

## Design the Stainless-Steel Water Hose Pipe by Using Flexible Spring

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**Abstract:** A clean toilet symbolizes a person's high personality. The importance of a clean toilet is to ensure that the toilet is comfortable to use and prevents the spread of germs and bacteria. Healthcare is one of the mandatory things for all communities in Malaysia. But still there are some people who take for granted in matters of hygiene in the bathroom. In addition, the use of dirty toilets can also lead to infections of the urinary tract or bladder which can be regarded as chronic. In addition, the use of unsystematic pipe hoses by leaving the hose on the bathroom floor and in the toilet, hole is a matter that will cause dangerous diseases due to various germs and bacteria that will attack a person's body. It is because the pipe hose is not re-suspended in its proper place. Therefore, the study was applied stainless steel pipe hose using this flexible spring, the pipe hose will not fall to the floor again because the spring will return the pipe hose to its original place without the user placing the hose pipe back to the hose hanger. This study focused on only one bathroom in a private home. The test method that will be implemented is a pipe leak test and test the effectiveness of the pipe hose using the Quality Function Distribution (QFD) by being tested by 20 respondents by providing a survey form in the form of google forms. By using this system, , the purpose of this project is to ensure the cleanliness of the toilet is always kept away from bacteria by ensuring that toilet equipment such as plumbing is always in its original place without the user re-hanging the hose after using it and it is protected from all impurities.

**Keywords:** Water hose pipe, Flexible spring, Quality function distribution, Bacteria

### 1. Introduction

The toilet is a plumbing system whose main purpose is to get rid of human waste such as urination or defecation. Since 1994, the Malaysian government has launched a clean toilet campaign. However, to this day, there are still many public toilets that have not reached a satisfactory level of cleanliness[1]. From 2014-2016, the government has spent almost RM60 million to repair and build new toilets nationwide. Among the negative attitudes of the community when using the toilet are

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squatting on the sitting toilet, not re-pumping the toilet, letting the water pipe hose on the floor or in the toilet hole, throwing garbage everywhere and stuffing garbage into the toilet hole [2]. The cause of public toilets in this dirty country is the lack of civic awareness and lack of affection for public property. Only 350 or 3.4 percent achieved a five-star rating while 1,086 or 10 percent were in dire straits to get the minimum one-star rating [3]. In addition, the use of dirty toilets can also lead to infections of the urinary tract or bladder which can be regarded as chronic. The bacteria in question are known as *Escherichia coli* or *E. coli*. Moreover, the habit of cleaning your hand after using the toilet is not perfect is also capable of causing food poisoning had occurred where the germs that are on the surface of the hand will be transferred to the food and infect others [4].

### 1.1 Problem Statement

Toilets faced in Malaysia are a symptom let hose pipe on the floor / pit toilets always happen. Among them we can see is to let the hose, hose float and not hang back to its original place. There are also hanging hangers that are damaged or broken and left the hose under. Dirty toilet use can also lead to infections in the ducts or bladder that can be considered chronic. The infection may occur due to germs found in the toilet environment entering the body through the anal canal [5]. The bacteria in question are known as *Escherichia coli* or *E. coli*. Symptoms of this disease are frequent urination, pain or soreness after urination, feeling like urinating again, even without urine (dissatisfied), pain in the lower abdomen, bloody urine or foul-smelling urine and moderate fever [6].

In this project, stainless steel pipe hose using flexible spring will be used to develop a quality product and free from bacteria and provide comfort to the user to use the hose pipe without hesitation [7]. In addition, to ensure that the products produced are successful, a survey has been formulated that the Quality Function Deployment (QFD) will be used to test the effectiveness of pipe hose design to connect enterprises or with consumers. Therefore, the purpose of this project is to ensure the cleanliness of the toilet is always kept away from bacteria by ensuring that toilet equipment such as plumbing is always in its original place without the user re-hanging the hose after use and it is protected from all impurities [8].

### 1.2 Project Objective

The specific objectives of this project includes:

- i. Design and produce pipes using flexible pipe hoses.
- ii. Test the effectiveness of flexible pipe hose designs using Quality Function Deployment (QFD) to the products produced.

### 1.3 Project Scope

- i. The study area is concentrated in the bathroom section of the private house, residential address No. 166 Jalan Pengkalan Barat 18, Taman Sri Sayang, 31650 Ipoh Perak Darul Ridzuan.
- ii. The main function of this study is to design and produce stainless steel pipe hoses using flexible springs as well as using Quality Function Distribution (QFD) to see the results of the products produced.
- iii. This study focuses on users who use the bathroom for bathroom cleaning as well as the cleaning process after urination and defecation.
- iv. These studies can be designed, developed and tested to ensure no more pipe hoses fall to the floor or into the toilet hole.

## 2. Literature Review

### 2.1 Hygiene and user behavior

Behavior is an act performed either directly or indirectly, semi-consciously or consciously and the physical manifestation of any attitude based on certain values [9]. In addition, behavior includes activities, actions, performance, reactions, actions and reactions in terms of techniques, activities involving the muscles, glands (glandular) and electrical activities by each organ [10]. Some scholars argue that the best way to overcome the problem of hygiene is to change the daily attitudes and behaviors that become the practice of society. At the same time, environmental worldview refers to the individual's beliefs, feelings and behavior towards the environment [11]. This Article focuses on self-interest (anthropocentric) focused environment (ecocentric) [12]. It concluded that the attitude towards cleanliness and behavior to get closer to the precise environment is to predict the best or positive behavior [13].

### 2.2 Universal Toilet Design

The universal design is about making the building safe and comfortable for all users, including the disabled. With regard to ambulant for public building users, there is no reliable anthropometry through data.

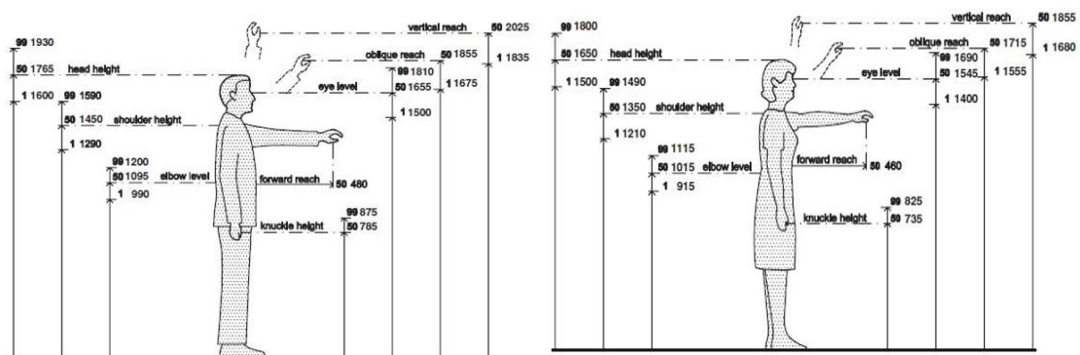


Figure 1: Body of men and women aged 18-60 years

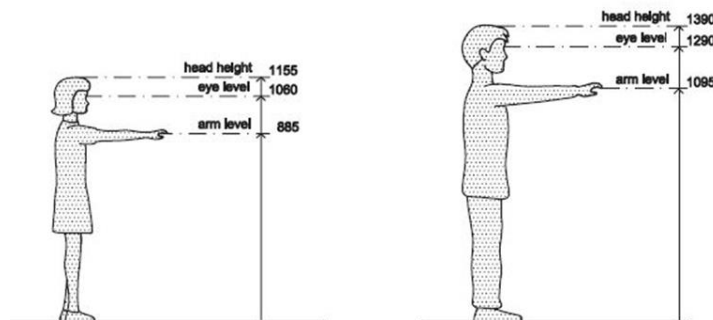


Figure 2: The body of a child is 6-10 years old

### 2.3 Types of Pipe Hoses

Among the reasons are that pipe hoses cannot be formed or loaded and bending is not suitable. There are several types of hoses commonly used as follows:

- i. Non-toxic pvc steel wire hose
- ii. Magic flexible hose water pipe
- iii. Rs pro 900 mm long flexible hose
- iv. Flexible stainless steel pipe hose

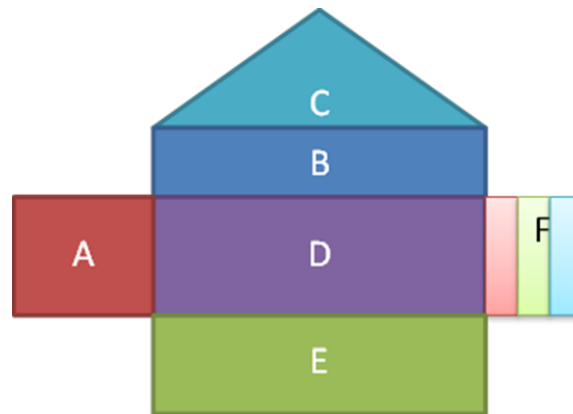
## 2.4 Type of Spring

Spring is classified according to its own characteristics after the force is applied to components such as:

- i. Tension/extension spring -Elongate as soon as the force is applied
- ii. Compression spring - Shortens when subjected to force
- iii. Tort spring - This spring is formed from a steel rod that can stretch against any force
- iv. Constant spring - Sustained force remains when deflected
- v. Spring variable - Spring resistance varies on each part when compressed

## 2.5 Quality Function Deployment (QFD)

This is a method developed to connect companies or with consumers [15]. The QFD method was developed and invented in the 1960s in Japan by Joji Akao and Prof. Shigeru Mizuno [16]. Then it is developed to get a complete system to ensure quality and customer satisfaction on new products and services. Writing in his book on the QFD approach to practitioners explains that QFD is a process that provides structure for the development cycle [17].



**Figure 3: The concept of Quality Houses (James 1991)**

## 3. Methodology

The methodology also covers the main aspects during the implementation of the study, i.e. designing the study, collecting data. The methodology contains reports and descriptions to produce evidence that can support a conclusion. Figure 4 shows a methodology chart for this study. A stainless-steel water hose pipe using with flexible spring has 4 phases of flow. The first phase begins with identifying the problems, the objectives of the study and continue the literature review. Subsequently, the second phase begins with the design process, material preparation, manufacturing and testing. In addition, at the end of this phase the test results will be identified. Next, the third phase is about the analysis and discussion of this project. Finally, the fourth phase is the conclusion and proposal for development of the stainless-steel water hose pipe using with flexible spring.

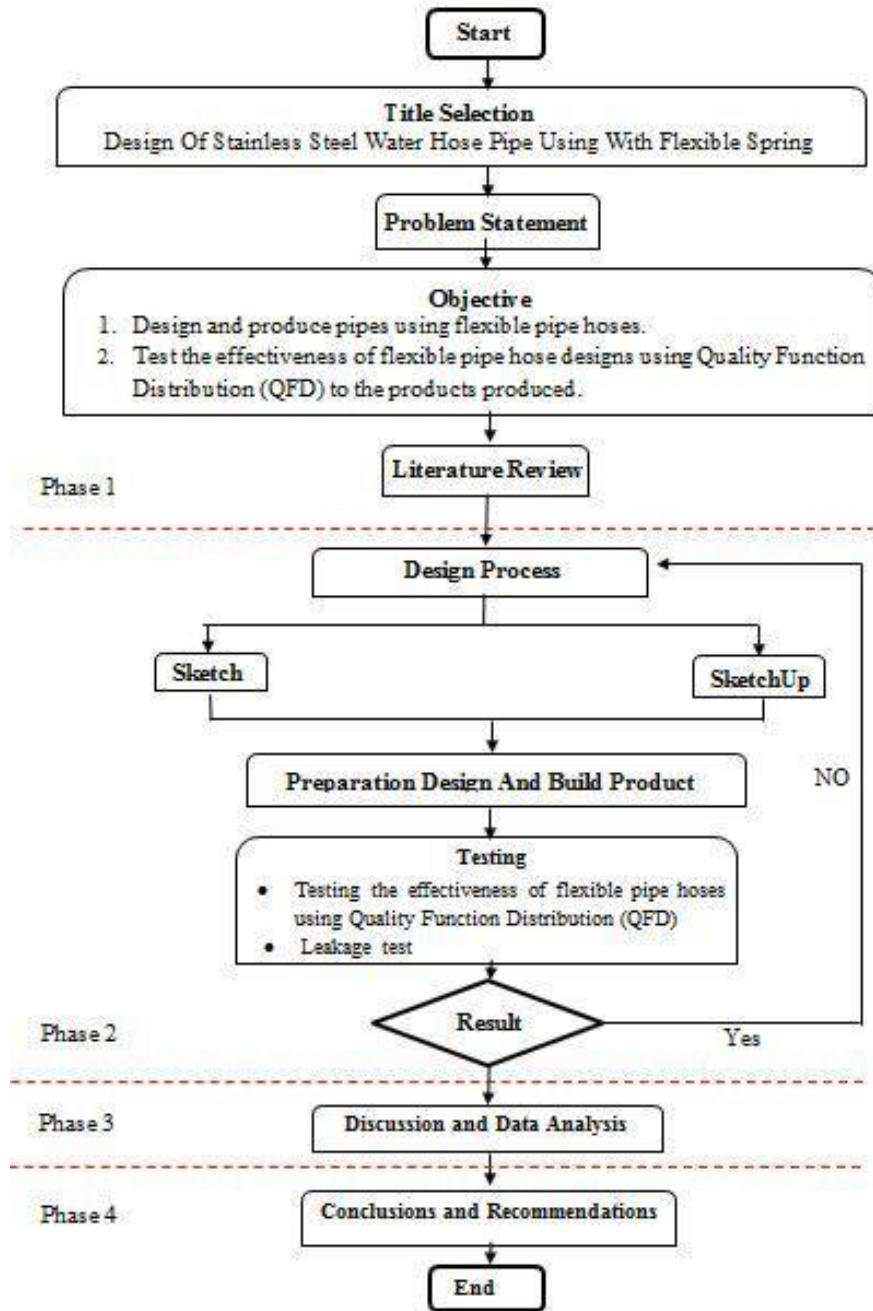


Figure 4: Methodology chart

The design of the latter is the complete idea of developing the final design, aimed at assessing its effectiveness. The process of designing the product starts with the sketch and then the sketch is simplified using a 3-dimensional device. In this phase there is also a selection of materials to produce product a design of stainless-steel water hose pipe using with flexible spring. The main materials used are readily available such as flexible spring, t-shaped connection, U bolt, iron rod blank for a binder between the spring with connectivity. Also have equipment used to produce flexible pipe hose designs such as pttte tape, measuring tape, spanar set and drill.



**Figure 5: the stainless-steel water hose pipe using with flexible spring has been completed**

The last second phase, the test must be done after producing the product. Pipe leak test must be done to ensure the effectiveness of the hose pipe has been produced. Also, the test the effectiveness of flexible pipe hoses using Distribution Quality Function (QFD). In testing the effectiveness of this flexible pipe hose will be tested by 20 respondents using it during the cleaning process or self-cleaning process. After that, respondents will be given a survey form on the effectiveness of using a flexible hose pipe Distribution Quality Function (QFD) product used are in favorable or unfavorable conditions in the form of Google Forms.

#### **4. Result and Discussion**

The data analysis process is very important in a study. This process also discusses the tests and results obtained from the studies that have been conducted. This test is to ensure that the designed pipe hose can be used properly without any defects and leaks. In addition, it easy for users to use it properly and free of bacteria

##### **4.1 Leak Test Against Pipe Hosts**

Leak testing is done to ensure that the installation has been installed correctly, and there is no water leakage at the connection point of pipe components and pipe hoses. This test takes 10 minutes to ensure that the pipe hose connection can be used without leakage. After 10 minutes later the product produced no leakage occurred.

##### **4.2 Test the effectiveness of flexible pipe hoses using Quality Function Deployment (QFD)**

In this study, data were collected by distributing questionnaires to 20 or more respondents from a user who uses the toilet everyday residence in a private house cleaning processes such as family, relatives and closest friends to try this product hose pipe.

###### **4.2.1 Respondent data using hose pipe**

From the results of the distribution of the survey form to family and close friends can be seen in Table 1 as follows:

**Table 1: Demographic data of respondents**

Data	Items	Total
Gender	Men	6 person (30.0 %)
	Women	14 person (70.0%)
Nation	Malays	19 person (95.0%)
	Others	1 person (5.0%)
Ages	20-29 years	18 person (90.0%)
	50-59 years	2 person (10.0%)
Weight	40-50 kg	4 person
	50-60 kg	6 person
	60-70 kg	2 person
	70-80 kg	4 person
	80-100 kg	4 person
Height	1.50-1.60 cm	10 person
	1.60-1.70 cm	6 person
	1.70-1.90 cm	4 person
Total		20 Respondents

#### 4.2.2 Data Importance Rating

This importance rating data is from the distribution of survey forms that have questions about the design in Part B of each attribute based on each respondent. The questions given to the respondents consisted of 5 questions obtained from the results of the questionnaire.

**Table 2: Value importance rating**

No.	Customer Requirement	Importance Rating
1.	Ergonomic Product Design	4.85
2.	Durable Material	4.9
3.	Convenience in Product Use	4.8
4.	Interesting shapes	4.85
5.	Appropriate Product Size	4.65

The importance of rating there is the highest score value of 4.9 durable materials while the score of 4.85 which is an ergonomic product design and attractive shape and 4.8 facilities in product use it shows that this highest score gets positive feedback or very satisfied hearts of respondents. In addition, the lowest score value is 4.65 which is the appropriate product size, this means that the respondents are not satisfied with the size of this pipe hose and the feedback obtained is that the respondents want to ensure that the size or position of this hose is slightly lower according to the bathroom size.

#### 4.2.3 Respondent Perception Data on Overall Product Use

This data is from the distribution of questionnaires that have questions about the respondents' perception of the overall product use in Part C based on each respondent. The questions given to the respondents consisted of 20 questions obtained from the results of the survey.

**Table 3: Respondent perception data on overall product use**

No.	Perceptions of Respondents	Respondent Perception Value
1.	Are you satisfied with this plumbing hose	4.9
2.	Does this pipe hose not interfere with the cleaning process you are doing	4.65
3.	How do you assess stability this pipe hose	4.55
4.	How do you evaluate the effectiveness of this pipe hose in the concept of cleanliness	4.8
5.	Are you satisfied with the safety features available on this pipe hose	4.75
6.	Is the use of this pipe hose easy to use and customer friendly	4.75
7.	Does the use of this pipe hose increase the level of cleanliness in the bathroom	4.8
8.	Overall, express your satisfaction with the stainless-steel water pipe hose using a flexible spring	4.85

The respondents' survey data on the use of this product, for the highest score value is 4.9 to 4.8 that is, the respondents are very satisfied with the effectiveness of this pipe hose product in improving the level of cleanliness in the bathroom. There also the lowest score value of 4.55 to 4.65 indicates that the respondents are not satisfied with the stability and disrupt the washing process that is being done due to the size of the pipe hose which is slightly higher than the washing place. For the entire survey question data of respondents' perceptions of product use as a whole it was found that all respondents were very satisfied with the pipe hose products they tried.

#### 4.2.4 Technical Requirement

Technical requirements translate the needs of consumers in technical form so that products can be formed directly. In this section there are specific targets to be set that have been determined through customer needs.

**Table 4: Technical requirement**

No.	Customer Requirement	Technical Requirement
1.	Ergonomic Product Design	Spring length Diameter spring Thick Spring
2.	Durable Material	Resistant to Rust
3.	Convenience in Product Use	Simple washing process Safety ensured
4.	Interesting shapes	Addition of holder
5.	Appropriate Product Size	According to the correct specifications



### 4.3 The relationship between the Customer Requirements and Technical Requirements

At this stage the analysis is done on the relationship between user needs and technical needs until it is known whether the user needs to have a strong, moderate or weak relationship with its technical characteristics. A strong relationship is when a particular technical need is a direct interpretation of the user's needs. Meanwhile, the relationship is simple and weak if the technical characteristics are not a direct interpretation of the needs of users.

No.	Customer Requirement	Important Rating	Spring length	Diameter Spring	Thick Spring	Resistant to Rust	Simple washing process	Simple washing process	Addition of holder	According to the correct specifications
			1	2	3	4	5	6	7	8
1.	Ergonomic Product Design	4.85	5	5	5	5	5	5	5	3
2.	Durable Material	4.9	5	5	5	5	3	5	5	3
3.	Convenience in Product Use	4.8	5	5	5	5	5	5	3	5
4.	Interesting shapes	4.85	3	3	5	5	5	5	5	3
5.	Appropriate Product Size	4.65	5	5	5	3	5	5	3	5

**Figure 6: The value of the relationship between consumer needs and technical needs**

#### 4.3.1 Column Weight

Column weight is the process of obtaining information and levels in product design. The weight values of the columns are derived from the multiplication and addition of value assessments with the value of the relationship matrix between user needs and technical requirements. To find out the weight values of a column, use the following formula:

$$\text{Column Weight} = \Sigma (\text{Importance Rating} \times \text{Technical Requirements}) \quad \text{Eq.1}$$

No.	Customer Requirement	Important Rating	Spring length	Diameter Spring	Thick Spring	Resistant to Rust	Simple washing process	Simple washing process	Addition of holder	According to the correct specifications
			1	2	3	4	5	6	7	8
1.	Ergonomic Product Design	4.85	24.25	24.25	24.25	24.25	24.25	24.25	24.25	14.55
2.	Durable Material	4.9	24.5	24.5	24.5	24.5	14.7	24.5	24.5	14.7
3.	Convenience in Product Use	4.8	24	24	24	24	24	24	14.4	24
4.	Interesting shapes	4.85	14.55	14.55	24.25	24.25	24.25	24.25	24.25	14.55
5.	Appropriate Product Size	4.65	23.25	23.25	23.25	13.95	23.25	23.25	13.95	23.25
Column Weight			110.55	110.54	120.25	110.95	110.45	120.25	101.35	91.05

Figure 7: Column weight

#### 4.3.2 Correlation Matrix Service

A correlation matrix is a triangular table used to show the relationship between one technical need and another. The symbols used to indicate the relationship between technical requirements are the symbol (+) indicating a positive correlation and the symbol (×) indicating a negative correlation.

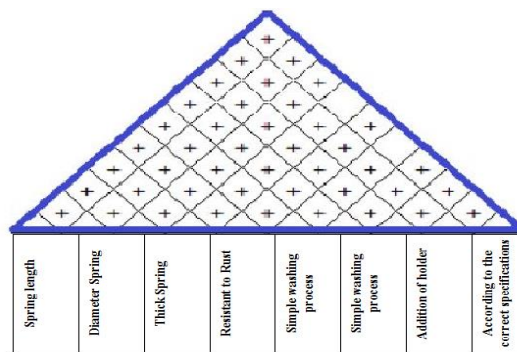


Figure 8: Relationship between technical requirements visible on correlation matrix

#### 4.3.3 House of Quality

The importance of rating respondents gave excellent answers among consumers using an ergonomic product design with a value of 4.85 and technical requirements also have a high value of 5 overall. In addition, the second consumer requirement is that the durable material gets the highest value of 4.9 and the overall value of technical requirements also has a high value of 5 overall. There is the lowest value among all user needs which is a measure that corresponds to the value of 4.65, showing that users do not agree with the existing measurements and get a lot of feedback flexible pipe hose measurements according to the size and area of the bathroom so that the hose can be used as best as possible. Next, the value of technical requirements, namely the length of the spring, the weight of the column weight is 110.55, the diameter of the spring is 110.54, the spring thickness is 120.25, it is resistant to rust 110.95, the easy washing process is 110.45, the safety is guaranteed 120.25, the holder is 101.35 and according to the correct specifications 91.05. From that, there is the lowest value

of 101.35 holder and 91.05 according to the correct specifications that need to be emphasized because the user is not comfortable with the features available on this pipe hose.

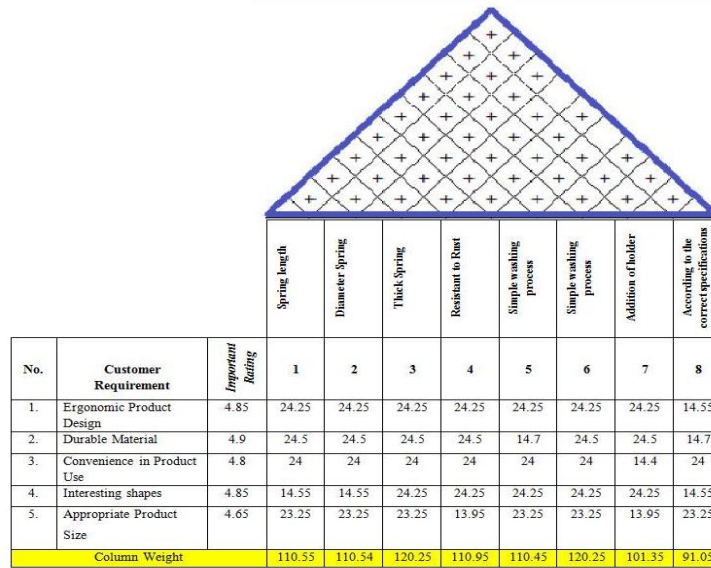


Figure 9: House of quality to evaluate the effectiveness of flexible pipe host products

## 5. Conclusion

Through the results of this study, based on the objectives can be concluded design of stainless-steel water hose pipe using with flexible spring successfully implemented. Therefore, the first objective is to design and produce pipes using flexible pipe hoses. This objective was successfully achieved by designing flexible pipe hoses based on sketches and ideas through observations throughout the use of the toilet. All calculations and details can be generated through the formulas that have been searched.

The second objective is to test the effectiveness of flexible pipe hose design using quality function deployment (QFD) to the products produced is also successfully implemented. To achieve this objective, a leak test was performed for 10 minutes after the installation process was completed. As a result of the leak test it was found that no leak occurred and this test was successful. After that, the questionnaire has been prepared for the review process and distributed to 20 respondents. In addition, this survey also uses the quality function deployment (QFD) and house of quality (HOQ) and the data shows that respondents tend to choose this product and in line with the needs of consumers and technical requirements of the product.

Some suggestions for future improvement of the study, the researcher can continue this study in part F of the house of quality which is the technical response section of quality information evaluation. Therefore, the first and second objectives succeeded in convincing the respondents where this pipe hose product can improve the level of cleanliness in the bathroom and ensure the cleanliness of the bathroom is always maintained and respondents choose this new hose to replace the old hose.

### 5.1 Problems and challenges while producing design stainless steel water pipe hose using with flexible spring

- i. Having problems with the process of finding a flexible spring that found difficult and time consuming for 3 months because pandemic covid-19
- ii. The price of an expensive item such as a spring and others.
- iii. Work processes such as welding had to be done off-campus and finding people to work with because the university was closed for student attendance due to covid-19 safety reasons.

- iv. The installation process had to be done at home with not enough carpentry tools for plumbing work.

## 5.2 Suggestions for improvement

- i. Create a test level of water pressure if the child using it.
- ii. Market this product in every public facility such as in private residential bathrooms, RnR stops, hotels, shopping malls and so on to maintain cleanliness and comfort while in the toilet.
- iii. Make the installation of pipes slightly lower according to the height of the toilet and the user.
- iv. Market and commercialize this product outside so that people can use it more comfortably and the toilet looks more beautiful and tidy.
- v. Improve the product by coating it with attractive colors.

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