: Visualization, Investigation. **Akbar Gunawan**: Data curation, Validation, Writing, Original Draft. **Yusraini Muharni**: Resources and Validation., **Ade Irman**: Review & Editing.

Acknowledgement

We would like to express our sincere gratitude to University X for providing us with the opportunity to conduct this research. We hope that the findings of this study will contribute meaningfully to the ongoing enhancement of academic services at University X, ultimately supporting its commitment to excellence in education.

Disclosure statement

The author declares that this manuscript is free from conflict of interest and is processed by applicable journal provisions and policies to avoid deviations from publication ethics in various forms.

Funding statement

The authors received no funding for this research.

Data availability statement

The authors confirm that the data supporting the findings of this study are available within the article or its supplementary materials.

AI Usage Statement

This manuscript utilizes generative AI and AI assisted tools to improve readability and language. All AI-generated content has been reviewed and edited by the authors to ensure accuracy and scientific integrity. The authors take full responsibility for the content and conclusions of this work and disclose the use of AI to maintain transparency and comply with publisher guidelines.

References

[1] I. Fatima, A. Humayun, U. Iqbal, and M. Shafiq, "Dimensions of service quality in healthcare: A systematic review of literature," *Int. J. Qual. Health Care*, vol. 31, no. 1, pp. 11–29, Feb. 2019, doi: 10.1093/intqhc/mzy125.

[2] A. S. Otto, D. M. Szymanski, and R. Varadarajan, "Customer satisfaction and firm performance: Insights from over a quarter century of empirical research," *J. Acad. Mark. Sci.*, vol. 48, no. 3, pp. 543–564, May 2020, doi: 10.1007/s11747-019-00657-7.

[3] T. Fatima, S. A. Malik, and A. Shabbir, "Hospital healthcare service quality, patient satisfaction and loyalty: An investigation in context of private healthcare systems," *Int. J. Qual. Rel. Manag.*, vol. 35, no. 6, pp. 1195–1214, Jun. 2018, doi: 10.1108/IJQRM-02-2017-0031.

[4] E. Widawati, "Analysis of student satisfaction with academic services and administrative services," *J. Mitra Manaj.*, vol. 4, no. 10, pp. 1500–1513, Oct. 2020, doi: 10.52160/ejmm.v4i10.478.

[5] F. Astuti *et al.*, "Improving the quality of jar products using the seven tools method (Case study: Mr. Ojid's

home industry)," *Barometer*, vol. 6, no. 1, pp. 307–312, 2021, doi: 10.24961/barometer.v6i1.1234.

[6] A. Parasuraman, V. A. Zeithaml, and L. L. Berry, "SERVQUAL: A multiple-item scale for measuring consumer perceptions of service quality," *J. Retail.*, vol. 64, no. 1, pp. 12–40, Spring 1988.

[7] R. Astuti, "Analysis of academic services using service quality and Six Sigma methods," *J. Educ. Cult.*, vol. 1, no. 1, pp. 43–50, May 2021.

[8] B. Kurdi, M. Alshurideh, and A. Alnaser, "The impact of employee satisfaction on customer satisfaction: Theoretical and empirical underpinning," *Manag. Sci. Lett.*, vol. 10, no. 15, pp. 3561–3570, 2020, doi: 10.5267/j.msl.2020.6.038.

[9] S. Ahmed, N. H. Abd Manaf, and R. Islam, "Effects of Six Sigma initiatives in Malaysian private hospitals," *Int. J. Lean Six Sigma*, vol. 10, no. 1, pp. 44–57, 2019, doi: 10.1108/IJLSS-08-2017-0099.

[10] S. Syaifullah, I. G. P. S. Wijaya, and A. Y. Husodo, "Academic administration service satisfaction information system based on science (Importance Performance Analysis) case study of the Faculty of Engineering, University of Mataram," *J. Comput. Sci. Informat. Eng. (J-Cosine)*, vol. 2, no. 1, pp. 37–43, Jun. 2018, doi: 10.29303/jcosine.v2i1.50.

[11] M. A. Adha, A. Supriyanto, and A. Timan, "Strategy for improving the quality of madrasah graduates using fishbone diagrams," *J. Keilmuan Manaj. Pendidik.*, vol. 5, no. 01, pp. 11–12, 2019, doi: 10.32678/tarbawi.v5i01.1794.

[12] I. N. Novadi and N. A. Mahbubah, "Evaluation of customer service quality based on Servqual–Six Sigma integration at Kuma Coffee and Eatery, Gresik Regency," *J. Sains Teknol.*, vol. 21, no. 2, pp. 302–317, 2021, doi: 10.36275/stsp.v21i2.423.

[13] L. R. Noer, "Analysis of improving the quality of service for ITS Surabaya technology management master students using the Servqual method and importance performance analysis (IPA)," *J. Res. Technol.*, vol. 2, no. 1, pp. 35–43, 2016, doi: 10.55732/jrt.v2i1.802.

[14] A. Degoes, I. Bachtiar, and A. N. Rukmana, "Proposal for improving the quality of goods delivery services using the Servqual method at CV. KMD," in *Proc. Tek. Ind.*, 2021, pp. 224–230, doi: 10.29313/ti.v0i0.29285.

[15] C. Jienardy, "Gap analysis of consumer perception and expectations of service quality, price, and product quality at Esus," *J. Performa: J. Manaj. Start-up Bisnis*, vol. 1, no. 6, pp. 703–710, 2017, doi: 10.37715/jp.v1i6.398.

[16] S. Moha and S. Loindong, "Analysis of service quality and facilities on customer satisfaction at the Yuta Hotel in Manado City," *J. EMBA: J. Riset Ekon., Manaj., Bisnis Akunt.*, vol. 4, no. 1, pp. 575–584, 2016, doi: 10.35794/emba.4.1.2016.11715.

[17] E. Wahyuningsih, S. A. Azizah, M. I. Firdaus, and S. R. Siregar, "The analysis of delivery service quality using Six Sigma and Servqual methods in improving customer satisfaction," in *Proc. Glob. Res. Sustain. Transp. Logist.*, 2021, pp. 1–10.

[18] T. Pyzdek and P. A. Keller, *The Six Sigma Handbook: A Complete Guide for Green Belts, Black Belts, and Managers at All Levels*, 3rd ed. New York, NY, USA: McGraw-Hill, 2010.

[19] R. Nuresa, E. M. A. Khosi'in, and A. R. Febriyani, "Implementation of Six Sigma principles in building Islamic education quality management," *Evaluasi: J. Islam. Educ. Manag.*, vol. 6, no. 2, pp. 1–15, 2022, doi: 10.32478/evaluasi.v6i2.1052.

[20] D. S. Soediantono, "Literature review of Lean Six Sigma (LSS) implementation and recommendations for implementation in the defense industries," *J. Ind. Eng. Manag. Res.*, vol. 3, no. 2, pp. 1–15, 2022, ISSN: 2722-8878.

[21] M. Ulfah, F. Arina, and L. R. Hafsha, "Application of the Green Lean Six Sigma and factorial experiments approach to improve the quality of the bottled drinking water process," *J. Teknol. Ind. Pertan.*, vol. 34, no. 3, pp. 229–240, Dec. 2023, doi: 10.24961/j.tek.ind.pert.2024.34.3.229.

[22] S. Slameto, "The application of fishbone diagram analysis to improve school quality," *Dinamika Ilmu*, vol. 16, no. 1, pp. 59–74, 2016.

[23] N. Martono, *Metode Penelitian Kuantitatif*. Jakarta, Indonesia: Raja Grafindo Persada, 2010.

[24] A.U. Fanany, S. Suhartini, and G.H.M. Basuki, "Analysis of service quality on community satisfaction with Service Quality method and Importance Performance Analysis method at Berbek Village Office, Sidoarjo Regency," in *Proc. Nat. Seminar Sustain. Ind. Technol. III (SENASTITAN III)*, 2023, pp. 1–10.

[25] P. A. Ranitaswari, S. Mulyani, and C. A. B. Sadyasmara, "Analysis of consumer satisfaction on coffee product quality and service quality using Importance Performance Analysis method (Case study at Geo Coffee)," *J. Rekayasa Manaj. Agroind.*, vol. 6, no. 2, pp. 147–156, 2018, doi: 10.24843/JRMA.2018.v06.i02.p06.

[26] I. Alwi, "Empirical criteria in determining sample size in statistical hypothesis testing and item analysis," *Formatif: J. Ilmiah Pendidik. MIPA*, vol. 2, no. 2, pp. 140–148, 2012, doi: 10.30998/formatif.v2i2.95.

[27] Karwanto *et al.*, *Adaptation of New Habits of Indonesian Society in the Era of the COVID-19 Pandemic: A Review of Various Disciplines*, 1st ed. Indonesia: Akademia Pustaka, 2020.

[28] J. Weimar, "Enhancing the passenger service quality at Frankfurt airport," *Manag. Excellence Programme*, Frankfurt, Germany, 2011.

[29] C.-C. Chou, L.-J. Jen, S.-C. Fang, J.-F. Ming, and T.-L. Chen, "An evaluation of airline service quality using the fuzzy weighted SERVQUAL method," *Appl. Soft Comput.*, vol. 11, no. 2, pp. 2117–2128, Mar. 2011, doi: 10.1016/j.asoc.2010.07.010.

[30] T. M. Al Muhareb and J. Graham-Jones, "Using Lean Six-Sigma in the improvement of service quality at aviation industry: Case study at the departure area in KKIA," *Int. J. Soc., Manag., Econ. Bus. Eng.*, vol. 8, no. 1, pp. 150–156, 2014.

[31] Sahyar, "Analysis of service quality of higher education study programs using Servqual and Six Sigma methods," *Pekbis J.*, vol. 4, no. 3, pp. 141–151, Nov. 2012.

[32] S. Darwati, C. Sumantri, and A. T. Pratiwanggana, "Production performance between F1 commercial meat type × Kampung chicken and Kampung chicken × commercial meat type at 0-12 weeks," *J. Ilmu Prod. Teknol. Hasil Peternak.*, vol. 3, no. 2, pp. 72–78, Jun. 2015.

Author information

Maria Ulfah is a Lecturer in Department of Industrial Engineering, Universitas Sultan Ageng Tirtayasa, Indonesia. Her research interests include Supply Chain and Risk Management and Optimization.

Faula Arina is a Lecturer in Department of Statistics, Universitas Sultan Ageng Tirtayasa, Indonesia. Her research interests include Statistics, Multivariate Statistics, Experimental design, Statistical process control.

Yusraini Muharni is a Lecturer in Department of Industrial Engineering, Universitas Sultan Ageng Tirtayasa, Indonesia. Her research interests include Production System, Artificial Intelligence, and Data Mining.

Atia Sonda is a Lecturer in Department of Statistics, Universitas Sultan Ageng Tirtayasa, Indonesia. Her research interests include mathematics.

Shanti Kirana Anggraeni is a Lecturer in Department of Industrial Engineering, Universitas Sultan Ageng Tirtayasa, Indonesia. Her research interests include Economics Analysis, Engineering Economics, Cost Analysis.

Akbar Gunawan is a Lecturer in Department of Industrial Engineering, Universitas Sultan Ageng Tirtayasa, Indonesia. His research interests include strategic management and information systems.

Ade Irman Saeful Mutaqin is a lecturer in Department of Chemical Engineering, Universitas Sultan Ageng Tirtayasa, Indonesia. His research interests include Scheduling, Production System, Facility Layout, Logistics and Supply Chain Management, Simulation, Optimization.

Appendices

Table A1
5W+1H improvement for departmental services

Dimension	What	Why	Where	When	Who	How
Tangible (1st Attribute)	There is no management of the number of students in the room	The number of students exceeds the room capacity	Classroom	During class time	Faculty & Pusda Info	It is necessary to manage the number of students who contract courses, the division of class time and space by University X.
	Lack of management of learning time	Lecturers who exceed the class hour limit		During and after class hours	Lecturer	-Lecturers need to arrive on time, according to class hours.
	There is no projector operation training	Lecturers are less competent in operating the projector		During class time	Lecturer	Lecturers need to manage learning time, paying attention to the limits of the material to be provided and time limits according to course credits.
	CCTV was not installed	There is no CCTV in the classroom		During and after class hours	Faculty & WD II	It is necessary to hold training on the use of projectors for all lecturers so that they do not interfere with the teaching and learning process.
	Projector maintenance is rarely carried out	Many projectors are dead/other damaged in the classroom		During and after class hours	Faculty & WD II	University X needs to install CCTV in classrooms to ensure the safety of Industrial Engineering students.
	AC maintenance is rarely carried out	There is an AC that is dead/not in good condition		During and after class hours	Faculty & WD II	- It is necessary to check the projector as scheduled by University
	Light maintenance is not/rarely carried out	There is a study room that lacks lighting		During and after class hours	Faculty & WD II	- Providing action on projectors such as servicing damaged projectors, and renewing and procuring projectors in classrooms that need them.
	Lack of attention to the ergonomics of the chair	Class chairs are less ergonomic		During class time	Faculty & WD II	- It is necessary to carry out a scheduled AC check by University X
	There is nothing about prohibiting campus conduciveness	Lack of conducive conditions outside the classroom		During and after class hours	The faculty	- Providing action to projectors such as servicing damaged ACs, and renewing and providing ACs in classrooms that need them

Table A2
5W+1H improvement for laboratory services

Dimension	What	Why	Where	When	Who	How
Tangible (1st Attribute)	It is necessary to manage the number of students who contract courses, the division of class time and space by University X.	The number of practitioners exceeds the room capacity	Practical Room	During practical hours	During practical hours	It is necessary to manage the number of practitioners who contract courses/practicums, and allocate time and space by assistants.
	-Lecturers need to arrive on time, according to class hours. - Lecturers need to manage learning time, paying attention to the limits of the material to be provided and time limits according to course credits.	Assistant exceeds practicum hour limit		During and after completing practical hours	During and after completing practical hours	-The assistant needs to arrive on time, before practical time. - Assistants need to manage practicum time, paying attention to the limits of the material to be provided and practicum time limits
	It is necessary to hold training on the use of projectors for all lecturers so that they do not interfere with the teaching and learning process.	Assistants are less proficient in operating the software		During and outside practical hours	During and outside practical hours	It is necessary to provide training on the use of projectors for all lecturers so that they do not interfere with the practicum process.
	University X needs to install CCTV in classrooms to ensure the	There is no CCTV in the practicum room		During and after complet	During and after completing the	University X needs to install CCTV in classrooms to ensure the safety of Industrial Engineering students.

Dimension	What	Why	Where	When	Who	How
	safety of Industrial Engineering students.			ing the practicum	practicum	
	- It is necessary to check the projector as scheduled by University	Many projectors are dead or have other damage in the practicum room		During practical hours	During practical hours	- It is necessary to check the projector as scheduled by University
	- Providing action on projectors such as servicing damaged projectors, and renewing and procuring projectors in classrooms that need them.	Many projectors are dead or have other damage in the practicum room		Practicum Room During practicum hours	Practicum Room During practicum hours	- Providing action on projectors such as servicing damaged projectors, and renewing and procuring projectors in practicum rooms that require them.
	- It is necessary to carry out a scheduled AC check by University X - Providing action to projectors such as servicing damaged ACs, and renewing and providing ACs in classrooms that need them	There is an AC that is dead/not in good condition		During and after completing practical hours	Faculty & WD II	- It is necessary to carry out a scheduled AC check by University X. - Providing action to projectors such as servicing damaged ACs, and renewing and providing ACs in practicum rooms that need them
	It is necessary to check and update the classroom lighting which is not bright enough or the lights are off.	There is a practical room that lacks lighting		During and after completing practical hours	Faculty & WD II	It is necessary to check and update the classroom lighting which is not bright enough or the lights are off.
	It is necessary to manage the number of students who contract courses, the division of class time and space by University X.	The practicum chair is less ergonomic		During class time	Faculty & WD II	Chair facilities need to be standardized and updated to make them more comfortable and ergonomic.
	-Lecturers need to arrive on time, according to class hours.	Lack of conducive conditions outside the practicum room		During and after class hours	The faculty	It is necessary to enforce regulations such as SOPs for conduciveness during active lecture hours
	- Lecturers need to manage learning time, paying attention to the limits of the material to be provided and time limits according to course credits.	Practicum space is not fixed		During practicum	Department	Departments need to facilitate laboratories to establish practicum rooms, especially in practicums with a large number of practitioners