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Quality Improvement Program for Colocation Data Center Services Using Quality Function Deployment (QFD)

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***Abstract*—When a product is launched, it's always been expected by the company that the product is going to be sold out in the market. But, after three years of selling XYZ colocation data center services, the sales of this product still hasn't achieve its target. Therefore, an evaluation is needed to know how costumers value the product in the market and what's needs to be done to improve its value. XYZ Data Center Management has conducted a preliminary analysis through discussion with customers, a comparative study with competitors, and discussion with internet service provider association. It's concluded that there is quality in XYZ Data Center, both in features and services that don't satisfying enough. Further analysis then conducted with Quality Function Deployment or QFD as a research method. The reason behind the use of QFD is because of its ability to identify what customers want, and translate it into the company's need in terms of technical responses. The result obtained from this research is the attributes that customers need and the technical responses required to answer it. Examples of attributes are the availability of the working room, the availability of site visit procedure, the accuracy of time needed for installation, etc. And for technical response, the examples are making a portal for trouble handle monitoring in integration with a call center, an improvement on IT Hall layout building a portal for installation monitoring, etc.**

***Keywords*—Chi Square, Defect, Quality, Sigma Level, Weighing and Gauging.**

I. INTRODUCTION

EVERY industry is now doing what's called digitalization. And to do that, IT infrastructures become a necessity. One of them is the data center. The need for data center itself is split into two categories, which are Internet Data Center and Enterprise Data Center.

Since UMKM in Indonesia is growing fast, the need for Internet Data Center is growing in the same direction. Its mainly because Internet data centers offer not only colocation but also connectivity such as hosting and cloud. Market research done by IDC in 2015 shows that 50% of IT spending in Indonesia is allocated for a data center, and the other 50% is for hardware, software package, etc. It is estimated that for the Asia-Pacific data center services market to be worth US$14.13 billion in revenue in 2016 and to reach US$31.95 billion at the end of 2022 [1].

As the aim of company X is to be the leader in not only telecommunication industry but also in IT Services, company X, which already has an enterprise data center in its portfolio through its subsidiary called company Y, creates an Internet Data Center called XYZ Data Center. XYZ Data Center itself is a collaboration between company X and company Y, where company X as the holding company build and provide the infrastructures for the data center, and daily operation is manage by company Y. This collaboration started in 2016 when XY data center is launched. 2 years after XY Data Center is launched, company X decides to upgrade its features and also change the name into XYZ Data Center.

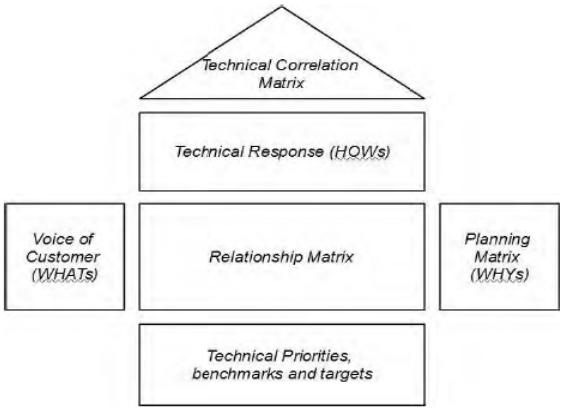

Figure 1. House of quality.

But now, after three years of operation, the sales of XYZ Data Center still haven't fulfilled the targets determined by the management. From 2016 where the administration put 15 racks to be sold, XYZ Data Center (XY Data Center at that time) can only sell five racks. Table 1 below shows that the trend of sales in XYZ Data Center is increasing, but the target still hasn't achieved yet. Operation teams and Sales team of XYZ Data Center, specifically in Surabaya, has gathered information that the reason behind the lack of sales of XYZ Data Center is because there are several features that are not available in XYZ Data Center in comparision to another Data Centers.

The purpose of a business is to fulfill customers satisfaction [2]. Because of that, and together with the information that already gathered, the management of XYZ Data Center wants an improvement so the sales number can grow immediately. To help the management in improving XYZ Data Center, the QFD method is used in this research to support management review its product and highlight what features in the product that needs improvement.

II. METHOD

A. Concept of QFD

There are several definitions of QFD. The first definition is QFD is a method which can transform customers need into a product with specific technical characteristic [3]. Another

Table 1.
Amount of rack sold and target to achieve each year

	2016	2017	2018	2019 (September)
Rack Sold	5 units	3 units	10 units	9 units
Target	15 units	18 units	22 units	36 units

Table 2.
Validity test result

Code	R Table	Importance		Satisfaction	
		R arithmetic	information	R arithmetic	Information
Q1	0.381	0.406	Valid	0.607	Valid
Q2	0.381	0.585	Valid	0.527	Valid
Q3	0.381	0.418	Valid	0.459	Valid
Q4	0.381	0.398	Valid	0.479	Valid
Q5	0.381	0.557	Valid	0.432	Valid
Q6	0.381	0.545	Valid	0.678	Valid
Q7	0.381	0.547	Valid	0.430	Valid
Q8	0.381	0.454	Valid	0.451	Valid
Q9	0.381	0.468	Valid	0.419	Valid
Q10	0.381	0.555	Valid	0.386	Valid
Q11	0.381	0.407	Valid	0.391	Valid
Q12	0.381	0.431	Valid	0.770	Valid
Q13	0.381	0.584	Valid	0.542	Valid
Q14	0.381	0.394	Valid	0.613	Valid
Q15	0.381	0.480	Valid	0.690	Valid
Q16	0.381	0.631	Valid	0.507	Valid
Q17	0.381	0.526	Valid	0.518	Valid
Q18	0.381	0.403	Valid	0.799	Valid
Q19	0.381	0.567	Valid	0.609	Valid
Q20	0.381	0.572	Valid	0.496	Valid
Q21	0.381	0.622	Valid	0.635	Valid
Q22	0.381	0.731	Valid	0.413	Valid
Q23	0.381	0.594	Valid	0.491	Valid
Q24	0.381	0.586	Valid	0.441	Valid
Q25	0.381	0.599	Valid	0.631	Valid
Q26	0.381	0.519	Valid	0.477	Valid
Q27	0.381	0.460	Valid	0.543	Valid
Q28	0.381	0.416	Valid	0.565	Valid
Q29	0.381	0.622	Valid	0.793	Valid

Table 3.
Reliability test result

Item	Cronbach Alpha (Table)	Cronbach Alpha (calculation)	Information
Importance	0.6	0.900	Reliable
Satisfaction	0.6	0.909	Reliable

explanation is that QFD is a system that can turn customer's needs into a company's requirement with actions such as research, production design, development, distribution, marketing, sales, and service [4]. So, by using QFD, the management of XYZ Data Center will have the ability to explore what the customers want and make improvements to fulfill those needs.

Though initially, the applications of QFD were centered in the automotive industry for product planning and design towards the years the application spread into product improvements and new product development. QFD as a tool was domiciled in technical functions such as engineering, product planning, and process engineering.

Shortly after that, the scope of QFD applications was extended to include purposes such as research and development, marketing, customer service, human resources, and manufacturing. Consequently, it is now also utilized for organizational assessment, internal functions, and problem-solving. The examples for the use of QFD in organizational assessment is done when research on quality improvement in general affair at PT. Meratus Line is conducted in 2010 while the use of QFD for problem-solving is shown on research at a restaurant that has declined sales [5-6].

B. QFD Matrix

To perform QFD, there are several matrices that built a house of quality. There is two central part of these matrices, which are the horizontal part and the vertical part. The horizontal part contain information about customers and the vertical section contains technical knowledge as a response to input obtained from customers.

Generally, the amount of matrix used for analyzing in QFD is six matrices such as [7]:

a. Voice of Customers (WHATs)
b. Technical Responses (HOWs)
c. Relationship Matrix
d. Technical Correlation Matrix (ROOF)
e. Technical Matrix
f. Planning Matrix

All of the matrices above then compile into House of Quality (HOQ). Figure 1 below shows the general description of the house of quality.

Table 4.
Whats matrix

Code	Attributes
Q1	Cleanliness and feasibility of the IT Hall
Q2	Cleanliness and feasibility of the NOC
Q3	The appearance of employees (Company Y)
Q4	The appearance of employees (Company X)
Q5	Availability of working room
Q6	Availability of rack type
Q7	Availability of PreCabling
Q8	Availability of Internet (IP Public)
Q9	Installation time accuracy
Q10	Ease of contacting employees (Company Y)
Q11	Ease of contacting employees (Company X)
Q12	The ability of employees (Company Y) in answering questions
Q13	The ability of employees (Company X) in answering questions
Q14	Hospitality and alertness of employees (Company Y)
Q15	Hospitality and alertness of employees (Company X)
Q16	Site visit information procedure
Q17	Assistance in meeting additional service needs
Q18	The speed of handling complaints by employees (Company Y)
Q19	The speed of handling complaints by employees (Company X)
Q20	Availability of info regarding maintenance activities
Q21	Availability of SmartHand services *(reboot, troubleshooting, etc)*
Q22	Compatibility with SLA regarding *connectivity availability*
Q23	Compatibility with SLA regarding *power availability*
Q24	Compatibility with SLA regarding I *cooling availability*
Q25	Security of data center building
Q26	Security of data center firewall
Q27	Employees (Company Y) empathy in serving customer needs
Q28	Employees (Company X) empathy in serving customer needs
Q29	Ease of site visit in urgent case

C. Data Collection

Data used in this research divided into primary and secondary. Primary data is a quantitative data collected through questionnaire. The questionnaire contains a list of attributes of collocation data center services, both service, and features. The subject for the survey is customers of XYZ Data Center located in Surabaya and Makassar.

Another data, secondary data, is indirect data obtained through literature such as company documents, journals with a related topic, etc.

III. RESULT AND DISCUSSION

A. Validity and Reliability

After the questionnaire is given to customers, the first thing to do is the validity test. A validity test, by definition, is a test to assess how accurate a measurement instrument [8]. But in this case, is to make sure that the result obtained from the questionnaire is valid. As shown in Table 2, every item in the questionnaire is valid. Hence, the reliability test can be conducted. Reliability refers to how dependably or consistently a test measures a characteristic [9]. The reliability score for either importance or satisfaction is calculated, as shown in Table 3. A characteristic is announced as reliable when the croanbach alpha scored is bigger than 0.6 [10].

B. House Of Quality (HOQ)

After the result from the questionnaire is declared as valid and reliable, the House of Quality then ready to assemble [11]. As mention in section 2.2 about QFD Matrix, the house of quality is constructed by six matrices. The first matrix is the customer's need or whats matrix. In this matrix, some attributes represent things that customers might need. The characteristics are gathered from discussions between writer and management of XYZ Data Center. Besides, a comparative study to competitors also conducted to gather information on what made competitors survive. Last but not least, a list of complaint from customers is also analyzed to form the attributes in what's matrix. The final form of what's matrix is shown in Table 4 [12].

After listing what customer needs, the management then decides what response should be given to accommodate the needs of the customer. After several discussion regarding what response needed and seeing the company ability from either financial or technical aspects, the management proposes 13 technical responses such as: (1) Improve the layout design of IT Hall. (2) Work uniform for the employee (company Y). (3) Build a working room. (4) Adding IP Public facility, etc.

Knowing the relationship between what's matrix and technical responses is an essential thing. Therefore, building a relationship matrix is a critical job to do. From the relationship matrix, the writer and management will know whether the technical responses have an impact or not to fulfill what customers need. Figure 2 is used to show the relationship between what's matrix and technical responses [13].

After building a relationship matrix, another matrix that needs to be made is a technical correlation matrix. A technical correlation matrix or usually called roof (It shaped the roof of a house in HOQ), is used to show the relationship between

		Technical Responses (How's)													
		Improve the layout design of IT Hall	Work uniform for the employee (company Y)	Build a working room	Made a dedicated space for IT Hall	Adding IP public /30	Built a portal for provisioning monitoring	Training for Company employees	Sharing knowledge between Company X and Company Y	Made a portal for trouble monitoring	Adding smart hand features	Adding security layer on building premises	Adding a firewall	Make Call Center
	Cleanliness and feasibility of the IT Hall	9		3	3								1	
	Cleanliness and feasibility of the NOC			9		3					1			
	The appearance of employees (Company Y)		9											
	The appearance of employees (Company X)							1						
	Availability of working room	3		9	1									
	Availability of rack type	9			9									
	Availability of PreCabling	9		3	3	9								
	Availability of Internet (IP Public)			1		9								
	Installation time accuracy						9							
	Ease of contacting employees (Company Y)						1			9				9
	Ease of contacting employees (Company X)						9			9				9
	The ability of employees (Company Y) in answering questions							9						
	The ability of employees (Company X) in answering questions								9					
	Hospitality and alertness of employees (Company Y)							9	3					1
	Hospitality and alertness of employees (Company X)								3					1
	Site visit information procedure						3					3		
	Assistance in meeting additional service needs									3				
	The speed of handling complaints by employees (Company Y)									9				9
	The speed of handling complaints by employees (Company X)									9				9
	Availability of info regarding maintenance activities						1				1			
	Availability of SmartHand services *(reboot, troubleshooting, etc)*						3			3	9			
	Compatibility with SLA regarding *connectivity availability*													
	Compatibility with SLA regarding *power availability*													
	Compatibility with SLA regarding i *cooling availability*													
	Security of data center building											9		
	Security of data center firewall												9	
	Employees (Company Y) empathy in serving customer needs													1
	Employees (Company X) empathy in serving customer needs													1
	Cleanliness and feasibility of the IT Hall						3			3				9

Figure 2. Relationship matrix.

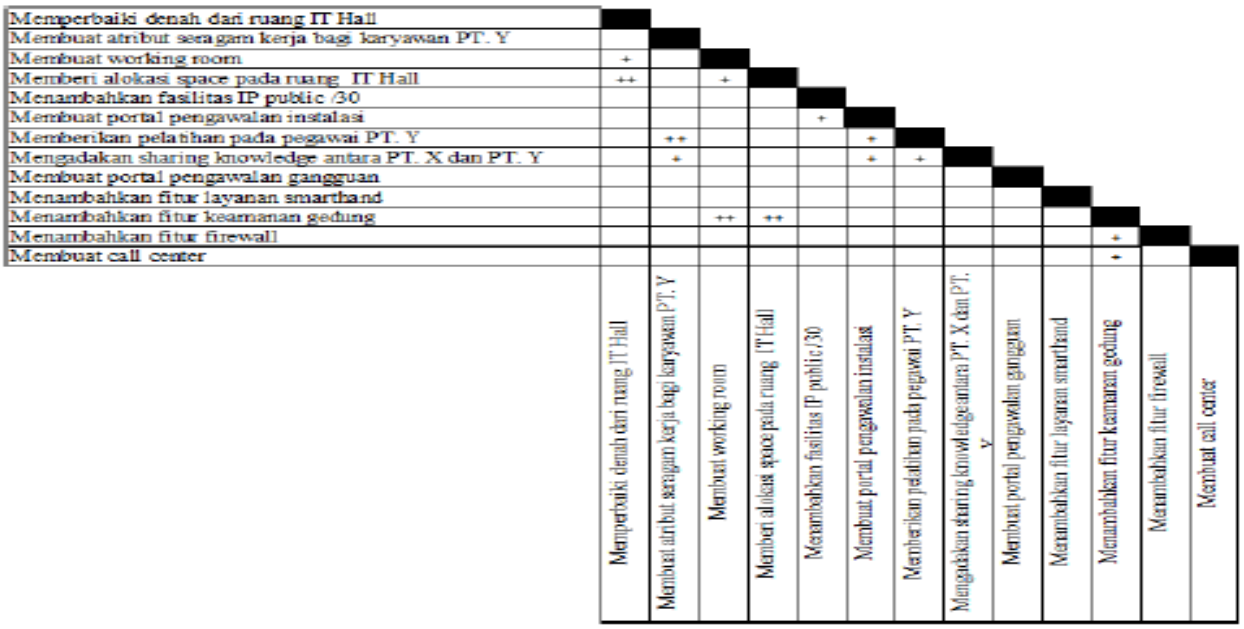

Figure 3. Technical correlation matrix.

each technical response. By using this matrix, if there is a response that has a negative impact to other answers, they can be review. The technical correlation matrix is showed in Figure 3.

The next matrix that we need to focus on is the planning matrix. Planning matrix is consist of several values such as importance to a customer, customer satisfaction performance, goal, improvement ratio, raw weight, and normalized raw weight. The planning matrix is shown in Table 5.

The last matrix to be built in the technical matrix. The technical matrix is used to show the order of priority from technical responses based on the contribution of each technical responses to what customers need. A bigger contribution score implies more priority the technical response is. Table 6 show the contribution score for each technical respons.

TR9, which is making a portal for trouble monitoring, has the biggest contribution score of all technical responses. It hence TR9 is the number 1 priority to be applied. And the second technical response that needs to be prioritized is TR13, which is the call center.

But, to simplify the action needed by the company, management decide to merge call center with portal for trouble monitoring in one integrated portal. So, the second action to be done is improve the layout design of IT Hall. And

Table 5.
Planning matrix

Attributes	Importance to Customer	Customer Satisfaction Performance	Goal	Improvement Ratio	Raw Weight	Normalize Raw Weight
Cleanliness and feasibility of the IT Hall	3.89	3.41	4.00	1.17	4.57	3.89%
Cleanliness and feasibility of the NOC	3.04	3.56	3.60	1.01	3.08	2.62%
Appearance of employees (Company Y)	3.56	3.33	3.63	1.09	3.88	3.30%
Appearance of employees (Company X)	3.52	3.63	3.63	1.00	3.52	3.00%
Availability of working room	3.26	2.48	4.00	1.61	5.25	4.47%
Availability of rack type	3.15	2.85	3.50	1.23	3.87	3.29%
Availability of PreCabling	3.52	3.11	3.50	1.13	3.96	3.37%
Availability of Internet (IP Public)	3.93	3.19	3.75	1.18	4.63	3.94%
Installation time accuracy	3.81	2.93	3.80	1.30	4.95	4.21%
Ease of contacting employees (Company Y)	4.00	3.85	4.00	1.04	4.15	3.53%
Ease of contacting employees (Company X)	3.59	3.67	4.00	1.09	3.92	3.33%
The ability of employees (Company Y) in answering questions	3.56	3.41	3.52	1.03	3.68	3.13%
The ability of employees (Company X) in answering questions	3.52	3.52	3.52	1.00	3.52	3.00%
Hospitality and alertness of employees (Company Y)	3.41	3.78	3.78	1.00	3.41	2.90%
Hospitality and alertness of employees (Company X)	3.44	3.67	3.67	1.00	3.44	2.93%
Site visit information procedure	3.59	2.81	4.00	1.42	5.10	4.34%
Assistance in meeting additional service needs	3.37	3.07	4.00	1.30	4.39	3.73%
The speed of handling complaints by employees (Company Y)	3.59	3.48	4.00	1.15	4.12	3.51%
The speed of handling complaints by employees (Company X)	3.48	3.30	4.00	1.21	4.22	3.59%
Availability of info regarding maintenance activities	3.44	2.63	3.50	1.33	4.58	3.90%
Availability of SmartHand services *(reboot, troubleshooting, etc)*	3.41	2.81	3.50	1.24	4.24	3.61%
Compatibility with SLA regarding *connectivity availability*	4.19	3.96	3.96	1.00	4.19	3.56%
Compatibility with SLA regarding *power availability*	3.96	3.63	3.63	1.00	3.96	3.37%
Compatibility with SLA regarding i *cooling availability*	3.93	3.74	3.74	1.00	3.93	3.34%
Security of data center building	4.04	3.44	4.00	1.16	4.69	3.99%
Security of data center firewall	3.48	2.74	3.00	1.09	3.81	3.24%
Employees (Company Y) empathy in serving customer needs	3.26	3.78	3.78	1.00	3.26	2.78%
Employees (Company X) empathy in serving customer needs	3.52	3.52	3.52	1.00	3.52	3.00%
Ease of site visit in urgent case	3.41	3.22	3.50	1.09	3.70	3.15%

Table 6.
Technical matrix

TR	Contribution	Priorities
TR1	1.08	3
TR2	0.30	10
TR3	0.90	5
TR4	0.56	7
TR5	0.74	6
TR6	0.99	4
TR7	0.58	7
TR8	0.44	8
TR9	1.59	1
TR10	0.39	9
TR11	0.49	8
TR12	0.33	10
TR13	1.38	2

the third priority is made a portal for provisioning monitoring that will also enlist the procedure for a site visit.

IV. CONCLUSION

The results show that of 29 attributes regarding the quality that customer needs in a data center, 17 characteristics have a low satisfaction score. Those attributes are the availability of the working room, availability of info regarding maintenance activities, etc. And to improve customer satisfaction scores, 13 technical responses are produced in this research. Since there are limitations on the company's ability, either financially or technically, there are technical responses that get prioritized. The priority is portal for trouble monitoring, which integrated with the call center. The second technical response is to improve the layout design of IT Hall. And the third priority is made a portal for provisioning monitoring that will also enlist the procedure for a site visit.

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