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Employing Fuzzy-weighted SERVQUAL, Refined-KANO, IPA, and QFD to Assess Service Quality in Vocational Higher Education

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Abstract: This research aims to evaluate the quality of vocational higher education services and determine which characteristics most influence service quality. The research used multiple service quality methods, including Fuzzy Weighted SERVQUAL, Refined Kano, Importance-Performance Analysis, and Quality Functional Deployment. This study was conducted in 7 aviation polytechnics: Indonesian Aviation Polytechnic Curug, Medan Aviation Polytechnic, Palembang Aviation Polytechnic, Surabaya Aviation Polytechnic, and Makassar Aviation Polytechnic, and Aviation Polytechnic Jayapura under the Human Resources Development Centre for Air Transportation - Ministry of Transportation. Random sampling was used to determine the number of samples. The population was 3063 cadets, with 507 samples drawn from seven Aviation Polytechnics in Indonesia. The research instrument was a questionnaire with Servqual dimensions and attributes that meet two criteria: service quality Servqual includes five dimensions and attributes of service quality in vocational higher education comprising 23 attributes. The data analysis techniques used were both quantitative and qualitative. The results of this study found that; (1) Of the 23 service quality items at vocational colleges, 14 items are the voice of customers for the Cadets of the seven aviation polytechnics under the PPSDMPU with modern or up-to-date practice lab equipment as the most item that needed to be improved. (2) Formulate 22 alternative technical problem-solving sequentially according to priority with the fulfillment of items carried out by considering the capability of the resources owned by each aviation polytechnic with the application of rights and obligations to all learners as the most quality characteristics that should be implemented.

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Introduction

It was projected that the COVID-19 pandemic (World Health Organization, 2020) would affect virtually all formal and informal elements of life, including education. The pandemic has shaken the global higher education landscape, causing the education community to carry out learning activities in one of three ways (Smalley, 2020; Hodges et al, 2020): (1) continuing to carry out learning in the classroom by implementing social distancing, (2) implementing blended learning by limiting the number of face-to-face meetings, or (3) switching to a fully online platform. Unlike previous transitions, from face-to-face learning to blended learning, entirely online, or flipped learning, which required careful planning and validation, the change in emergency remote teaching (a temporary shift from face-to-face learning to alternative learning occurs unexpectedly for pandemic emergencies. However, case studies demonstrate that this remote emergency tutoring increases student academic performance (Pradas, et.al, 2021). With improvements in the

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classroom presentation paradigm, student learning activities over the semester, and test administration, the number of totally online learning activities has increased considerably (Dascalu, et.al, 2021). Additionally, emphasis should be made on developing interactive learning activities to enhance student learning outcomes and evaluate student work (Bichler, et.al, 2021).

Additionally, the epidemic has affected vocational education (Han et al., 2020). Face-to-face learning is being replaced by hybrid or fully online learning. The objective of vocational education is the mastery of knowledge, skills, and attitudes, with the mastery of skills taking precedence. It presents challenges as face-to-face learning activities must be transformed into online learning using appropriate approaches (Davydova et al., 2021; Syauqi, Munadi, & Triyono, 2020). It can affect the quality of instruction teachers offer, and students receive. According to Han et al. (2020), 27% of vocational education in China delays practical learning during the pandemic, 37% of all learning is conducted through skill-training videos, and 37% utilizes novel learning methodologies using platforms. These include online training, virtual reality simulation, training at home, and workplace demonstrations. Online learning promotes interaction between students and teachers and between students and learning resources in vocational education. It enhances students' satisfaction with learning activities.

Student satisfaction with learning activities impacts the service quality in postsecondary vocational education. Vocational higher education categorizes educational services to improve service quality (Rinanto et al., 2019). In addition to the pandemic factor, evaluating the quality of vocational education services is also driven by the government's plan to enhance worker capacities in the face of global competitiveness that demands high-quality workers. Also, efforts must be made to increase the quality of higher education services supplied to its students to enhance education quality (Pohyae et al., 2016). Universities strive to provide high-quality instructional programs and administrative procedures, such as the learning process, that are of high quality (the material presented follows the latest scientific developments and is needed by the community). Moreover, in terms of administration, education personnel constantly do their best to help students by administering in accordance with university regulations. Educational curriculum and administrative processes are not the only significant factors that can improve the quality of higher education. Facilities and infrastructure, educational systems, student competencies, research and community service performed by lecturers and involving students who need attention are also significant. Therefore, universities should prioritize students as their primary audience, strive for continuous growth to produce competent and competitive graduates, and maximize student satisfaction with the services provided (Nurjannah et al., 2020).

Vocational colleges must provide superior service quality to increase student loyalty and attract new students. Good service quality in vocational higher education has minimized student turnover and increased new student enrollment. Consequently, vocational higher education institutions are typically financially stable. It has inspired all vocational schools to continue enhancing the quality of their programs (Baird, 2011). Hence, this study aims to evaluate the quality of vocational higher education services and determine which characteristics are most influential in determining service quality using Weighted-Fuzzy Servqual, Refined-Kano, IPA, and QFD. Furthermore, improvement priorities and technology actions to enhance service quality are defined.

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Research Method

This study employed multiple service quality research methods, including Fuzzy Weighted SERVQUAL (Chou et al, 2011), Refined Kano (Yang, 2005), Importance-Performance Analysis (Yang, 2005), and Quality Functional Deployment (Tan & Pawitra, 2001). This is survey research with the research object of vocational education cadets from Indonesian Aviation Polytechnic Curug, Medan Aviation Polytechnic, Palembang Aviation Polytechnic, Surabaya Aviation Polytechnic, Makassar Aviation Polytechnic, and Aviation Polytechnic Jayapura under the Human Resources Development Centre for Air Transportation - Ministry of Transportation. Random sampling was used to determine the number of samples. The entire population was 3063 cadets, with 507 samples drawn from seven Aviation Polytechnics in Indonesia. A questionnaire created with Google Forms media is used to collect data. The instrument employed is a standard instrument that prioritizes the characteristics of assessing the quality of vocational education services on five dimensions of service quality (Rinanto et al, 2019). On July 20, 2022, the questionnaire was administered to 30 cadets to assess their readability and comprehension. The data was collected between July 25 and August 3, 2022 and got 507 respondents. On September 6, 2022, a focus group discussion with education experts was held to acquire QFD data. The research data were analyzed both quantitatively and qualitatively. Using quantitative data analysis, the results of the collected surveys were analyzed.

Data analysis techniques of this research used Fuzzy Weighted-SERVQUAL to analyze the most significant gap between students' expectations and perceived service. Refined-KANO data were analyzed to get the functional and dysfunctional attributes. Then, the data were analyzed by Important Performance Analysis to get the specific strategies for each category by diagnosing abilities and service quality. Ultimately, customers' voices were analyzed using Quality Functional Deployment to know which service attributes should be improved and how to improve them.

Results and Discussion

Fuzzy-Wigthed Servqual

The most critical step in establishing and offering the finest service is understanding what clients expect and want (Chien et al., 2010). As a result, the SERVQUAL approach, developed by Parasuraman et al. (1985, 1988) and revised by Parasuraman et al. (1991, 1994), is one of the best evaluation methods for analyzing expectations and perceptions (Ladhari 2009, Chien et al., 2010). The SERVQUAL method has five dimensions to measure service quality, according to Lovelock and Wirtz (2004): (1) tangibles (the appearance of physical elements), (2) reliability (reliable, accurate performance), (3) responsiveness (speed and help), (4) assurance (competence, courtesy, credibility, and security), and (5) empathy (easy access, good communication, and customer understanding). Customers assess service quality by analyzing whether there is a mismatch between their expectations and perceptions. SERVQUAL is founded on the premise that quality is a customer's subjective judgement because service is an experience rather than a physical commodity. It computed the disparity between customer expectations and perceptions. As a result, a "gap" exists between expectations and perceptions. A positive gap suggests that perception exceeds expectations, indicating good quality, whereas a negative gap indicates low quality. A neutral gap with a score of zero indicates that the quality is good (Chien et al., 2010).

Because human judgements and preferences are frequently ambiguous and cannot be calculated with definite numerical values, using the linguistic variable to convey the desired value and its weighting, such as extremely low, low, sufficient, and high, is more practical.

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Various fuzzy approaches for measuring service quality have been used because they have the advantage of being the correct method for measuring uncertainty (Chien et al., 2010; Zimmermann HJ, 1996). Table 1 shows the difference between the initial SERVQUAL method and the Fuzzy weighted SERVQUAL approach.

Table 1. The Distinction Between SERVQUAL and Fuzzy Weighted SERVQUAL

Differences	SERVQUAL (Parasuraman et.al 1985)	FUZZY WEIGHTED SERVQUAL (Chien et.al 2010)
Scale	Likert Scale	Linguistic Variable
Importance Weight Criteria	Only Dimension to be tested	All items to be tested
Calculation	Statistical Calculation	Fuzzy Set Theory Calculation

Refined-Kano

The Kano model is a paradigm for measuring service quality widely utilized in various sectors. The Kano model gives a different function on each customer satisfaction attribute, which consists of five attributes, namely (1) attractive quality attribute (pleasure attribute), where the amount of client contentment increases as the attribute performance improves. However, a decline in attribute performance does not decrease customer satisfaction; (2) one-dimensional quality attribute (anticipated attribute), where attribute performance is linearly related to customer satisfaction. Client satisfaction will rise if the attribute performance corresponds to the client's preferences.

Client satisfaction will suffer if the attribute's performance does not correspond to the client's preferences. The more the attribute function, the greater the client contentment; (3) quality attribute (basic attribute), i.e., the customer will be dissatisfied if the attribute performance is poor. Client satisfaction will not increase significantly if the attribute performance has been met. That is because the client believes the attribute performance should be in this manner; (4) indifferent quality attribute, if there is no attribute, this will not affect client satisfaction or dissatisfaction; and (5) reserve quality attribute, that is, the existence of the attribute causes client dissatisfaction. In contrast, lacking qualities will result in client contentment (Lin, Yang, Chan, & Sheu, 2010; Caesaron, Makapedua, Lukodono, 2021; Yang, 2005). Yang (2005) improved the Kano model into what is commonly utilized as a paradigm for enhancing service quality (Caesaron, Makapedua, Lukodono, 2021). By restricting the weight given to each attribute, the Refined-Kano Model is more particular in addressing client needs. According to Lin et al. (2010), not all traits are equally crucial in client acquisition. You may raise customer satisfaction more quickly by increasing the value of each attribute and the rate at which it is valued (Caesaron et al., 2021). Figure 1 Kano Model quality attributes and Figure 2 Activate the quality feature of the Refined-Kano Model. Table 2 shows the distinction between the Kano Model and the Refined-Kano Model in the field of qualitative qualities.

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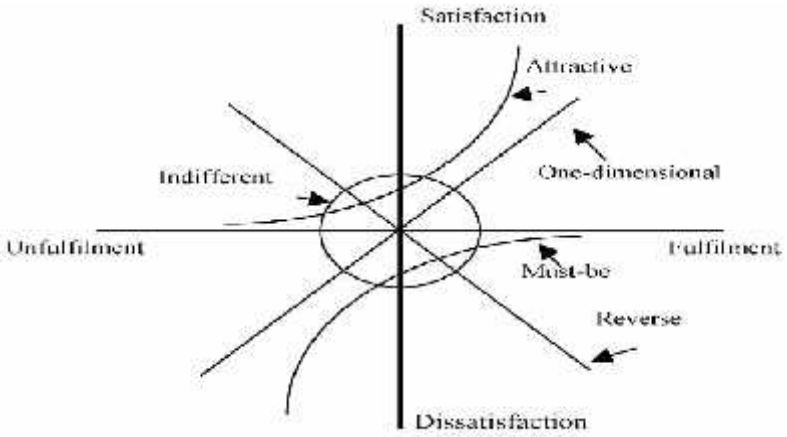

Figure 1. Kano's Model Quality Attributes (Yang, 2005)

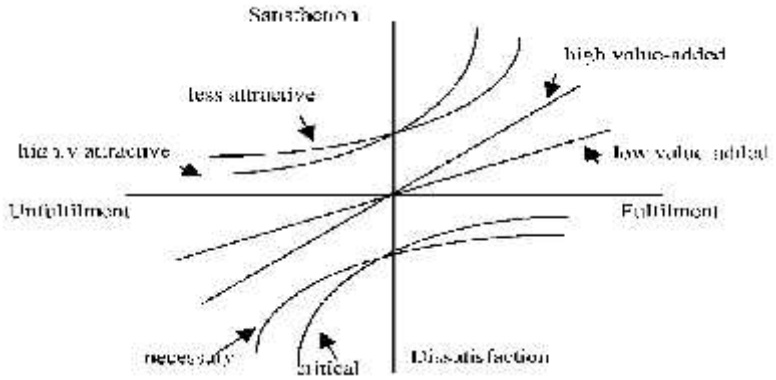

Figure 2. Refined-Kano's Model Quality Attributes (Yang, 2005)

Table 2. Kano Model and Refined-Kano Model Quality Attribute Category (Yang, 2005)

Categories of quality attributes in Kano's model	Categories of quality attributes with high importance in refined model	Categories of quality attributes with low importance in refined model
Attractive	Highly attractive	Less attractive
One-dimensional	High value-added	Low value-added
Must be	Critical	Necessary
Indifferent	Potential	Care-free

Importance Performance Analysis (IPA)

Following the determination of the service quality attribute category, customer satisfaction is analyzed, and the priority of service quality improvement is determined using Importance Performance Analysis (IPA). Combining Kano and IPA is a diagnostic tool for determining specific strategies for each category by diagnosing abilities and service quality qualities. According to Yang (2005), there are four categories in the IPA: (1) excellent attributes that are deemed necessary by the client and performance attributes that result in client satisfaction; (2) to be improved attributes that are also deemed necessary by the client, but the performance of the attributes has not met the client's expectations or satisfaction; and (3) surplus attributes that are less important for clients but have provided client satisfaction and (4) carefree characteristics have low or low client satisfaction levels. Fig. 3. displays the IPA matrix.

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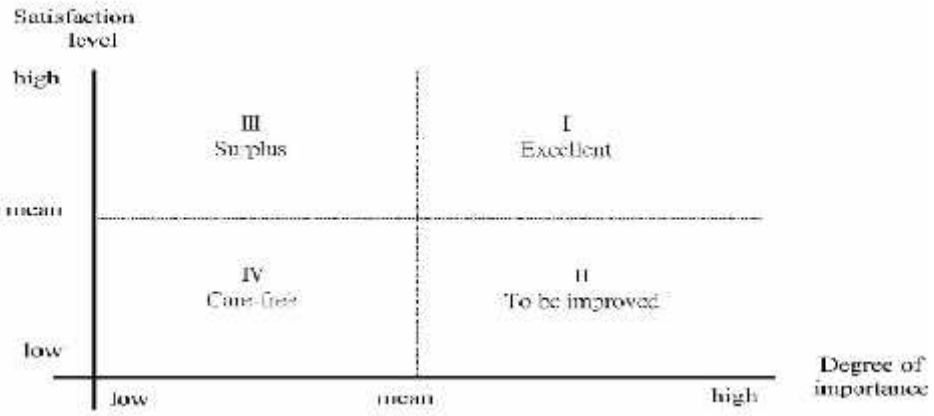

Figure 3. Importance Performance Analysis Matrix (Yang, 2005)

Quality Function Deployment (QFD)

Quality Function Deployment (QFD) is used in planning quality improvement and product development. This method was first created in 1972 by the Japanese shipyard Kobe, Mitsubishi Heavy Industry Ltd. It subsequently evolved into a variety of enterprises. QFD is an engineering method for translating customer requirements into quality attributes and producing product designs (Lee et al., 2000). The QFD approach is used in service quality research to determine improvement measures based on customer needs. As a result, technical improvement measures can be described as recommendations to increase service quality in QFD.

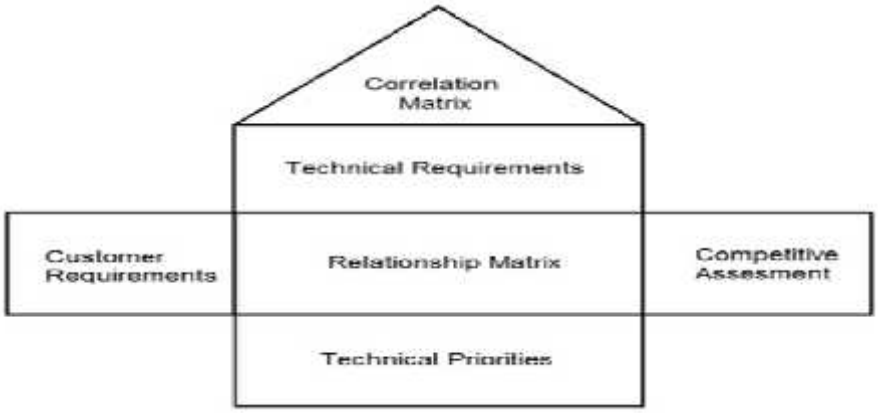

Figure 4. House of Quality Matrix (Caesaron et.al., 2021)

The QFD technique focuses on customer service standards (Voice of Customer (VOC)). The House of Quality (HOQ) matrix is a tool in QFD that can be used for quality improvement. These are linked to determine a product or service's client needs and technical aspects. This matrix is constructed by producing VOC tables, which are then translated into technical language for implementation via technical answers. The correlation between each attribute and its aim is compared to competitors in the same field. Creating a HOQ matrix can be beneficial for increasing the quality of existing services by setting goals and prioritizing service enhancements (Caesaron et al., 2021). Figure 4 depicts the House of Quality Matrix.

In this investigation, the phases of processing the data are as follows:

1) After sorting the data based on the findings of the questionnaire, one hundred percent of the data from the respondents can be used.
2) Utilizing SPSS to calculate the study data's validity and reliability.
3) Extracting information from the Servqual and Kano databases.

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4) First, the values for Servqual are transformed into a fuzzy number, and then the weighting is determined using that number.
5) The information obtained from Kano is arranged in an improved Kano format.
6) Filtering is performed on the findings obtained from fuzzy-weighted Servqual and refined-kano. Items that could be considered "less attractive" have been eliminated from the list.
7) Construct a cartesian diagram to analyze the relationship between importance and performance. The care-free state does not apply to the fourth quadrant. The "voice of the customer" can be derived from the initial 21 items, which includes the following 14 items.
8) Conduct an FGD to ascertain the technical answer and conduct a QFD analysis.
9) Conclusion.

Utilizing the Fuzzy-SERVQUAL model, preliminary data analysis obtained aspects of the quality of vocational education services. In addition, refined KANO was utilized to determine the significance of service quality features. The acquired results were further evaluated using IPA to establish priorities for enhancing service quality features. The third phase was an examination of Quality Function Deployment (QFD) to identify technical steps to enhance the quality of vocational higher education services. The research conclusion was based on the results of the QFD, which establish the order of priority for corrective actions. The research instrument was a questionnaire with Servqual dimensions and attributes that meet two criteria: service quality Servqual, which includes five dimensions and attributes of service quality in vocational higher education comprising 23 attributes (Rinanto, 2019). In Table 3, these dimensions and features are detailed.

Table 3. Qualitative Dimensions and Attributes of Vocational Higher Education Services (Rinanto, et al, 2019)

Dimension	Atribut
Tangible	1. Modern or up to date practice/lab equipment.
	2. Reference books in the library are up to date
	3. The theory class equipment is suffiecient
	4. Supporting infratructures are sufficient
	5. The atmosphere of campus is comfort because of its cleanliness and green space
Reliability	6. Consistent to provide 1 machine/equipment for 1 student during practicum
	7. The education system make students have the characters needed by the industry
	8. The education system makes students have skills needed by industry
	9. Reliable administrations system
	10. Consistent assessment criteria
	11. Machine or equipment is always ready to use
	12. Tuition fee are comensurate with facilities and activities
Responsiveness	13. Immediately takes action to repair or replace out of order equipment
	14. Immediately takes action to repair out of order infrastructures
	15. Academic staff respond to questions, requests, claim quickly and enthusiastically
	16. Teaching staff (instructors and lectures) immediately provide solutions if students experience learning difficulties
Assurance	17. Institutions provide guarantees for students to get a job after graduation
	18. Clear goal education
	19. Instructors/lecturers have knowledge and experience in industry

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	20. Students feel safe and comfortable in the campus
Empathy	21. No discrimination
	22. Teaching staff (lecturers and instructors) are always available
	23. Teaching staff (lecturers and instructors) are available for personal discussion

Five questions were developed for each attribute, including the instrument for Servqual and its weighting, in addition to the instrument for Kano. The Linkert scale is the one that is utilized to acquire Servqual data. This scale consists of the following response options: Strongly Agree, Agree, Neutral, Disagree, and Strongly Disagree. Additionally, this scale has a weighting scale that reads as follows: Very Important, Important, Fairly Important, Not Important, and Very Not Important. The instrument that Kano uses is a five-point scale, with the options S = Like (I like that kind of thing), H = Hope (I expect that kind of thing), N = Neutral (I am neutral), T = Tolerant (I do not like it but I can tolerate/accept things like that), and TS = Dislike (I do not like and cannot accept things like that). TS = Dislike is the most negative option. Both Servqual and Kano include questions about the expectations and the actuality of the quality of the Vocational Higher Education services. At the same time, Kano also includes questions about the functional and dysfunctional aspects of the quality of the services.

After the questionnaire was compiled, an instrument trial was conducted on thirty PPI Curug cadets who were not the target respondents to test the questionnaire's understandability and wording. It was necessary since the dimensions and reference attributes used English, which was then translated into Indonesian. The test findings were analyzed and used to refine the existing questionnaires. After the data was collected, the validity and reliability of the data are then calculated. The results of calculating the validity using SPSS. All sig.2 tails <0.05 means that all data is valid, and the Cronbach Alpha calculation results are 0.745, which means the data is reliable.

Empirical Analysis of Fuzzy-Weighted Servqual (Chou et al, 2011).

Questionnaire results data regarding perceptions, expectations, and weighting in the form of a Linkert scale are converted into fuzzy numbers with linguistic variables:

Strongly disagree: 0.0 1.0 2.0
Disagree: 1.0 2.0 3.0
Neutral: 2.0 3.0 4.0
Agree: 3.0 4.0 5.0
Strongly agree: 4.5 5.0 5.0

While the linguistic variable for importance weight of criteria is as follows:
Very Not Important: 0.0 1.0 2.0
Not Important: 1.0 2.0 3.0
Important enough: 2.0 3.0 4.0
Important: 3.0 4.0 5.0
Very Important: 4.5 5.0 5.0

Make a table of perception, expectation, and gap, then compile the existing defuzzied data and rank it from the largest to the smallest gap. After that, determine the items to be analyzed using Refined-Kano. Then determine the Empirical Analysis of Refined-KANO by changing the results of the questionnaire into numeric with a scale of Like = 5, Hope = 4, Neutral = 3, Tolerance = 2, Dislike = 1. At last, create a functional and dysfunctional matrix as follows:

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Tabel 4. The Kano evaluation (Tan & Pawitra, 2001)

Customer need		Like	Must-be	Dysfunctional Neutral	Live with	Dislike
Functional	Like	Q	A	A	A	O
	Must be	R	I	I	I	M
	Neutral	R	I	I	I	M
	Live with	R	I	I	I	M
	Dislike	R	R	R	R	Q

Notes: A = attractive, O = one-dimensional, M = must-be, Q = questionable, R = reverse, I = indifferent

Then calculate the average data and make a recapitulation of responses from respondents.

Table 5. Recapitulation of Respondents' Responses

Atribut	A	O	I	M	Q	R	Total	Kategori
1	207	107	112	13	62	6	507	A
2	211	91	136	14	46	9	507	A
3	192	126	105	9	66	9	507	A
4	173	138	109	18	62	7	507	A
5	169	186	83	12	52	5	507	O
6	171	158	101	17	51	9	507	A
7	145	179	120	13	45	5	507	O
8	138	175	117	24	45	8	507	O
9	139	178	121	26	39	4	507	O
10	151	168	116	21	45	6	507	O
11	173	158	103	20	44	9	507	A
12	107	224	100	31	38	7	507	O
13	164	157	122	21	37	6	507	A
14	160	152	123	25	40	7	507	A
15	147	165	123	26	41	5	507	O
16	186	157	102	16	40	6	507	A
17	156	201	85	24	36	5	507	O
18	106	249	80	27	39	6	507	O
19	174	173	109	11	37	3	507	A
20	141	207	94	23	36	6	507	O
21	77	276	82	32	36	4	507	O
22	168	164	122	14	33	6	507	A
23	204	119	128	14	39	3	507	A

Following this, the average Importance is computed. High Importance if the value is greater than the mean. Low Importance if the value is less than the mean. Then, it was classified as *Highly Attractive* (used in the subsequent stage), *Less Attractive* (not used in the next stage), *High-value-added* (used in the subsequent stage), *Low-value-added* (used in the next stage), *Must be Important* and *Essential Indifference* (potential and unconcerned). It determined the items to be employed in the subsequent analysis. An empirical examination of the importance-performance analysis (IPA) as follows:

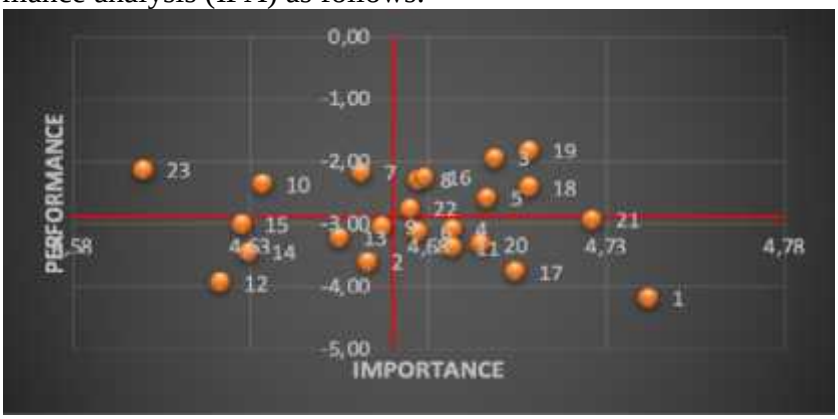

Figure 5. The Result of Empirical Examination of the IPA

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The results of IPA are used to determine the voice of customer (VOC), as follows:

Table 6. Voice of Customer

Rank	Items
1	1. Modern or up to date practice/lab equipment.
2	11. Machine or equipment is always ready to use
3	6. Consistent to provide 1 machine/equipment for 1 student during practicum
4	4. Supporting infratructures are sufficient
5	17. Institutions provide guarantees for students to get a job after graduation
6	20. Students feel safe and comfortable in the campus
7	21. No discrimination
8	22. Teaching staff (lecturers and instructors) are always available
9	16. Teaching staff (instructors and lectures) immediately provide solutions if students experience learning difficulties
10	3. The theory class equipment is suffiecient
11	19. Instructors/lecturers have knowledge and experience in industry
12	5. The atmosphere of campus is comfort because of its cleanliness and green space
13	18. Clear goal education
14	8. The education system makes students have skills needed by industry

From VOC then be determined House of Quality, as follows:

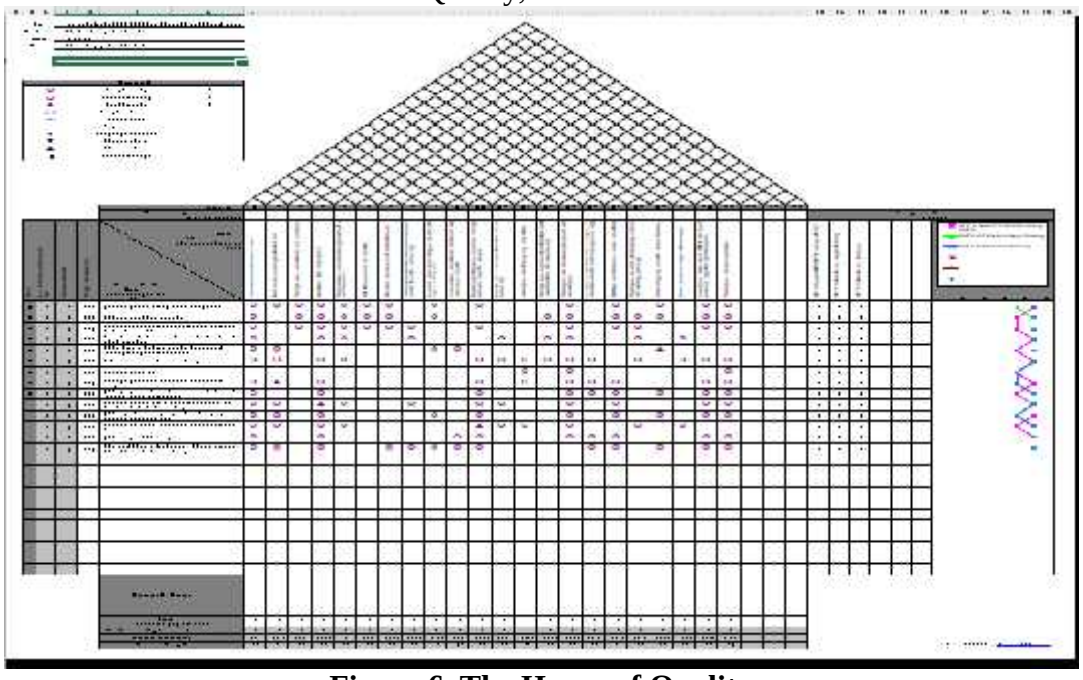

Figure 6. The House of Quality

- Define WHAT (result of integration of Fuzzy Weighted Servqual, Refined-Kano, and IPA).
- Discussion to establish HOW (solution of WHAT).
- Define WHAT and HOW relations (strong/medium/weak).
- Determine the relationship between HOW (roof).
- Calculating difficulty to accomplish (below).
- Counting competitors (right).
- Setting the result (improvement priority).

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Table 7. Recapitulation of Fuzzy Weighted Servqual, Kano, Refined Kano, IPA and QFD Calculation Data

Dimension	Atribut	Fuzzy Weighted Servqual						Kano	Refined-Kano		IPA	VOC
		Perception	Expectation	Gap	Weighted	Fuzzy Weighted Gap						
Tangible	1. Modern or up to date practice/lab equipment.	3,665	4,555	-0,891	4,676	-4,164	1	A	Highly Attractive	√	To be improved	1
	2. Reference books in the library are up to date	3,720	4,498	-0,778	4,604	-3,582	4	A	Less Attractive	X	Care-free	X
	3. The theory class equipment is suffiecient	4,123	4,538	-0,415	4,636	-1,923	22	A	Highly Attractive	√	Excellent	10
	4. Supporting infratructures are sufficient	3,862	4,524	-0,662	4,625	-3,060	10	A	Highly Attractive	√	To be improved	4
	5. The atmosphere of campus is comfort because of its cleanliness and green space	4,044	4,598	-0,554	4,635	-2,568	15	O	High Value-Added	√	Excellent	12
Reliability	6. Consistent to provide 1 machine/equipment for 1 student during practicum	3,942	4,614	-0,672	4,616	-3,102	9	A	Highly Attractive	√	To be improved	3
	7. The education system make students have the characters needed by the industry	4,124	4,593	-0,470	4,601	-2,161	20	O	Low Value-Added	√	Surplus	x
	8. The education system makes students have skills needed by industry	4,080	4,572	-0,492	4,617	-2,270	18	O	High Value-Added	√	Excellent	14
	9. Reliable administrations system	3,900	4,558	-0,658	4,607	-3,030	11	O	Low Value-Added	√	Care-free	X
	10. Consistent assessment criteria	4,023	4,536	-0,512	4,575	-2,345	17	O	Low Value-Added	√	Surplus	x
	11. Machine or equipment is always ready to use	3,877	4,606	-0,728	4,625	-3,367	6	A	Highly Attractive	√	To be improved	2
	12. Tuition fee are comensurate with facilities and activities	3,705	4,565	-0,860	4,562	-3,922	2	O	Low Value-Added	√	Care-free	X
Responsiveness	13. Immediately takes action to repair or replace out of order equipment	3,894	4,591	-0,697	4,595	-3,202	8	A	Less Attractive	X	Care-free	X
	14. Immediately takes action to repair out of order infrastructures	3,842	4,592	-0,750	4,571	-3,426	5	A	Less Attractive	X	Care-free	X
	15. Academic staff respond to questions, requests, claim quickly and enthusiastically	3,908	4,561	-0,653	4,570	-2,984	12	O	Low Value-Added	√	Care-free	X
	16. Teaching staff (instructors and lectures) immediately provide solutions if students experience learning difficulties	4,115	4,598	-0,483	4,617	-2,231	19	A	Highly Attractive	√	Excellent	9
Assurance	17. Institutions provide guarantees for students to get a job after graduation	3,812	4,621	-0,809	4,641	-3,754	3	O	High Value-Added	√	To be improved	5
	18. Clear goal education	4,118	4,635	-0,517	4,645	-2,401	16	O	High Value-Added	√	Excellent	13
	19. Instructors/lecturers have knowledge and experience in industry	4,242	4,632	-0,390	4,646	-1,812	23	A	Highly Attractive	√	Excellent	11
	20. Students feel safe and comfortable in the campus	3,876	4,590	-0,714	4,632	-3,306	7	O	High Value-Added	√	To be improved	6
Empathy	21. No discrimination	4,013	4,636	-0,623	4,662	-2,906	13	O	High Value-Added	√	To be improved	7
	22. Teaching staff (lecturers and instructors) are always available	3,996	4,591	-0,595	4,614	-2,745	14	A	Highly Attractive	√	Excellent	8
	23. Teaching staff (lecturers and instructors) are available for personal discussion	4,091	4,559	-0,468	4,543	-2,127	21	A	Less Attractive	X	Surplus	X

According to the table, the VOC comprises 14 different components, down from the initial 23 different items, which were whittled down by employing the three different models in the past. Furthermore, the HOW or actions that the management of vocational higher education must take are acquired based on the QFD result. It ensures that the manager is always moving in the right direction. Twenty-two priority actions can be carried out depending on the priorities and resource capabilities of the aviation polytechnic management.

Table 8. Priorities of Action to Improve the Quality of Vocational Higher Education Services

Rank	Quality Characteristics (How)	Weight of Importance
1	Application of rights and obligations to all learners	771,6
2	Planning involves the user	750
3	ISO 17025:2017 Certification	713,8
4	Implementation of an independent campus	707,2
5	Monitoring the conformity of CPMK and sub-CPMK to learning activities.	642,5
6	Review/updating curriculum and tools (internal campus autonomy)	585,5
7	Learning strategies according to the characteristics of the students.	535,4
8	Maintenance supervision (preventive, repair, and evaluation)	450
9	Benchmarking to other Polytechnics	329,1
10	Lecturer industrial internships on a regular basis.	328,7
11	Collaborating with related agencies (Airnav, Angkasa Pura, etc.)	321,9
12	Implementation of classroom service response time and its accessories	320,9

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13	Monitoring the presence of lecturers with priority on the implementation of the tri dharma of higher education.	320,7
14	Consistent application of regulations	257,2
15	Laboratory utility achievement standard	257,1
16	Improving public facilities services (water, sanitation, parks, etc.)	257
17	It is necessary to determine the ratio of the number of students to the number of supporting facilities	256,5
18	SOP Use of practice tools	193
19	Increased competency and number of laboratory assistants	193
20	Green campus as an institutional KPI	192,7
21	Increasing the implementation of K3 (Health, safety, and security)	192,5
22	Providing additional competencies according to industry needs	149,9

Because this investigation involves a significant amount of data processing, it is essential to develop an application integrated with Google Forms and Excel for data processing, particularly on fuzzy numbers and their corresponding defuzzied numbers.

The most significant gap between the quality of vocational higher education services and what students expect is modern or up-to-date practice/laboratory equipment. It demonstrates that facilities in vocational education that emphasize practice over theory are not supported by laboratories that can keep up with technological advancements in the industry. Aviation vocational education is essential to keep pace with technological advancements as aviation technology advances. Laboratory equipment for aviation education is a costly purchase. Nevertheless, to offer aviation vocational education, the institution must be able to provide a lab comparable to those utilized in the field. It is beneficial to deconstruct the complex flows observed in flying environments in the laboratory to make the problem more challenging and emphasize the influence of significant constituent phenomena (Jones et al., 2022).

Conclusion

Based on the study's analysis, it can be concluded that : (1) Of the 23 service quality items at vocational colleges, 14 items are the voice of customers for the Cadets of the seven aviation polytechnics under the PPSDMPU, with modern or up-to-date practice lab equipment as the most item that needed to be improved; (2) Formulate 22 alternative technical problem-solving sequentially according to priority with the fulfillment of items carried out by considering the capability of the resources owned by each aviation polytechnic with the application of rights and obligations to all learners as the most quality characteristics that should be implemented.

Recommendation

For the vocational leaders, it would be better to implement alternative technical problem-solving by considering the capability of the resources owned by each aviation polytechnic. For the lecturers of vocational higher education, it would be beneficial to the students if the lecturer mastered learning strategies according to the characteristics of the students. For the staff of vocational higher education, it would be easier if the staff developed an application to convert raw data into fuzzy numbers.

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