Implementation of drinking water treatment device for primary school students and teachers (Case study at SDIT Insantama Malang, Indonesia)

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Abstract. The education and health sectors are placed in the top position of Indonesian government priority scales, since both have positive relationship and should be developed together. Education and health sector collaboration actually creates a health awareness for children as early as possible, which starts at the age of primary school. Unfortunately, the drinking water treatment device that can be operated continuously with low cost or energy for elementary students are never be found in Malang, Indonesia. This study aimed to install the drinking water treatment device based on membrane filtration and UV sterilization at primary school and also to analyze of teachers and students satisfaction toward the device applied. In this study, the importance performance analysis (IPA) and consumer satisfaction index (CSI) are used as a method for analyzing of teachers and students satisfaction. The data was collected from 100 respondents and 13 attributes were analyzed. The IPA results showed that maintenance of the device attribute was categorized as priority for improvement (quadrant I). Attributes that are categorized into quadrant II (maintain achievement) were appearance, freshness, taste, volume precision and quality testing in laboratory. While attributes that are categorized as second priority for improvement (quadrant III) are flavor, color, volume, hygiene of water and affordability. The attributes of practicality of use and the ergonomic design were categorized into quadrant IV or high level of performance implementation. The consumer satisfaction level by using CSI was 76%, indicating a high customer satisfaction level on the water produced by drinking water treatment device installed in their school.

1. Introduction
The 2018th Indonesia Government Work Plan has been decided through 10 national priorities. The education and health sectors are the two fields that occupy the top position in the national priority scale pyramid in that year, since its have a positive relationship and must grow together. Educational priority programs are held at all levels of education ranging from early childhood, primary, secondary, and higher education, both formal and informal. Furthermore, this priority program also aims to improve education quality assurance, quality learning development, and innovation. While the national priority in the health sector consists of three priority programs, namely the Improvement of Maternal and Child Health, Disease Prevention and Management, and Preventive Promotion (Healthy Living Community Movement) [1].
Basically, the education plays a key role to ensure the nation’s survival and development since it is
a vehicle to enhance the human resources quality. At a more concrete stage, active cognitive education
begins in the primary education period or in the age range of 6-12 years when the child is in an
primary school. Physical growth of children at the age of primary school tends to be slower and more
inconsistent when compared with early childhood. The average primary school age child gains around
2.5-3.5 kg, and heights gain 5-7 cm per year [2]. The education problem is closely related to the health
problem. Therefore it is needed the education and health collaboration, to create an order of health
awareness for children as early as possible, at least starting when the cognitive and psychomotor
stages that is qualified in the primary school [3].

One of the health problems for primary school student is the lack of awareness for drinking a water.
On the other hand, this problem is also triggered by inadequate drinking water facilities in schools.
This is because a low cost and energy saving technology for drinking water treatment is hardly found
in Malang, Indonesia. All these problems have become the main constrain in SDIT (Integrated Islamic
Primary School) Insantama Malang. Therefore this study aims to implement of drinking water
treatment based on membrane filtration and UV technology and to analyze the consumer (teachers and
students) satisfaction toward drinking water treatment device.

There are two methods, widely used to analyse customers’ satisfaction, namely Importance
Performance Analysis (IPA) and Customer Satisfaction Index (CSI). The advantages of the IPA
method include easy interpretation, easy implementation and understanding, low cost, as well as direct
determination of essential product attributes for sustaining customer satisfaction. While the advantages
of CSI method include easy application, simple operation, superior sensitivity and reliability, as well
as highly efficient in pointing out both satisfaction indexes and dimensions or attributes to be
improved [4]. In this study, the consumer satisfaction analysis is used to determine the extent of
satisfaction of teachers and students at SDIT Insantama, toward the water produced from drinking
water treatment device that has been installed.

2. Materials and Method
2.1. Drinking water treatment devices
The drinking water treatment devices are consists of aeration space, zeolite manganese filter tubes,
activated carbon filter tubes, microfiltration membrane filters and UV sterilizers. The installation is
also equipped with standard operational procedures including how to use and how to repair and
maintain the device. The detailed specification of the drinking water treatment based on membrane
filtration and UV technology and also several tests of the water product as describes in Astuti study
[5]. The water produced meets all parameters of microbiological, chemical and physical, indicating its
suitability as drinking water.

2.2. Education activities
The education method using participatory exercise, so it invites participants to be active and practice
the training materials directly. This activity was attended by 100 participants (85 students and 15
teachers). During the educational activities, participants were given a pre-test and post-test
questionnaire. An evaluation of the activity was carried out to evaluate the successful implementation
of the team in delivering the education and also as an input to improve for future activities.

2.3. Validity and reliability test
Validity test was carried out to measure the accuracy of the content of an instrument (i.e.
questionnaire) used in a study. The validity can be determined by correlating the each variable score
of each respondent’s answer with the total score of each variable. The results were then compared with
the critical value with sig. 0.05 and sig. 0.01. Bivariate Pearson Correlation is one formula that can be
used to test data validity with the SPSS program. The formula of the Pearson Product Moment
Correlation is:
Where $r_{XY}$ is the Pearson product moment correlation, $n$ is the number of subjects studied, $\sum X$ is the amount of $X$ (item score), $\sum Y$ is the amount of $Y$ (total score).

The two-party test was carried out for testing with sig. 0.05. If the $r$ value $\geq r$ tables, the instrument or question items was significantly correlated to the total score and it was declared as valid. The reliability test was carried out to measure consistency of a questionnaire either for each variable that construct the questionnaire or for the whole questionnaire. A questionnaire is reliable if a respondent can give a consistent or a stable statement (i.e. answer) over time. Reliability is related to the consistency of the used measure (i.e. questionnaire) if repeated to diverse respondents. Cronbach’s Alpha method is well suited for application of measures with a scale (eg. 1-4, 1-5) or with stretch scores (eg. 0-20, 0-50). The formula of the Alpha (Cronbach’s) method is:

$$r_{11} = \left(\frac{n}{n-1}\right) \left(1 - \frac{\sum S_i^2}{S^2}\right)$$

Where $r_{11}$ is the instrument reliability, $n$ is the number of question items tested, $\sum S_i^2$ is the number of score variants per item and $S^2$ is total variant. If the alpha value $> 0.7$ indicates sufficient reliability and if alpha $> 0.80$ means strong reliability indicating that all variables are internally consistent.

### 2.4. IPA procedures

The IPA method applied was based on previous research reported by Shia et al. [6]. The initial step is to determine the appropriateness level between the importance and the quality performance level of the attributes examined by comparing the performance scores with the importance scores. The suitability is calculated using the formula below:

$$T_{ki} = \frac{X_i}{Y_i} \times 100\%$$

Where $T_{ki}$ is the respondent’s conformity level, $X_i$ is the performance assessment score and $Y_i$ is the importance assessment score.

The second step is to calculate the average value of each attribute recognised by the consumer, using the following formula:

$$\bar{X} = \frac{\sum X_i}{n} \quad \bar{Y} = \frac{\sum Y_i}{n}$$

Where $\bar{X}$ is average score of product performance level, $\bar{Y}$ is average score of product importance level, and $n$ is the number of respondents.

Furthermore, the average score of all importance attributes ($Y$) and performance attributes ($X$) is calculated as the limit of the Cartesian diagram, using the formula:

$$\bar{X} = \frac{\sum X_i}{k} \quad \bar{Y} = \frac{\sum Y_i}{k}$$

Where $\bar{X}$ is average score of all attributes performance level, $\bar{Y}$ is average score of all attributes importance level that influenced the product quality dimension, and $k$ is the number of attributes that influenced the product quality dimension. The final stage is to integrate each attribute into the Cartesian diagram.

### 2.5. CSI procedures

The first stage of the CSI is to calculate the Mean Importance Score (MIS) and the Mean Satisfaction Score (MSS). These values are resulted from the average of importance and of performance level of each product attribute.
The next stage is to calculate Weight Factors (WF) by dividing the MIS values per attribute with the total MIS values of all attributes. Then, calculate Weight Score (WS) by multiplying WF with the average MSS values. Both formulas are shown in the equation below:

$$WF_i = \frac{MIS_i}{MIS_{total}}$$
$$WS_i = MSS_i \times WF_i$$

Where MIS\(_i\) is Mean Importance Score\(_i\), MSS\(_i\) is Mean Satisfaction Score\(_i\), WF\(_i\) is Weight Factor\(_i\).

The final step is calculating the CSI, as follows:

$$CSI = \frac{\sum_{i=1}^{p} WS_i}{HS} \times 100\%$$

Where p is the attribute of importance p and HS is the maximum number of the scale used. In this study the scale of 1-5, thus the HS number selected was 5.

3. Results and Discussion

3.1. Education about the importance of drinking water

The education activity was held in SDIT Insantama hall and attended by 100 participants. The results of pre- and post-test, as well as the activities evaluation are shown in the Figure 1. Based on Figure 1a, it can be seen that question 4-6 were unknown to the participants in educational activities, while the first 2 questions were quite understandable. Questions that are quite understandable to participants are related to the importance of consuming healthy water on a daily basis and its impact if there is a lack of water. While the next 4 questions were related to how to process tap water into drinking water, the processing technology used, the difference in water consumed, and any parameters for drinking water. The results suggested that about 70% participants were still not aware about those issues. Therefore, all participants were very enthusiastic to participate in the educational activities. The post-test results showed that all the same questions given at the pre-test can be understood by all participants with an average understanding of 73.33%. Questions 3 and 4 were about how to treat normal water into drinking water and the technology used such as ultrafiltration membrane and ultraviolet sterilization mechanism. The results showed a fairly low level of understanding when compared with other questions. This is possibly due to the provided materials were too hardly to be understood for elementary students.

![Figure 1](image1.png)

**Figure 1.** The result of pre and post-test for the educational activities (a), and evaluation results of educational activities (b)

An evaluation of the activity was carried out to find out the successful to deliver the education and also as an input to improve for future activities. In the activity evaluation questionnaire, there are important points such as how useful the activity is, the participant's assessment of the contents of the
activity, resource persons and infrastructure used during the socialization and training, participant satisfaction with the activity, and suggestions from participants for the activity. Figure 1b shows that all questions have an average value of 4 (range 1-5). It means that all of the educational activities were considered to be good even close to very good. However, from these results there are still values below 4 or with a value of 3.7, namely in question number 7 which about the timeliness of activities.

3.2. Results of validity and reliability test

Table 1 shows both validity and reliability test results, which present the values of the corrected item total correlations (also known as the r-calculated value) of each attribute in the questionnaire tested. The r-count value was then compared with the r-table value to see whether the attributes in the questionnaire are valid or not. The r-table value for the significance level of 95% and n = 100 was 0.197. All corrected items in the total correlations or r-counts of each attribute in this research questionnaire were above the r-table values. This shows that the questionnaire used in this study can be said to be valid or this questionnaire is suitable for use in the research.

Table 1. Validity and reliability test results

| No | Attributes         | Test    | Level of Performance | Level of Importance | Information |
|----|--------------------|---------|----------------------|---------------------|-------------|
| 1  | Appearance         |         | 0.573                | 0.711               | Valid       |
| 2  | Freshness          |         | 0.598                | 0.571               | Valid       |
| 3  | Taste              |         | 0.626                | 0.542               | Valid       |
| 4  | Flavor             |         | 0.621                | 0.743               | Valid       |
| 5  | Color              |         | 0.574                | 0.773               | Valid       |
| 6  | Volume precision   |         | 0.562                | 0.364               | Valid       |
| 7  | Consistency        | Validity test | 0.662              | 0.669               | Valid       |
| 8  | Practicality       |         | 0.551                | 0.451               | Valid       |
| 9  | Laboratory testing |         | 0.605                | 0.603               | Valid       |
| 10 | Hygiene            |         | 0.318                | 0.671               | Valid       |
| 11 | Affordability      |         | 0.638                | 0.715               | Valid       |
| 12 | Ergonomic design   |         | 0.408                | 0.699               | Valid       |
| 13 | Maintenance        |         | 0.344                | 0.421               | Valid       |
|    | Reliability test α (Alpha Cronbach’s) |         | 0.803                | 0.863               | Reliable    |

Based on Table 1, the instrument is said to be reliable if the r-count is higher or equal to r-table, therefore the questionnaire in this study was applicable to be used. The Alpha Cronbach or r-count value was then compared with the r-table value. This study indicated that, in the reliability test results, the value of r-count was higher than r-table, with the value of 0.197. This indicated that the research questionnaire is reliable to be applied. The reliability test results also showed high reliability as indicated by a high r-calculated value of 0.7.

3.3. Importance Performance Analysis (IPA) results

This study found that the highest suitability level in drinking water treatment device was derived from the ergonomic design attribute, giving the value of 101.33% (Table 2). The score of the level of performance attribute variation exceeds the importance level score; therefore the score of the suitability level obtained was above 100%. As shown in Figure 1, the drinking water treatment design is very simple and comfortable to use for students and teachers. While the suitability level with the lowest score (86.25%) was the device maintenance attribute. Although this attribute was at the lowest conformity level, it is considered to be very suitable. The membrane-based ultrafiltration and UV
sterilization technology are something new for students and teachers in SDIT Insantama. Therefore, the maintenance method for drinking water treatment, which composed of complex components, has the lowest value in the conformity level.

The average of suitability level of all attributes asked to respondents was 93.20%. This value corresponds to the overall attributes measured were fall into the suitability score category of very appropriate. The average level of quality or performance attributes was 3.80, while the average level of importance of attribute was 4.07. This value is then used as the midpoint (on the X axis and Y axis) for determining the boundary of the quadrant in the Cartesian diagram. The Cartesian diagram divided the position of consumer satisfaction attributes into 4 quadrants, as illustrated in Figure 2.

| No | Attributes          | Performance level (Xi) | Importance level (Yi) | $\bar{X}_i$ | $\bar{Y}_i$ | Conformity level (TKi) (%) |
|----|---------------------|------------------------|-----------------------|-------------|-------------|---------------------------|
| 1  | Appearance          | 409                    | 436                   | 4.09        | 4.36        | 93.81                     |
| 2  | Freshness           | 406                    | 422                   | 4.06        | 4.22        | 96.21                     |
| 3  | Taste               | 384                    | 429                   | 3.84        | 4.29        | 89.51                     |
| 4  | Flavor              | 370                    | 384                   | 3.7         | 3.84        | 96.35                     |
| 5  | Color               | 378                    | 391                   | 3.78        | 3.91        | 96.68                     |
| 6  | Volume precision    | 357                    | 383                   | 3.57        | 3.83        | 93.21                     |
| 7  | Consistency         | 383                    | 417                   | 3.83        | 4.17        | 91.85                     |
| 8  | Practicality        | 380                    | 400                   | 3.8         | 4.00        | 95.00                     |
| 9  | Laboratory testing  | 382                    | 430                   | 3.82        | 4.30        | 88.84                     |
| 10 | Hygiene             | 377                    | 399                   | 3.77        | 3.99        | 94.49                     |
| 11 | Affordability       | 357                    | 398                   | 3.57        | 3.98        | 89.70                     |
| 12 | Ergonomic design    | 382                    | 377                   | 3.82        | 3.77        | 101.33**                  |
| 13 | Maintenance         | 370                    | 429                   | 3.7         | 4.29        | 86.25*                    |
|    | Total               | 4935                   | 5295                  | 49.35       | 52.95       |                           |

Average: 3.80 4.07 93.20%

Note: ** = highest conformity level and * = lowest conformity level

Figure 2. Cartesian diagram of IPA results
The first quadrant indicates main priority for improvements, which means that, although the satisfaction level for current condition was not evident, the attributes are highlighted as an essential factor to be further improved. In this study, only one attribute contained in first quadrant namely maintenance of the device. As discussed in the education process, that the ease of device maintenance is considered by participants both students and teachers as a something difficult in maintenance. It is because drinking water treatment based on the membrane and UV technology has several components that must be replaced at all times such as cartridge filters and backwashing for the membrane cleaning process. Therefore, the team coordinated with the head of school to appoint one person to be trained by the team regarding the technology used, how to maintain of drinking water treatment device to ensure consistency of hygienic and healthy water produced at SDIT Insantama.

The second quadrant is the maintain achievement, in which the attribute is considered as supporting factor, but still need to be maintained for good achievements in customer satisfaction. In this study, the attributes fall into quadrant II and need to be continuously maintained were appearance, freshness, taste, consistency and laboratory testing. These attributes get a good satisfaction score from consumers because of the physical appearance of clear water, fresh taste that is different from the water they normally consumed. Furthermore, the results of the laboratory test also indicate the quality of water is suitable for drinking and in accordance with standard regulation (Ministry of Health of the Republic of Indonesia No. 492 Year 2010) in terms of microbiological, chemical, and physical parameters.

The third quadrant is a low priority quadrant, in which the attributes are identified as less important by the respondents. The attributes classified into quadrant III (i.e. second priority for improvement) were flavor, color, volume precision, hygiene and affordability. Whereas the attributes categorized into quadrant IV were the practicality of use and the ergonomic design. These attributes had a low level of importance, but have a high level of performance implementation. The study confirmed that attributes in quadrant IV was acknowledged as not critical or not expected by the respondents. Therefore, the IPA results help in determining and allocating the resources to improve other attributes with higher priority level.

3.4. CSI results
Customer satisfaction is achieved if the provided services are meeting or exceeding their expectations. The results of CSI calculations gave the CSI value of 76%, indicating that the respondents or customers were satisfied with water produced by drinking water treatment installed in their school. The CSI value was in the range of 0.66 to 0.80 which means that overall consumers (students and teachers in SDIT Insantama) were satisfied with the quality drinking water treatment’s performance.

4. Conclusions
The application of drinking water treatment technology based on membrane filtration and UV sterilization has been installed at SDIT Insantama Malang to provide drinking water for teachers and students continuously. Attribute with the main priority for improvement (quadrant I) was maintenance of the device. Attributes as the second priority for improvement (quadrant III) were flavor, color, volume precision, hygiene and affordability. While attributes as supporting factor for good customer satisfaction (quadrant II) included appearance, freshness, taste, consistency and laboratory testing. Attributes with the lowest priority level (quadrant IV) were practicality of use and the ergonomic design of drinking water treatment device. The findings showed a high customer satisfaction with the CSI value of 76%. Yet, further improvement to the performance attributes based on the IPA results is still needed, which is expected to increase the CSI value up to 100%.

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