Performance Measurement of Offshore Facility Maintenance Service Provider Using Quality Function Deployment

Achmad Nanang Zulfikar and Moses Laksono Singgih
Department of Management Technology
Sepuluh Nopember Institute of Technology (ITS)
ananangz@gmail.com, moseslsinggih@ie.its.ac.id

Abstract

Many oil and gas company operations use the support of service providers, including maintenance. The quality of maintenance services is a challenge for companies to align with an adequate operational program. The authors conducted research using field observation methods, questionnaires, and interviews with experts and service providers. The Service Quality Model is used to determine service quality attributes and view service quality by measuring the level of response level (gap) or perceptions of service quality. Classification of the importance and quality of attributes developed with the concept of importance-performance analysis, which then develops responses to technical service attribute priorities using the Quality Function Deployment method. The results showed that the service quality attributes could still not meet consumer expectations. The sequential dimensions and weight were reliability (-0.770), tangible (-0.739), empathy (-0.654), responsiveness (-0.603), and assurance (-0.577). Meanwhile, the three priorities for technical responsibility for quality improvement are contractors who have dedicated technicians (19.9%), are led by competent project managers (17.4%), and have specialist maintenance or maintenance specialists (12.1%).

Keywords
Maintenance, Offshore, Quality Function Deployment, Service Quality

1. Introduction

Maintenance of PTX facilities is carried out using a scheduled maintenance system (preventive maintenance) and combined with a predictive maintenance system. The implementation of the maintenance program at PTX, including the corrective maintenance program, is carried out by the company's internal workers (in-house) and is supported by service providers or maintenance contractors.

Maintenance activities carried out by service providers or maintenance contractors aimed to support the company maintenance program that the company has determined in achieving operational production targets, including the availability and reliability of equipment. Facility maintenance service contracts are made based on equipment categories such as lifting equipment, instrumentation, electric motors, fabrication maintenance contracts, or the maintenance contractor's competency area. Service providers have become part of the modern industry, from the engineering design stage, the construction stage, the operational stage, and in the maintenance stage (Singgih et al. 2018 and Tamim et al. 2017). Maintenance for offshore facilities is complex in terms of planning and execution of the work because the work location is quite far away, and there is no direct support from other parties, such as the work carried out at the onshore location.

PTX is an oil and gas company that manages the West Madura Offshore block, where the work area is 40 nautical miles to the North of Madura Island, East Java, Indonesia. The PTX operations department has three central facilities maintenance contracts: instrument and control system, lifting equipment and the electric motor maintenance service contract, and the research object. The PTX operation department is a unit price contract for a three-year contract period, the type of work stipulated in the maintenance service contract, and the type and the number of work units made and adjusted to the approved work plan and company budget. The scope of work covered the rights and obligations of the company and service providers to provide company support in carrying out maintenance and

operational programs. However, after running for about two years, the three contracts have less than satisfactory user functions.

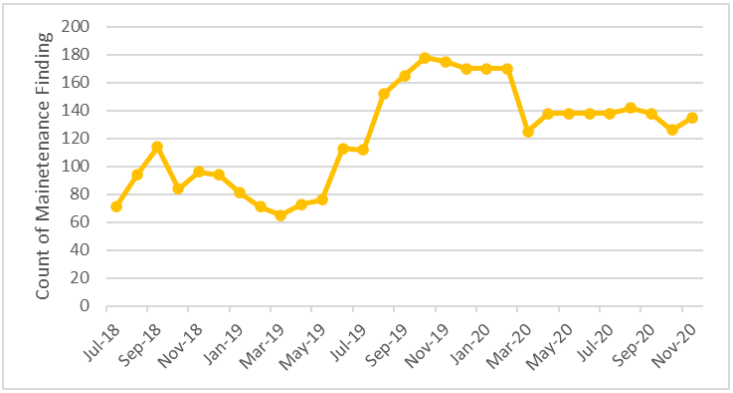


Figure 1. Number of Maintenance Defect Findings

The problems encountered in implementing maintenance service carried out by service providers in the service quality still do not meet user functions' expectations (consumer), such as slow response time and delay the corrective plan, as shown in Figure 1. In addition, problems such as poor planning, personnel competence, and lack of contractors' empathy to maintenance and operational issues. Those problems can reduce the level of availability and reliability of equipment, including safety in operation.

Performance measurement of contract work follows the guidance of the company's Contractor Safety Management System (CSMS), which focuses on aspects of the Health Safety Security Environment (HSSE), which regulates many general things. The performance appraisal is carried out at all the implementation stages, qualification stage, selection, pre-job activity, work in progress, and final evaluation (PHE, 2016). Maintenance contract performance measures the service quality attributes specified in the initial work activity process and referring to the company's CSMS guidelines.

The quality of the offshore facility maintenance service contract will be measured using the Service Quality method approach and combined with the Importance-Performance Analysis method. Performance measurement that focuses on the HSSE aspect makes work performance evaluation challenging to measure and control operational and technical aspects. Furthermore, technical responses and priorities developed using the Quality Function Deployment or QFD method.The objectives of the research is to determine the quality attributes of offshore facility maintenance contract services and determine the technical response and priorities in improving the quality of offshore facility maintenance contract services.

2. Literature Review

Services are actions or performances that can be offered or provided from one party to another are intangible and do not make any ownership (Kotler and Keller 2016). Services have four distinctive characteristics: intangible, inseparable, varied, and impermanent (Lovelock and Gummesson 2004). Two main factors affect service quality, namely expected service, and perceived service. Therefore, quality is the key to creating value and customer satisfaction. There are five dimensions or factors that can determine service quality, among others (Berry and Parasuraman 1991):

1. Reliability is the ability to provide or deliver the services promised appropriately.
2. Responsiveness is the dimension of willingness to help consumers or customers and provide services quickly or responsively.
3. Assurance is a dimension of knowledge and kindness of service provider personnel and delivering services with a high sense of trust and confidence. There are subdimensions, including competence, credibility, politeness, and security.
4. Empathy is a dimension of care providers provide to consumers and great attention to problems or consumer desires. There are subdimensions, including access, communication, and understanding customers.

5. Tangibles relate to things with a form or physical such as equipment, personnel and communication media facilities, physical objects, equipment, and appearance.

Figure 2 shows the determinants that influence or shape the perception of service quality and the extended service quality model (Parasuraman et al. 1988).

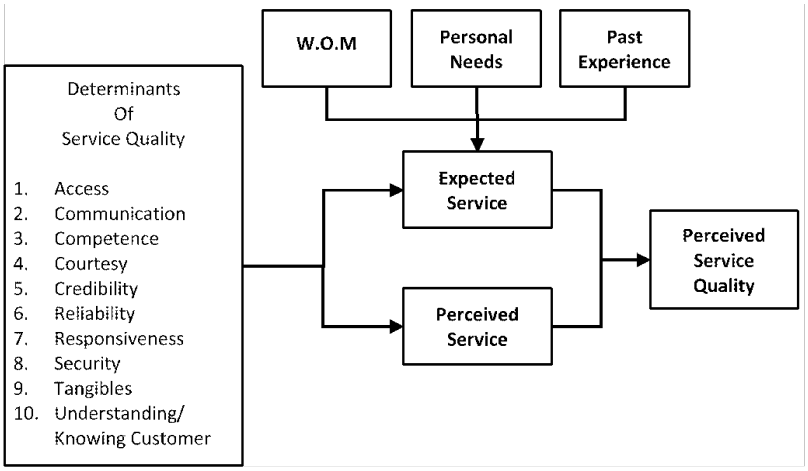


Figure 2. Determinant of Service Quality

There are five gaps in the service quality model (Figure 3), they are:

- Gap_1 is the gap or difference between consumer expectations and perceptions of service provider management of consumer expectations.
- Gap_2 is the gap or difference between consumer expectations perceived by management and service quality specifications.
- Gap_3 is the difference or gap between the service quality specifications by service delivery.
- Gap_4 is the difference or gap between what is meant by external communication and service delivery.
- Gap_5 is the gap or difference between the expectations or desires of consumers with the perception of services received.

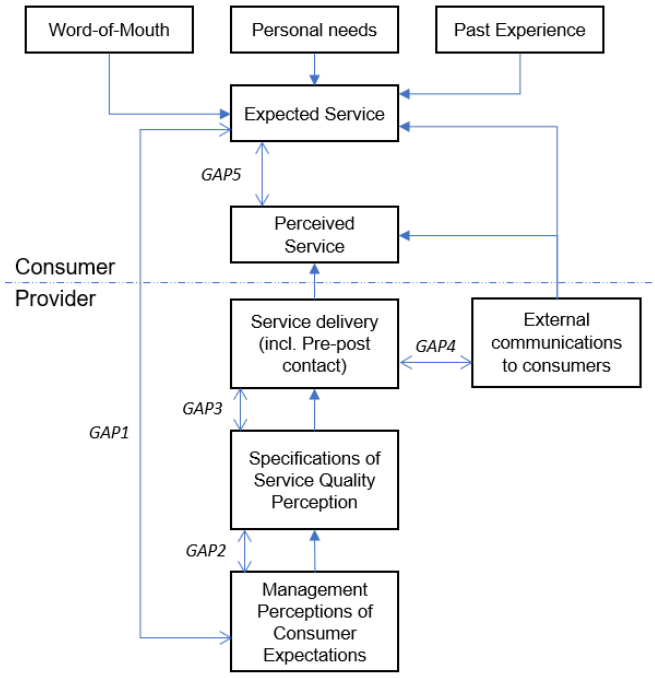


Figure 3. Service Quality Model

Service quality based on consumer perceptions depends on the gap between consumer expectations and perceptions (Gap_5) and gaps related to design marketing to service delivery processes.

Maintenance is all activities carried out to maintain or return functions to the conditions needed to fulfill their operational functions (Jardine and Tsang 2005). Preventive maintenance is maintenance carried out before or preventing equipment from being damaged. Preventive maintenance can also increase the reliability and availability of equipment and reduce maintenance costs (Singgih et al. 2018).

Outsourcing transfers business functions or processes to another party, often to another company aiming for companies to focus on the main business (Larson and Grey 2011 and Singgih et al. 2018). Most of these outsourcing works are project and contractual, where the advantages of outsourcing a job or project include cost savings or cost reduction, faster completion of work, obtaining a higher level of expertise, and flexibility or flexibility. The contract is not only a formal agreement or agreement. The contract is also a legal codification that governs the relationship between service providers and users. The contract binds both parties in terms of responsibilities, conditions, implementation, rights, including the solution to the party who violates its obligations. A contract must detail the specific transactional parties involved, and an inconsistent and lacking contract will be difficult to understand and execute (Larson and Grey 2011).

Importance-Performance Analysis (IPA) is a method that can show the importance and relative performance of several attributes of a product (Wijaya 2018). IPA will combine the measurement of the dimensions of expectation and importance in two categories. The categories of importance and performance are depicted in a Cartesian diagram with the importance value on the vertical axis and the performance value on the horizontal axis and using the average value as a secant. The cartesian diagram of IPA can be seen in Figure 4, divided into four quadrants, and becomes the focus of the development strategy.

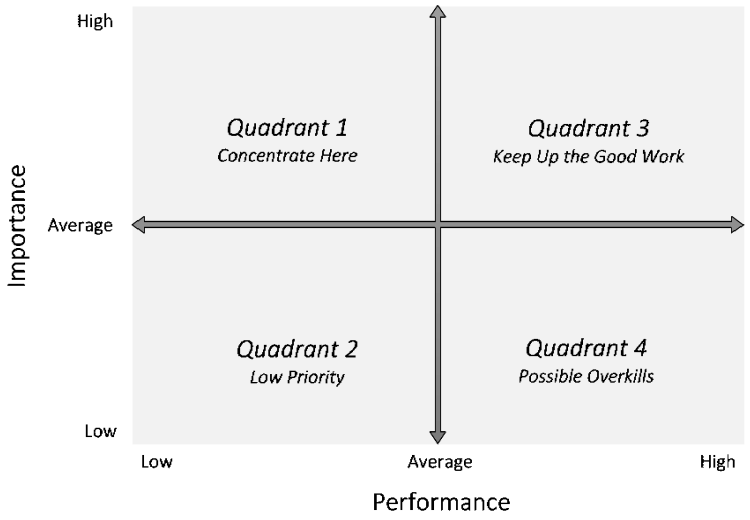


Figure 4. Importance-Performance Analysis Diagram

Quality Function Deployment (QFD) is a methodology that can help translate customer needs into planning needs in technical responses or technical requirements so that the products produced are suitable and meet customer needs. QFD is widely used in various industries to design, develop, and repair goods and services (Cohen 1995 and Erdil and Arani 2019). Other benefits of developing QFD include customer focus, time efficiency, teamwork orientation, and documentation orientation (Wijaya 2018). The QFD method uses a matrix called the House of Quality (HOQ), which provides information on customer needs (voice of the customer/whats), technical response design needs (voice of organization/technical requirements or hows), priority design consumer needs, relationships between customer requirements and technical requirements, and the relationship between technical requirements as in Figure 5 (Cohen 1995 and Deveci et al. 2019).

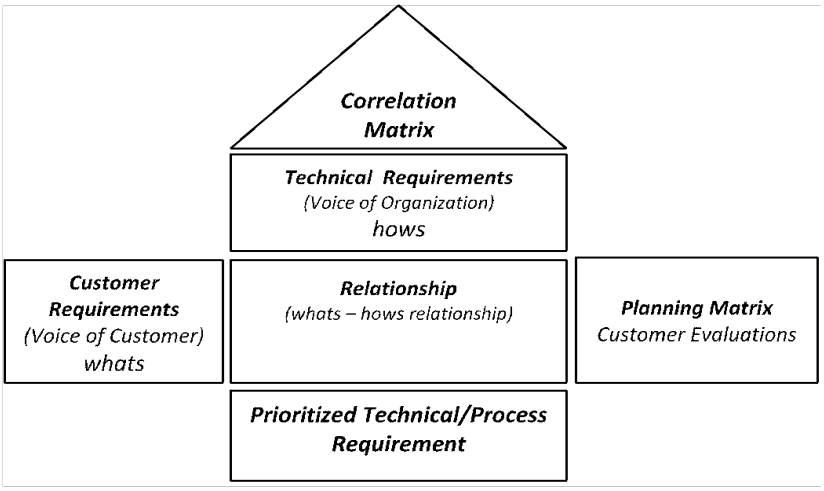


Figure 5. House of Quality

Table 1 shows the relationship between consumer requirement (whats) and technical requirement (hows) as their respective levels or values. Meanwhile, Table 2 shows the correlation between technical requirements.

Table 1. Symbols and Relationship Level of Customer and Technical Requirement

Symbol	Relationship Level	Point
●	Strong Relationship	9
○	Moderate Relationship	3
△	Weak Relationship	1

Table 2. Technical Requirement Symbols

Symbol	Relationship
●	Strong Positive Correlation
○	Positive Correlation
✖	Negative Correlation
⛒	Strong Negative Correlation

The service provider carried out the facility maintenance contract, or contractor is carried out, with the initial stage being work planning. The contractor manages this planning stage by listing scheduled and corrective maintenance. The contractor manages time-based planning and work priorities. Then the contractor creates and submits a cost estimate for each maintenance job refer to in the contract. Cost estimates are made and contain information on the scope of maintenance, use of resources, work timelines, and work targets. The work order becomes the basis for the contractor to start job preparation, including preparing personnel, equipment, work procedures, and components. The next stage is to carry out maintenance under the scope of the work order. The final stage is creating a maintenance report and making recommendations if there are findings or non-conformities in maintenance. Figure 6 shows the cycle of the implementation stage.

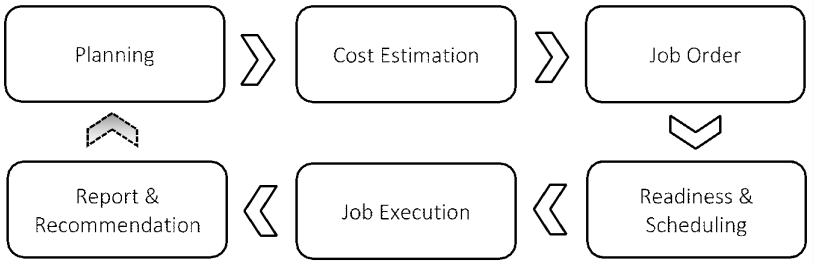


Figure 6. Maintenance Process by Maintenance Provider

3. Methods

The research begins with field observations related to the problems that occur. The determination of quality attributes and questionnaires were obtained based on literature studies and also carried out by the Delphi method. Opinions from experts or competent people collected using the Delphi method (Ciptomulyono 2001). The 20 service quality attributes obtained and used for the questionnaire are as shown in Table 3. Consumers filled the questionnaire about the maintenance service at PTX. Attributes used in the field of maintenance by service providers include both functional quality and technical quality (Rasila and Gersberg 2007).

Table 3. Research Questionnaire Attributes

Dimension	Quality Attributes
Tangible	Planning information is proper and correct media and format
	Availability of Resources
	The components/parts provided are of good quality
	Work equipment according to company standards
	Planning, Reports, and Recommendations Information are easily accessible
Empathy	Planning is suitable according to operational conditions
	Provide solutions to administrative problems
	Cost Estimation refers to costs, time, and quality
	Inform the status and progress of work clearly
	Have concern for company assets
Assurance	Planning, Cost Estimates, Reports, and Recommendations Information for activities that are made in detail and well
	Work procedures are made in detail and precise
	Personnel have good HSSE behavior
	Technicians have high competence (skill, attitude and knowledge)
Responsiveness	Ability to request additional requests
	Delivery of Plans and Recommendations on time and regularly
	Planning information, Cost Estimates, Preparations, and Reports are quickly
Reliability	Maintenance data and information facilities that are ready for planning according to actual conditions/valid
	Able to provide (technical) solutions to findings /non-conformities
	Maintenance activities according to the work plan (time and results)

4. Data Collection

The data obtained where a total of 18 attributes are valid or where the count value of correlation exceeded the value of the r table and was reliable, or the Cronbach alpha value was more significant than 0.6 (Table 4).

Table 4. Validity and Reliability Test Result

Attributes	$r_{Importance}$	$r_{Expectation}$	$p_{erceived}$	t_{able}
Q1	0.7958	0.7307	0.7494	0.3882
Q2	0.6819	0.7425	0.8477	0.3882
Q3	0.6193	0.6258	0.7511	0.3882
Q4	0.7888	0.5774	0.8598	0.3882
Q5	0.5526	0.3930	0.8358	0.3882
Q6	0.3882	0.6669	0.8239	0.3882
Q8	0.7029	0.6596	0.8617	0.3882
Q9	0.5684	0.8179	0.7044	0.3882
Q10	0.5979	0.7053	0.8654	0.3882
Q11	0.7218	0.6279	0.8809	0.3882
Q12	0.4853	0.6666	0.8889	0.3882
Q13	0.7398	0.5857	0.8637	0.3882
Q14	0.6967	0.5588	0.7895	0.3882
Q15	0.6420	0.7311	0.8835	0.3882
Q16	0.6903	0.7243	0.8405	0.3882
Q18	0.5754	0.8242	0.8954	0.3882
Q19	0.7186	0.5851	0.8471	0.3882
Q20	0.7937	0.6240	0.7186	0.3882
Reliability				
Cronbach Alpha	0.919	0.922	0.972	

5. Results and Discussion

5.1 Results

With the service quality method approach, the perceived value of service quality is still below consumer expectations or user functions for all service quality dimensions, as in Table 5.

Table 5. Service Quality Dimension Gap

Dimension	Gap	Rank
Reliability	-0770	1
Tangible	-0739	2
Empathy	-0654	3
Responsiveness	-0603	4
Assurance	-0577	5

In the Importance Performance Analysis in Figure 7, the classification of attributes based on importance and performance shows that four attributes are the focus to be improved (quadrant I), including:

1. Planning information is proper and correct media and format
2. Availability of Resources
3. Have concern for company assets
4. Able to provide (technical) solutions to findings /non-conformities

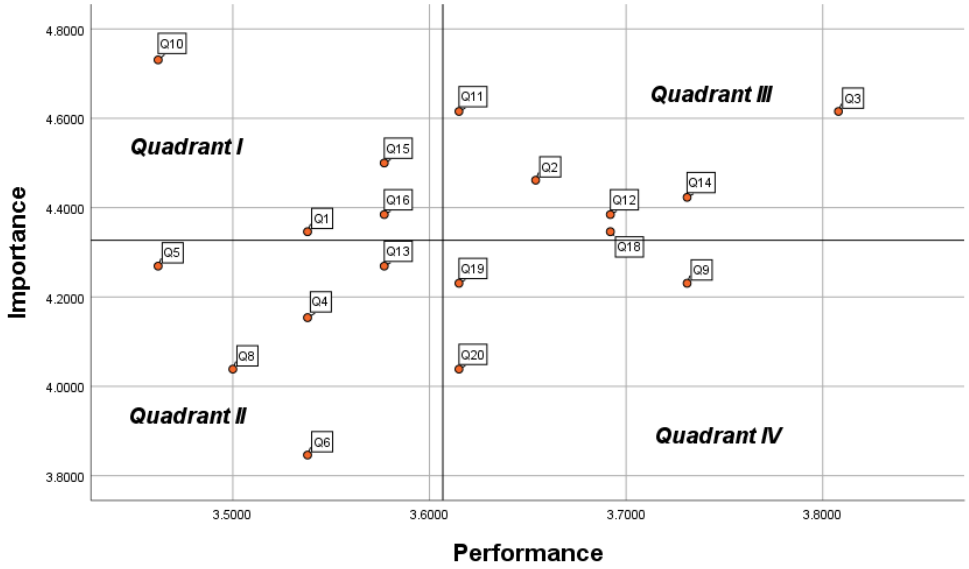


Figure 7. Importance-Performance Analysis

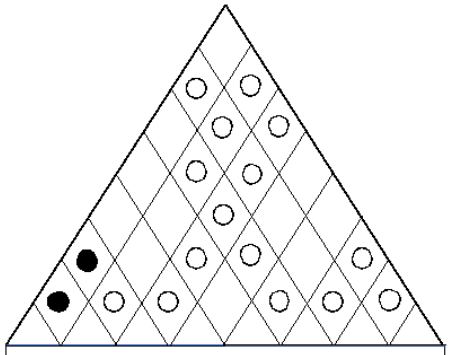
To improve the performance of the required customer requirement attributes, technical responses or technical requirements are needed to fulfill these attributes. Technical requirements captured using the Delphi method. Data input from maintenance service providers and internal company experts obtained eight technical requirements that can improve service quality according to existing customer requirements. The eight technical requirements include:

1. Using a maintenance and planning information system
2. Have a maintenance planner
3. Led by a competent project manager
4. Have own competent technicians
5. Has its work equipment
6. The duration of the contract made with longer durations or at least three years
7. Using the company asset information system
8. Having a maintenance specialist

5.2 Discussion

The results showed that the performance quality of maintenance services in the offshore facility of PTX still did not meet the user function expectations. This applies to all dimensions, attributes with the most significant gaps in quality of components or spare parts, availability of resources, ability to provide technical solutions to findings/non-conformities, delivery of planning and recommendations regularly, and clearly of work and status progress information. Five dimensions of service quality have a balanced weight of importance in studies conducted in offshore maintenance services: reliability (19,96%), tangible (20,49%), empathy (19,92%), responsiveness (18,95%), and assurance (20,67%).

Furthermore, by combining attributes with the level of user perception relative to their level of importance, the research will focus on the four attributes needed in the development effort according to customer needs. The four attributes are proper and precise information planning, availability of resources, concern for company assets, and capability of providing (technical) solutions to findings/non-conformities. The subsequent development uses the Quality Function Deployment approach with the House of Quality, producing technical needs and priority levels. The three main technical requirements that can improve the quality of maintenance services by a service provider have a dedicated, competent technician in contact. A competent project manager leads the project, and the service provider must assign a maintenance specialist or maintenance engineer. Figure 8 shows the House of Quality of the QFD development.



		hows: Using a maintenance & planning information system	Have a maintenance planner	Led by a competent project manager	Have own competent technicians	Has its own work equipment	Duration of the contract made with longer durations or at least 3 years	Using the company asset information system	Having a maintenance specialist	Customer Satisfaction	Target	Sales Poit	Importance to Customer	Absolute Weight	Rank
whats	Planning information is conveyed in proper and correct media & format	●	●	●				△		3,538	4,154	1,2	4,346	5,085	4
	Availability of Resources				●	●				3,462	4,385	1,5	4,731	6,008	1
	Have concern for company assets	○	△	●	●		●	●	○	3,577	4,346	1	4,500	5,445	3
	Able to provide (technical) solutions to findings /non-conformities				△			△	●	3,577	4,5	1,2	4,385	5,525	2
	Absolute Weight	52,6	43,6	79,6	87,5	42,6	40,5	49,2	53,0						
	Relative Weight	62,1	51,2	94,8	108,6	54,1	49,0	59,6	66,1						
	Relative Weight Percent (%)	11,4	9,4	17,4	19,9	9,9	9,0	10,9	12,1						
	Rank	**4**	**7**	**2**	**1**	**6**	**8**	**5**	**3**						

Figure 8. Research House of Quality

5.3 Proposed Improvements

In the research, the technical requirements come from Quality Function Deployment with several aspects: current level of performance, targets, and sales point. However, in operational management, several other criteria need to be considered, such as cost criteria and the difficulty level of implementing technical requirements. In further research, it is necessary to combine the priority technical requirements of Quality Function Deployment with other criteria such as cost and difficulty with other decision support system methods.

6. Conclusion

The service quality approach in determining the quality attributes of maintenance service performance is sufficient to assess service quality perceptions based on a user-based approach. Technical requirement development based on customer requirements developed with the Quality Function Deployment method gets priority technical requirements that are good enough to be implemented to improve the quality of maintenance services at offshore facilities.

The service quality approach in determining the service performance attributes of Offshore Maintenance service is sufficient to assess service quality perceptions based on a user-based approach. Technical requirements development based on customer needs that is developed by Quality Function Deployment method generate priority technical

requirements are good enough to be applied in service performance measurement in order to improve the quality of offshore facility maintenance services

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Biographies

Achmad Nanang Zulfikar, is a postgraduate student at Department of Management Technology, Sepuluh Nopember Institute of Technology (ITS), Surabaya, Indonesia. He received his Bachelor's degree from Mechanical Engineering, Brawijaya University, Malang, Indonesia. He is a professional with an interest in the area of service quality and reliability. For further information, please contact the author via email at ananangz@gmail.com

Moses Laksono Singgih is a Professor at the Department of Industrial and Systems Engineering, Sepuluh Nopember Institute of Technology (ITS), Surabaya, Indonesia. He received his Bachelor's and Master's degree from Industrial Engineering Department, Institut Teknologi Bandung (ITB), Indonesia. He received Ph.D. from the University of Queensland, Australia. His research interests are productivity, quality, and manufacturing systems. Currently, he supervises postgraduate students with topics: a design for manufacturing and assembly (DFMA); quality management; lean six sigma; internet of things; sharing economy; circular economy and product-service systems. He is a Professional Member of the IEOM Society. Please find his publications at www.moseslsinggih.org/publications