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Enhancing Service Quality Through Effective Language and Fuzzy SERVQUAL in Occupational Safety Companies

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ABSTRACT

This study explores the application of the Fuzzy SERVQUAL method to evaluate and enhance service quality in Occupational Safety and Health (OSH) training, with a particular focus on effective communication. The research aims to identify gaps between participant expectations and perceptions, particularly regarding the clarity and effectiveness of language used during training sessions. Data were collected through questionnaires distributed to OSH Expert Training participants at various stages of their training, supplemented by direct observations to gain deeper insights into their interactions with service providers. The responses were then converted into fuzzy values and analyzed using a gap analysis approach to determine the extent to which service quality expectations were met. The results indicate that all gap values were negative, suggesting that the services provided have not yet achieved a satisfactory level for participants, especially in terms of communication effectiveness. The most significant gaps were found in the clarity of information, responsiveness of instructors, and overall service reliability. These findings highlight the need for improvements in language use and communication strategies to enhance participant satisfaction and service effectiveness. Based on the Fuzzy SERVQUAL analysis, specific recommendations are proposed to optimize service delivery through clearer and more structured communication approaches, ultimately improving the quality of OSH training and ensuring better engagement from participants.

1. INTRODUCTION

The rapid growth of OSH training in Indonesia has increased the demand for high-quality service providers [1]. Effective communication plays a crucial role in ensuring that OSH training delivers clear and structured safety messages [2]. However, many OSH service companies face challenges in using systematic and effective language, leading to miscommunication, reduced participant engagement, and lower training effectiveness [3]. Poorly structured language can cause confusion, hinder knowledge retention, and negatively impact workplace safety compliance. The main challenge in this industry is increasing participant participation and obtaining constructive feedback [4].

Despite efforts to improve service quality, gaps between participant expectations and actual service delivery persist [5]. These gaps stem from inconsistencies in communication clarity, responsiveness of instructors, and overall service reliability [6]. Addressing these issues requires a systematic approach to evaluating and improving language effectiveness in training services. Facing fierce competition, OSH service companies must continuously enhance their training methods and materials in alignment with technological advancements, regulations, and industry needs [7, 8].

This study emphasizes the importance of analyzing effective language use using the Fuzzy SERVQUAL and TRIZ methods [9]. Fuzzy SERVQUAL helps measure and analyze service quality, while TRIZ provides a framework for innovative solutions [10]. With these two methods, companies can analyze and identify areas that need improvement and develop effective solutions. The quality of OHS training is not only in the final results, but also the processes and strategies used [11]. The company periodically and continuously updates training methods and materials according to technological developments, regulations, and industry needs [7]. This study is expected to improve the quality of OHS training services resulting from the analysis of the use of effective and communicative language [12]. By using effective language, the process of activities in the field of occupational safety services is expected to produce accurate and easy-to-understand information so that work accidents in the field can be reduced.

The initial phase of this research focuses exclusively on the use of Fuzzy SERVQUAL to identify and analyze service quality dimensions within OSH training. Fuzzy SERVQUAL is employed to evaluate the gaps between participants' expectations and their perceptions of the actual service provided, thus highlighting specific areas requiring improvement. Once these critical areas are identified through Fuzzy SERVQUAL, the subsequent phase involves applying the TRIZ methodology to develop innovative solutions and strategies tailored to address the identified issues. By adopting this two-step approach, the research ensures a systematic and thorough analysis, beginning with precise identification of service quality deficiencies and followed by the creative resolution of these deficiencies to enhance overall training effectiveness and participant satisfaction.

2. LITERATURE REVIEW

2.1 Fuzzy-SERVQUAL method

Fuzzy SERVQUAL is an extension of the traditional SERVQUAL method, incorporating fuzzy logic to address uncertainties in service quality assessment. It is particularly useful when customer perceptions and expectations involve subjective judgments, making it a valuable tool for evaluating qualitative aspects of service delivery. In the context of OSH training, ensuring high service quality requires a precise understanding of communication effectiveness and training satisfaction. By utilizing Fuzzy SERVQUAL, this study aims to identify key service gaps and propose improvements in communication strategies.

The traditional SERVQUAL method evaluates five dimensions: tangibility, reliability, responsiveness, assurance, and empathy. However, recent studies highlight that this method can be inadequate in handling uncertainty and the subjectivity of customer data [10].

Recent studies have expanded on this by incorporating fuzzy logic into the SERVQUAL model. Suranti and Yupianti [6] implemented Fuzzy SERVQUAL to evaluate the service quality of agricultural extension officers, demonstrating how fuzzy logic can handle the vagueness and ambiguity inherent in human perceptions. Similarly, Supardi et al. [1] evaluated the satisfaction of mining safety training participants using a Service Quality model and Importance Performance Analysis, highlighting the flexibility and accuracy of Fuzzy-SERVQUAL in capturing customer perceptions.

2.2 Effective communication in OSH training

Effective communication is crucial for the success of OSH training. It ensures that safety protocols and procedures are clearly understood and correctly followed by all participants, thereby reducing the risk of workplace accidents and enhancing overall safety culture [13]. Emphasized the significance of effective safety communication in the oil and gas production fields, where clear and concise communication can significantly improve worker participation and satisfaction. They found that when safety messages are effectively conveyed, workers are more likely to adhere to safety guidelines and engage proactively in safety programs [14].

Similarly, Padhil et al. [15] analyzed the communication processes within PT. XYZ and their role in preventing workplace accidents. The study highlighted that effective communication strategies, including the use of clear language, regular safety briefings, and interactive training sessions, are essential in ensuring that safety information is comprehended and retained by employees.

This research underscores the impact of effective communication in fostering a culture of safety, where employees feel informed, valued, and motivated to prioritize safety in their daily tasks. These findings suggest that in OSH training, the way safety information is communicated is just as important as the content itself, directly influencing the overall effectiveness of safety initiatives.

By integrating Fuzzy SERVQUAL and TRIZ methodologies, this study aims to systematically evaluate how language clarity and structured communication impact service quality in OSH training. This dual approach ensures a comprehensive assessment and provides actionable recommendations for enhancing communication effectiveness in safety training programs.

3. RESEARCH METHODOLOGY

This study adopts the Fuzzy-SERVQUAL approach to evaluate and enhance service quality in the OSH training process for prospective OSH expert candidates at OSH Services Company. The method addresses uncertainties commonly encountered in qualitative assessments during customer satisfaction surveys.

Step 1: Primary data was collected through the distribution of questionnaires to training participants at various stages of their training program. The questionnaire was designed to measure their perceptions across five service dimensions: responsiveness, reliability, assurance, empathy, and tangibles. Direct observations were also conducted to gain deeper insights into the interactions between trainees and service providers.

Step 2: Upon gathering the data, responses from the questionnaire were converted into fuzzy values. Converting scale values into fuzzy sets from input variables to each attribute. Fuzzy scale Function Diagram of Linguistic Variabel values can be seen in Figure 1.

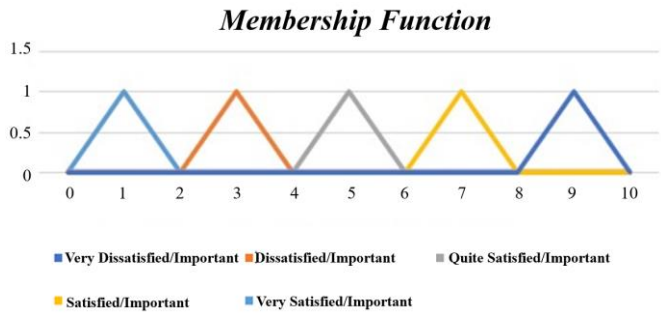

Figure 1. Membership function diagram of linguistic

Step 3: Next, the fuzzification process is carried out to determine the score given by respondents for each attribute asked in the questionnaire. Obtaining the composition of the fuzzy set of all respondents by using the arithmetic mean to obtain the average weighted score. to calculate fuzzy fication using arithmetic mean to obtain the average weight score:

Formula to calculate the upper limit (bi):

$$b_i = \frac{b_{i2}n_1 + b_{i3}n_2 + b_{i4}n_3 + b_{i5}n_4 + b_{i5}n_5}{(n_1 + n_2 + n_3 + n_4 + n_5)} \quad (1)$$

Formula to calculate the middle limit (ai):

$$a_i = \frac{b_{i1}n_1 + b_{i2}n_2 + b_{i3}n_3 + b_{i4}n_4 + b_{i5}n_5}{(n_1 + n_2 + n_3 + n_4 + n_5)} \quad (2)$$

Formula to calculate the lower limit (ci):

$$a_i = \frac{b_{i1}n_1 + b_{i2}n_2 + b_{i3}n_3 + b_{i4}n_4 + b_{i5}n_5}{(n_1 + n_2 + n_3 + n_4 + n_5)} \quad (3)$$

Step 4: Then continued with the defuzzification process, this process is used to determine the degree of membership and defuzzification. The average value of *ai*, *bi*, *ci* is the defuzzification value which will be formulated as follows:

$$d = \frac{\text{ai} + \text{bi} + \text{c}}{3} \quad (4)$$

Description:
b = upper limit value
a = middle limit value
c = lower limit value
bi = average fuzzy set value per level of importance
n = number of respondents per level of importance

Step 5: The gap between perception and expectation (Expectation-Perception Gap) was calculated using the defuzzified values from each service dimension. This provided a deeper insight into how well the service providers met the expectations of trainees across various aspects of service delivery.

Step 6: Based on the gap analysis and findings from the Fuzzy-SERVQUAL process, recommendations were formulated to enhance service quality. These recommendations included specific steps that PT. Fusi Teknika Indonesia could take to improve satisfaction and loyalty among OSH training participants.

4. RESULT

In data collection conducted in this study, primary data was obtained through direct observation and interviews with both training participants (service users) and PT Fusi Teknika Indonesia infrastructure (service delivery) regarding complaints and obstacles that occurred during the training process. From the identification results, 0 service attributes were obtained, which have been categorized according to the 5 serval dimensions. Table 1 below is the result of the identification of Service Quality attributes.

Determination of fuzzy set from each answer given by the respondent for each attribute submitted in the questionnaire in the form of linguistic variables. The linguistic variables used for perception are very dissatisfied, less satisfied, quite satisfied, satisfied, and very satisfied. The linguistic variables used for expectations are very unimportant, less important, quite important, important, and very important. To determine the membership function, the author determines the universe of discussion, namely from 0-10, which is then used to determine the fuzzy domain. The following is the determination of the fuzzy domain by dividing the speaker universe values into 5 categories, Table 2 below is Fuzzy set perception/expectation.

Table 1. Result of identification of service quality attributes at PT Fusi Teknika Indonesia

Dimensions	Code	Service Attributes	Source
Tangibles	A1	The training materials are well structured and relevant to the needs of AK3U certification.	[16]
	A2	Clear information is available regarding the training schedule.	[17]
	A3	Training tools and materials are available.	[1]
	A4	Completeness and readiness in the training process.	[18]
Reability	A5	Training materials are delivered consistently and according to plan.	[19]
	A6	All links provided are working properly.	[20]
	A7	Training Institute is a trusted institution.	[21]
	A8	Staff reliability in providing accurate and timely information.	[22]
	A9	Easy to understand voice and language.	[23]
Responsiveness	A10	The training organizer quickly handled participant complaints.	[1]
	A11	Clarity of information provided by staff regarding training.	[24]
	A12	Suggestions and complaints from training participants become consideration for the agency.	[25]
Assurance	A13	The instructor has sufficient credibility and knowledge.	[26]
	A14	Participant information and evaluation data are managed securely.	[23]
	A15	Knowledge and skills after participating in training activities.	[22]
Empathy	A16	The training organizer uses communicative language that is easy for participants to understand.	[27, 28]
	A17	Good communication between the training organizer and participants.	[29]
	A18	Providing the same service and communication to all training participants without exception.	[30, 31]

The Fuzzy SERVQUAL Gap calculation is carried out to determine the Gap between Perception and expectations which is useful for determining the quality of service from AK3U certification training at PT Fusi Teknika Indonesia. The following is the Gap Calculation on the Tangibles 1 attribute:

Gap = Perception-Expectations = 7.225 – 7.95 = -0.725

The following are the results of the calculation of the gap between perception and expectations using Microsoft Excel

software, Table 3 is the result of calculating the gap between perception and expectations.

From the results of the gap calculation, all gap values show values less than zero. This indicates that the services provided have not been able to provide satisfaction to training participants, and there still needs to be improvements to improve the quality of service.

The findings indicate that communication effectiveness in OSH training remains a challenge. The Fuzzy SERVQUAL analysis reveals significant gaps between participant expectations and actual service delivery, particularly in language clarity and responsiveness of instructors. These results suggest that OSH training providers should prioritize structured and interactive communication strategies to enhance participant engagement and learning outcomes.

Table 2. Fuzzy set perception/expectation

Universe of Speakers	Fuzzy Set Name	Domain	Range
0-10	Very Dissatisfied/Important	0-2	0,1,2
0-10	Dissatisfied/Important	2-4	2,3,4
0-10	Quite Satisfied/Important	4-6	4,5,6
0-10	Satisfied/Important	6-8	6,7,8
0-10	Very Satisfied/Important	8-10	8,9,10

Table 3. Result of calculating the gap between perception and expectations

Dimensi SERVQUAL	No.	Defuzzyfikasi		Gap Per Question Indicator	Rank	Gap Per Aspect	Rank
		P	E				
Tangible	A1	7.23	7.95	-0.73	1	-0.99	4
	A2	6.72	7.87	-1.15	4		
	A3	6.87	7.85	-0.98	2		
	A4	6.85	7.95	-1.10	3		
	A5	6.75	7.83	-1.08	5		
Reability	A6	7.02	7.90	-0.88	3	-0.84	2
	A7	7.59	7.95	-0.36	1		
	A8	6.87	7.75	-0.88	2		
	A9	6.95	7.92	-0.97	4		
	A10	6.56	7.75	-1.19	2		
Responsiveness	A11	6.84	7.80	-0.96	1	-1.16	5
	A12	6.43	7.75	-1.33	3		
	A13	7.15	7.85	-0.70	2		
Assurance	A14	6.83	8.02	-1.19	3	-0.85	3
	A15	7.15	7.82	-0.67	1		
	A16	6.98	7.82	-0.84	2		
Empathy	A17	6.88	7.80	-0.92	3	-0.82	1
	A18	7.17	7.88	-0.72	1		

This study also highlights important implications for OSH training policies. Training institutions should consider developing standardized communication guidelines and incorporating technology-based solutions, such as interactive modules or real-time feedback systems, to improve training effectiveness. Additionally, instructors should receive specialized training in communication techniques to better convey complex safety messages.

However, this study has certain limitations. First, the research was conducted within a specific sector, which may limit its generalizability to other industries. Future research could expand to different OSH training settings to provide a broader perspective. Additionally, while Fuzzy SERVQUAL effectively identifies service gaps, it does not fully capture the psychological factors influencing participant engagement, such as motivation or learning styles. Further studies could integrate qualitative approaches to gain deeper insights into participant experiences.

Compared to previous studies by Dion [2] and Yanar et al. [3], which primarily focus on content delivery in OSH training, this study emphasizes the role of language clarity and structured communication. The findings align with prior research on service quality gaps in safety training but offer a new perspective on the importance of effective language use in improving training outcomes.

5. CONCLUSION

Based on the analysis using the Fuzzy SERVQUAL method, the Empathy dimension in OSH training certification training at OSH services company reveals significant gaps between participants' perceptions and expectations. Attributes requiring particular attention include the use of communicative language that is easy for participants to understand (Gap: -0.84), good communication between training organizers and participants (Gap: -0.92), and consistency in service and communication for all participants without exception (Gap: -0.72). These findings indicate an urgent need to enhance communication effectiveness and empathy during training sessions to improve participant satisfaction.

This study identified significant gaps in communication effectiveness within OSH training, emphasizing the importance of structured and clear communication strategies. The findings suggest that OSH training providers should develop standardized guidelines and interactive learning approaches to improve engagement and service quality.

Looking forward, future research could explore how digital tools, such as AI-driven feedback systems or virtual training modules, can further enhance OSH training effectiveness. Additionally, applying this study's framework to different industries could provide broader insights into communication

challenges in workplace safety training. Policymakers and industry leaders should consider these findings when designing more effective OSH training programs, ensuring that safety messages are not only delivered but also well understood and implemented in practice.

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