INCORPORATING SERVQUAL-QFD WITH TAGUCHI DESIGN FOR OPTIMIZING SERVICE QUALITY DESIGN

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ABSTRACT
Deploying good service design in service companies has been updated issue in improving customer satisfaction, especially based on the level of service quality measured by Parasuraman's SERVQUAL. Many researchers have been proposing methods in designing the service, and some of them are based on engineering viewpoint, especially by implementing the QFD method or even using robust Taguchi method. The QFD method would found the qualitative solution by generating the "how's", while Taguchi method gives more quantitative calculation in optimizing best solution. However, incorporating both QFD and Taguchi has been done in this paper and yields better design process. The purposes of this research is to evaluate the incorporated methods by implemented it to a case study, then analyze the result and see the robustness of those methods to customer perception of service quality. Started by measuring service attributes using SERVQUAL and find the improvement with QFD, the deployment of QFD solution then generated by defining Taguchi factors levels and calculating the Signal-to-noise ratio in its orthogonal array, and optimized Taguchi response then found. A case study was given for designing service in local bank. Afterward, the service design obtained from previous analysis was then evaluated and shows that it was still meet the customer satisfaction. Incorporating QFD and Taguchi has performed well and can be adopted and developed for another research for evaluating the robustness of result.

*Keywords***:** SERVQUAL, customer gaps, QFD, Taguchi, optimized service design,

1. INTRODUCTION

Since firstly proposed by Parasuraman et al (1988), Service Quality (SERVQUAL) has been applied for evaluating the quality level of services, and as reference for improving the service design. Based on the 5 dimensional customer attributes, the SERVQUAL measures the 5 gaps, including the customer gap i.e. the difference between customer expectation and perception. Attributes with large negative gaps represents some dissatisfactions and lead to the opportunity for improving them. However, many researches evaluate the effectiveness of SERVQUAL related to large amount of variables in questionnaire, and also their likert scale that is considered difficult to interpret (Buttle, 1995). Some papers proposed modifications of SERVQUAL by developing similar procedures or dimensions for particular service, such as DINESERV (Stevens et al, 1995) for evaluating restaurant service, SERVPERF (Cronin & Taylor, 1992) for omitting the customer expectation rather than calculate its different with the perception, and HEDPERF (Abdullah, 2006) for evaluating education service.

Considering the customer gaps in SERVQUAL, the improvement should accommodate all those negative gaps, especially the larger ones. The researchers often qualitatively generate the improvement plans according to the gaps and then implement them, see Anderson (1995), and Magi & Julander(1999). A well-known tool for generating those plans is Quality Function Deployment (QFD), as used by Sangeeta et al, (2004) and Apriani & Juliani, (2015). QFD would produce the "hows", i.e. solutions related to the negative gaps in SERVQUAL called "whats", then by subjectively weighting and associating between hows and whats, priority in implementing the improvement would be found.

Once the prioritized improvement plans implemented, they should fulfill and satisfy the customers, and reduce the negative SERVQUAL gaps. However, there's no guarantee that the prioritized plans produced by QFD would robustly satisfying the customers because the customer can only accept what the QFD hows determined, which has qualitatively generated and subjectively weighted. Customers don't have a chance to select which plans they prefer to implement, so those plans can't be reliably satisfying over time and fall to un-optimized deployment. Otero (1996) and Koh (2008) proposed the Taguchi method in selecting best combination in the QFD hows for designing the deployed service for customer by determining additional plans levels, similar to factors in experimental design method

Incoporating Taguchi with SERVQUAL and QFD has not been discussed before, this paper proposed new approach in increasing robustness of service design through Taguchi method. The framework is started from identifying the variables, calculating the gaps, generating the improvement plans through QFD, and then applying Taguchi method for optimizing the plans into service design. A case study has been conducted and the deployed service design is obtained, and related analysis is performed for evaluating this framework.

2. LITERATURE REVIEW
2.1. SERVQUAL-QFD
The Parasuramans's SERVQUAL (Parasuraman et al, 1998) has been popular method in evaluating the quality of service. There are 5 gaps as the main idea in this analysis, represent unsatisfactory of customer and inconvenience managed service, see figure 1. One of SERVQUAL advantage adopted in this research is the gap analysis for measuring the customer satisfaction, i.e. the difference between expectation and perception of customers. The negative gap shows the unsatisfactory of customers, and the positive ones represent fulfillment of their expectation. All negative gaps considered to be improved, with the scope of 5 dimensions, i.e. tangible, empathy, reliability, responsiveness, and assurance.

The incorporated QFD takes place to generate improvement plans due to negative gaps which called what, see Green (2014). The improvement plan (hows) then associated with the whats followed by calculating weight of prioritized plan. Solutions for customer gaps refer to the highest priority represented by highest relative weight. All this analysis could be done in a tools called House of Quality, see figure 2.
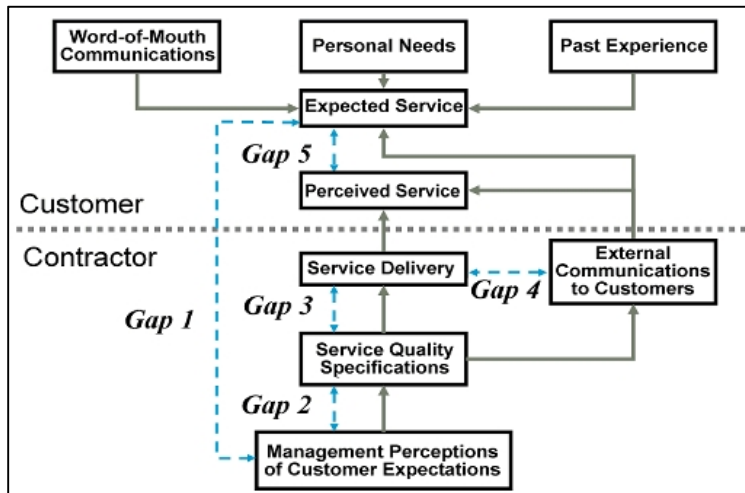
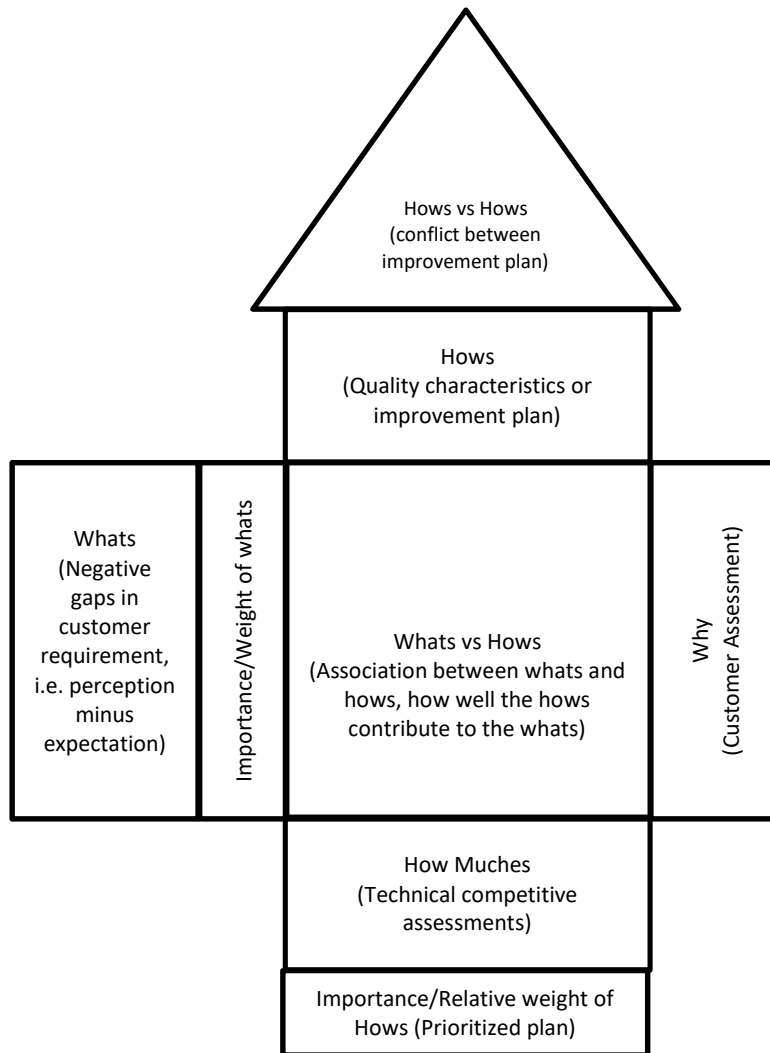Figure 1. SERVQUAL gaps (taken from Parasuraman et al, 1998)

Figure 2. House of Quality in QFD

2.2. Taguchi Method

The Taguchi method usually applied in hard engineering for finding the best experiment factor combinations that optimize the response, see Belavendram (1995) and Roy (2001), and its development as in Pontes et al. (2010), Hadiyat & Wahyudi (2013) and Hadiyat (2012). First step, researchers determine the factors to be optimized including their levels. Following by conducting experiment refer to orthogonal array design. By calculating averages for each factor level and rank the difference between each of them, Taguchi could find the optimal level combination that optimize the interested response transformed in term of signal-to-noise ratio (SNR), considering the objective of optimization as follows:

    a. Signal-to-noise ratio for larger the better
    b. Signal-to-noise ratio for nominal the best
    c. Signal-to-noise ratio for smaller the better

Only larger the better signal-to-noise ratio would be used in this paper, since the objective in Taguchi was maximized customer response. Formula of signal-to-noise ratio for larger the better shown in (1)

$$S = -10 \, lc \, \left[\frac{1}{n} \sum_{i=1}^{n} \frac{1}{y^2} \right] \tag{1}$$

In this research, the Taguchi method would be used for designing robust service determined before by SERVQUAL-QFD. Koh (2008) has successfully applied Taguchi in designing retail service, but the factors and also their levels was determined qualitatively by brainstorming the customers, so the subjective consideration still dominates them. One needs to conduct the Taguchi pre-determined process in selecting factors and levels especially for service analysis. In this research, the pre-process will be incorporated with the SERVQUAL-QFD analysis, so the factors should be more subjectively determined.

3. FRAMEWORK AND METHODOLOGY

As mentioned above, the SERVQUAL-QFD and Taguchi method need to be incorporated and then complemented by additional steps. This research framework is shown in figure 3. The SERVQUAL and Taguchi part of the framework needs customer feedback, while the QFD part still needs subjective weighting determination of prioritized plans. However, these subjective processes can be neutralized by customer response in Taguchi part. Steps in implementing the framework briefly explained below.

1. Generating questionnaire variables refer to SERVQUAL dimensions, and then conducting survey
2. Once the feedbacks got, calculate the customer gaps for each variables
3. Selecting the variables with negative gaps to be whats component in QFD, and weighting them refer to those gaps value.
4. Subjectively generate QFD hows (the improvement plans), and associate them with whats by using relationship weighting, so the prioritized plans should be resulted from.
5. Prioritized plans as factors in Taguchi design. Determine the two levels of each factor, and then assign them in the orthogonal array.

6. Each run in orthogonal array represents the combination of prioritized plan, which should gain confirmation responses from customer.

Optimizing the response using Taguchi technique, then the optimal combination of plans should be obtained. This results the robust service design.

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┌─────────────────────┐                              ┌──────────────────┐
│     SERVQUAL        │                              │  Negative gaps   │
│                     │ ──────────────────────────▶  └──────────────────┘
│  The customer gaps  │                                       │
│ (Difference between │                                       ▼
│ customer expectation│                              ┌──────────────────┐
│   and perception)   │                              │    Improved      │
└─────────────────────┘                              └──────────────────┘
          │                                                   │
          ▼                                                   ▼
┌─────────────────────┐                              ┌──────────────────┐
│   Positive gaps     │                              │ QFD what's and its│
└─────────────────────┘                              │   weight, refer to│
          │                                          │   negative gaps   │
          ▼                                          └──────────────────┘
┌─────────────────────┐                                       │
│    Maintained       │                                       ▼
└─────────────────────┘                              ┌──────────────────┐
          ▲                                          │ Improvement plan as│
          │                                          │    QFD hows      │
┌─────────────────────┐                              └──────────────────┘
│    Optimized        │                                       │
│ improvement plan    │                                       ▼
│ based on Taguchi,   │                              ┌──────────────────┐
│ as robust service   │                              │  QFD prioritized │
└─────────────────────┘                              │ improvement plan │
          ▲                                          │    by weight     │
          │                                          │ associating the  │
┌─────────────────────┐                              │  whats and hows  │
│ Customer response   │                              └──────────────────┘
│ refer to Taguchi    │                                       │
│ orthogonal array    │                                       ▼
└─────────────────────┘                              ┌──────────────────┐
          ▲        ┌──────────────┐  ┌──────────────┐│  QFD prioritized │
          │        │ Determining  │  │              ││ improvement plan │
┌─────────────────┐│ Taguchi's    │◀─│              │◀│ as Taguchi factors│
│ Creating Taguchi ││ factors      │  │              │└──────────────────┘
│ orthogonal array ││ levels       │  │
│ as combination of │└──────────────┘
│  factors levels   │◀
└─────────────────┘
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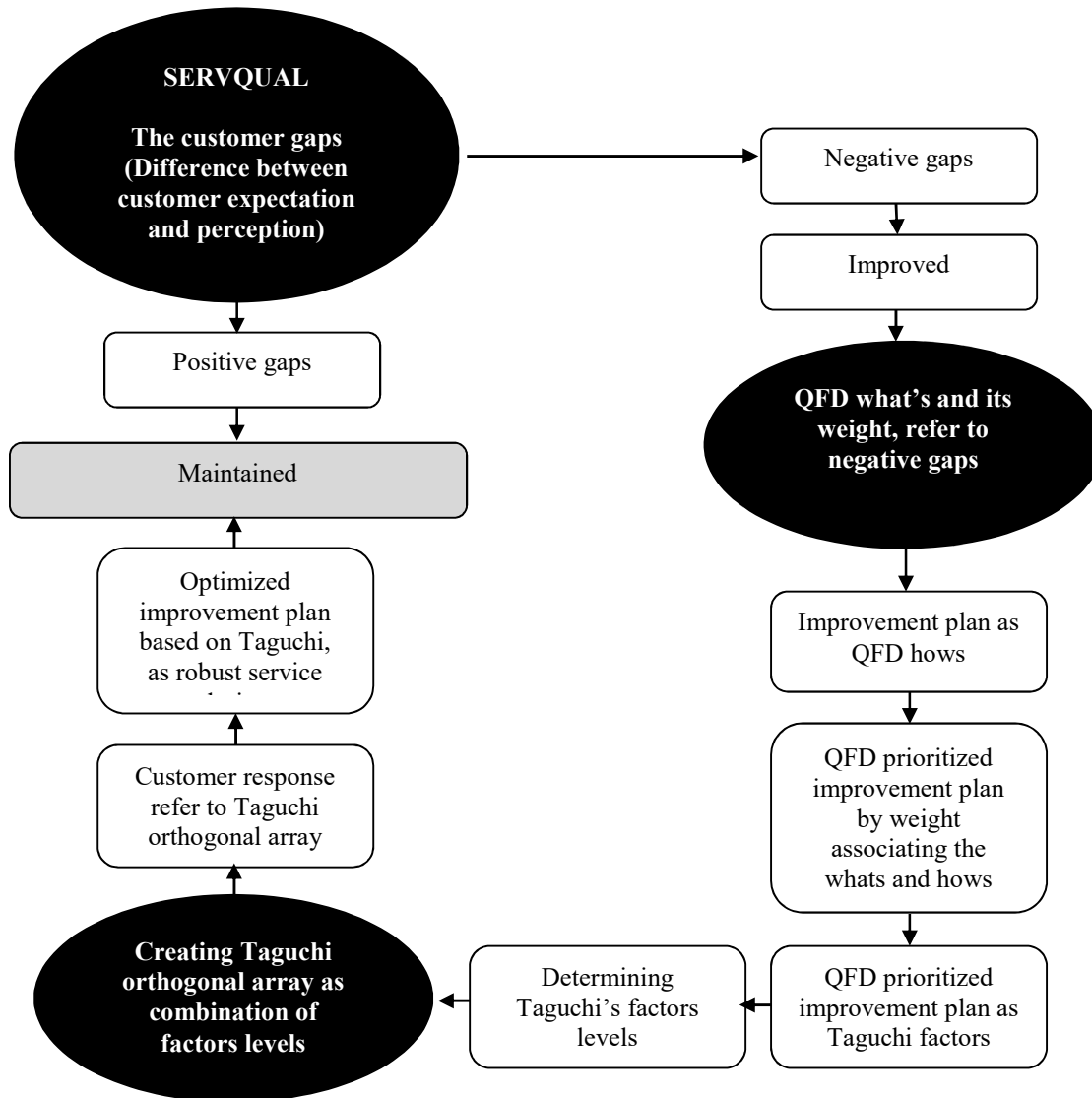
Figure 3. Incorporating SERVQUAL-QFD-Taguchi framework

Robust service design has accommodated almost all parts of customer responses. So, it should decrease the number of complaints and has longer timeframe implementation. One should maintain this design and periodically evaluate it. Someday, there's a chance where customer responses for this design will be decreased and needs to be re-improved.

Table 1. Variables with negative gaps

no	Variables	Expectation (E)	Perception (P)	customer gaps (P-E)
1	comfort waiting room	4.85	4.03	-0.82
2	variations of bank service	4.83	4.25	-0.58
3	responsiveness of customer service	4.71	4.22	-0.49
4	responsiveness of teller	4.74	4.22	-0.52
5	competency of customer service and teller	4.63	3.91	-0.72
6	willingness to answer customer questions	4.79	4.14	-0.65
7	friendly and polite service	4.69	4.23	-0.46
8	simplicity in conveying complaints	4.9	4.31	-0.59
9	full attention from bank officer to customer	4.9	4.35	-0.55
10	no discrimination in servicing customer	4.68	4.23	-0.45

4. RESULTS AND DISCUSSION

A case study was taken from Wiryawan (2014), which has evaluated the service quality of local bank in Indonesia, with 22 variables generated considering 5 dimensions in SERVQUAL. The customer gaps had calculated, and 10 variables with negative gaps (unsatisfactory) were found, list of those variables shown in table 1. All negative gaps would be the whats components in QFD, and their gaps value as weights. The improvement plan (hows component) then determined subjectively related to the whats. There were 6 hows generated, and the associate weight with whats component also put in QFD, this result could be seen in figure 4. The prioritized plans were then obtained by calculating relative weight for each improvement plan, see table 2. Without incorporating Taguchi, these prioritized plans were the final solution for improving bank service design.

However, there were no such confirmation process form customers so those solutions had no guarantee to survive over a long periodic evaluation. One should make sure that the solution would robust and reliable at longer time. The incorporated Taguchi then take place for increasing the service design robustness. The prioritized plans in table 2 then converted as factor in Taguchi experimental design. Levels from each factor then determined considering the high level and low level as in Taguchi. Table 3 shows these levels.

Row #	Max Relationship Value in Row	Relative Weight	Weight / Importance	Demanded Quality (a.k.a. "Customer Requirements" or "Whats")	standard for customer handling	smile and greet	idea mining from employee	training for employee	room facilities	updating jobdesc
1	9	14.1	0.8	comfort waiting room		▲			Θ	
2	9	9.9	0.6	variations of bank service		O	Θ			
3	9	8.4	0.5	responsiveness of customer service	Θ			Θ		O
4	9	8.9	0.5	responsiveness of teller	Θ					O
5	9	12.3	0.7	competency of customer service and teller			O	Θ		
6	9	11.1	0.7	willingness to answer customer questions	Θ	Θ				
7	9	7.9	0.5	friendly and polite service		Θ	▲	O		
8	9	10.1	0.6	simplicity in conveying complaints			Θ			O
9	9	9.4	0.6	full attention from bank officer to customer	Θ	▲	O	O		
10	9	7.7	0.5	no discrimination in servicing customer	O	Θ	O	O		

Figure 4. Association between whats (negative gaps) and hows (improvement plan) in QFD. Symbols represent association level.

Table 2. prioritized plan

the hows in QFD	QFD relative weight	prioritized plan
standard for customer handling	25.9	YES
smile and greet	20.9	YES
idea mining from employee	19.7	YES
training for employee	18.6	YES
room facilities	9.0	NO
updating jobdesc	5.9	NO

Only 4 factors selected into Taguchi analysis, omitting prioritized plans with low QFD relative weight as they didn't gives significant influence to customer. All these 4 factors and their levels then assigned into L_8 orthogonal array experiment design, selected design refer to the number of factors (Belavendram, 1995) with no assumption of interaction between factors.

Table 3. Taguchi factors and level

Taguchi factors	Prioritized plan (the hows in QFD)	level 1	level 2
A	standard for customer handling	create SOP then publish it to customer	create SOP without publish it, as it's confidential
B	smile and greet	mandatory for any level of employee, including the securities	mandatory only for customer service and teller, as they are directly communicate with customer
C	idea mining from employee	employee periodic meeting for idea mining	directly idea conveying with reward
D	training for employee	employee periodic training	employee training as needed

Combinations of levels in L_8 had assumed to be experiment runs in Taguchi, responses taken from customer were their perceptions for each level combination. For example in first run, customers were asked to gives their perception if the bank deploying this service designs:

a. create SOP then publish it to customer
b. mandatory for any level of employee, including the securities
c. employee periodic meeting for idea mining
d. employee periodic training

Customers fill a likert scale questionnaire represent how high they perception about this first run service design. This technique was similar to Otero (1996) and Koh (2008).

Table 4. Customer responses in Taguchi L_8

run	factors				unused columns			average customer responses	S/N ratio
	A	B	C	D					
1	1	1	1	1	1	1	1	2.2	6.848454
2	1	1	1	2	2	2	2	4	12.0412
3	1	2	2	1	1	2	2	3.3	10.37028
4	1	2	2	2	2	1	1	2.1	6.444386
5	2	1	2	1	2	1	2	2	6.0206
6	2	1	2	2	1	2	1	1.2	1.583625
7	2	2	1	1	2	2	1	2.1	6.444386
8	2	2	1	2	1	1	2	3.1	9.827234

Perceptions of customers for this first L_8 run would be the experiment responses, another experiment runs then treated in same way as well. Final responses from customers forming

a completed Taguchi L$_8$ orthogonal array are shown in Table 4. Transformation from responses to signal-to-noise also calculated as the objective of this experiment was maximizing customer responses

As standard Taguchi analysis, response table and graphic then created to find optimal responses. Table 5 and figure 5 shows optimal levels combination that had optimized customer responses. Final optimized service design was:
a. factor D level 1 : employee periodic meeting for idea mining
b. factor A level 1 : create SOP then publish it to customer
c. factor B level 2 : mandatory only for customer service and teller, as they are directly communicate with customer
d. factor C level 2 : directly idea conveying with reward

This final service design then could be deployed to customer and still need to evaluate periodically. It should be survives in a longer time until customer response decreased, if it be then the banks should re-improve the service design and find new one.

Table 5. S/N Taguchi response table

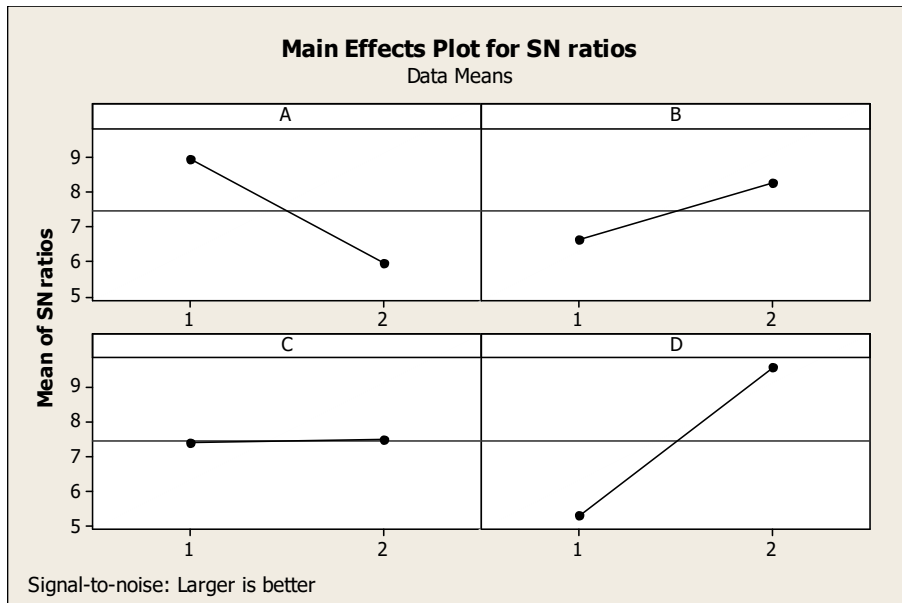| Level	factors			
	A	B	C	D
1	8.926	6.623	7.421	5.33
2	5.969	8.272	7.474	9.565
delta	2.957	1.648	0.053	4.235
rank	2	3	4	1

Figure 5. S/N Taguchi response graph

4. CONCLUSION

The framework for incorporating SERVQUAL-QFD-Taguchi has successfully implemented in this research, optimal service design has founded. It should have more reliable positive responses from customer, since it was obtained by optimization process. Further, the development of this research should include the reliability estimation of service design that has deployed, so the service life cycle could be predicted.

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