Quality Control and House Of Quality Analysis Process of the Product of the Petroleum Pump in Pt. XYZ

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Abstract

PT. XYZ is a company located on Jalan Bungur Besar, West Jakarta which has a factory in the Tangerang area that produces oil pumps that have been operating since 1986. In the production process, PT. XYZ, one of the losses experienced by the company is a decrease in quality to produce a product. Then, the decline in product quality includes defects in the product caused by several factors that require quality control in production. Quality control of petroleum pump products carried out at PT. XYZ is divided into several parts. The methods used in analyzing and solving porduct defect problems at PT. XYZ use Pareto diagrams, proportion control charts, fishbone diagrams, and the House of Quality method. By analyzing and solving product defect problems, defect reduction can be made by identifying, analyzing, and providing suggestions for improvement so that quality and quality standards are maintained so that product quality is maintained.

Keywords
Quality Control, Product Defect, Control Map, Fishbone Diagram, House of Quality.

1. Introduction

The manufacturing company is one type of business entity engaged in assembling raw materials to be processed into certain products. Every company will continue to improve the quality of its products in all aspects. In this production industry, the quality shown by the company must go through several tests so that the ability of its products can be used safely, efficiently, and efficiently.

PT. XYZ is an industrial company that has produced petroleum pump products since its establishment on 5th December 1986 with has its head office at Jl. Bungur Besar, Central Jakarta and has a factory located in the Tangerang area. The projects carried out by PT. XYZ are manufacturing petroleum pump or repairing this petroleum pump. Before carrying out a large project, the company first enters into an agreement between its customers which describes the demand for this pump, such as the depth required to enter this pump product into the well later.

Therefore, like many other manufacturing companies, PT. XYZ, which is a company engaged in the production of petroleum pumps, is trying to improve its quality to meet the desired target. In conducting this research, to find out the profile of the company that will be studied, it is continued by looking directly at the product process, the quality control process applied in the company, and analyzing directly, especially on the quality control that occurs at PT. XYZ.

2. Literature Review

This literature study was conducted with the aim if reviewing existing problems and presenting solutions with some concepts that has been considered.

2.1 Pareto Charts

According to Gasperz (1998), problems that occur the most are shown by the first highest bar graph and are placed on the far left until the problems that occur the least are shown by the last, lowest bar graph and are placed on the far right.

2.2 Proportion Control Map

This map aims to provide control over the quality of production owned by the company so that it can produce quality products. On the other hand, the control chart also provides information regarding the proportion of defects that have passed the upper control limit or lower control limit.

2.3 *Fishbone* Diagram

Fishbone diagram or cause-and-effect diagram is one method of quality control where this diagram shows an impact or consequence of a problem, with various causes. The main purpose of using a fishbone diagram is to graphically describe the relationship between cause (causative factors) and effect (quality characteristics). Cause-and-effect diagrams are also known as fishbone diagrams and are useful for showing the main factors that affect the quality and impact on the problem being studied (Haizer and Render, 2009).

2.4 House of Quality

The house of quality (HOQ) matrix is the most familiar form of QFD representation. This matrix consists of 2 main parts, the horizontal part of the matrix containing information related to consumers and called the customer table. The vertical part and the matrix containing technical information in response to consumer input and called the technical table. House Of Quality (HOQ) translates consumer needs, market research results, and benchmarking data to priority targets (Suprihatini, 2009). House of Quality is composed of a combination of the level of consumer interest, customer satisfaction, company targets, and the value of the level of importance by the consumer.

All of the methods in this research support the Quality Control (QC) activities to have a good process and good quality products for the companies. The 4 QC methods have been chosen for this research based on the need and requirements of our studies.

3. Methods

The research begins with a literature review to identify and find out various problems or needs desired by customers in products that will be ordered later. By identifying a need, the product to be designed can be tailored to the customer's needs. From this step, you will get a product according to what the customer wants later. After conducting a literature review, it is continued by analyzing several aspects to state that the feasibility of a product in terms of defects no longer exists or other defects. The next stage is data collection, where this data results form the identification of needs and scale of interest. Then, the existing data was tested using Pareto diagram analysis, proportion map, fishbone, and House of Quality. After analyzing the processed data, the last conclusion is the results of the analysis and knowing the feasibility of the product. The flowchart of the methods can be seen in Figure 1.

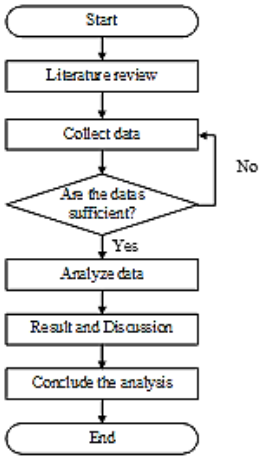


Figure 1. Methods

4. Data Collection

In the process of making pumps from PT. XYZ cannot be separated from errors that cause product defects. In the process, there are still components that have a shape that is not as desired. Defects in the manufacturing process can be caused by several factors including humans, machines, methods, measurements, the environment, and raw materials. The following are data obtained during practical work at PT. XYZ regarding the number of products and defects that occur in the products contained in this company in 2020, can be seen in table 1 :

Table 1. Data Collection

No.	Network Description	Unstable	Leakage	Unachieved	Total
1	Pump	11	9	8	28
2	Motor	8	11	9	28
3	Protector	6	9	6	21
4	Gas Separator	6	8	7	21
5	MLE	6	8	6	20
6	Cable	6	7	5	18
	Total				**136**

After collecting data, had unstable pump pressure defects, leaks, and the pressure pumps did not reach the target, which was 136 units.

5. Results and Discussion

To reduce the occurrence of defects in the manufacturing process, the company PT. XYZ will be analyzed by the author using the Pareto diagram method, proportion control chart (p-chart), fishbone diagram, and House of Quality.

5.1 Pareto Chart

The tool that will be used in the quality control process is to use a Pareto diagram. Pareto diagrams were introduced by an expert, Alfredo Pareto (1848-1923). This diagram contains the bars arranged in order of the number of events, which will be arranged from the highest number to the fewest.

Table 2. Calculation Results

No.	*Defect*	Number of Defects	Cumulative Frequency	Percentage	Cumulative
1	Leakage	52	52	38%	38%
2	Unstable	43	95	32%	70%
3	Unachived	41	136	30%	100%
Total		**136**			

After calculating the Pareto diagram, it is continued by analyzing the Pareto diagram of product defects at PT. XYZ . The following is a Pareto diagram of PT. XYZ can be seen in Figure 2.

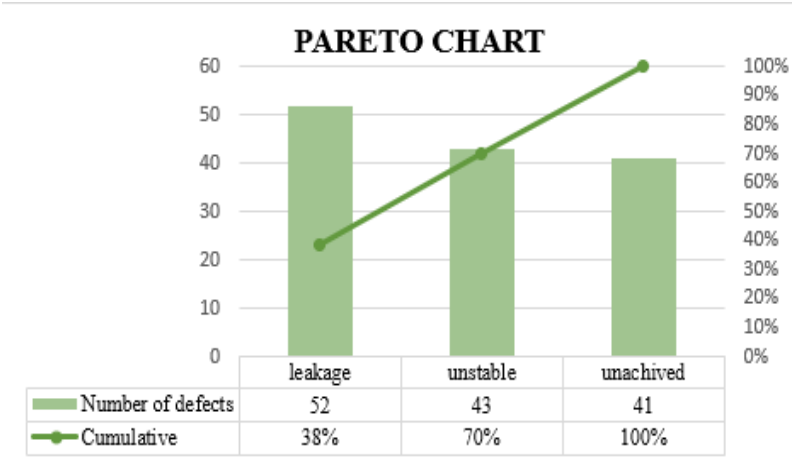


Figure 2. Pareto Chart

Based on the Pareto diagram of defects in 2020 at PT. XYZ , it can be concluded that the most common type of product defect found in the frequent occurrence of leaks in the pump with a percentage of 38%. Next, unstable pressure product defects with a percentage of 32%. The least defects are product defects in the form of extracting water from the earth's bowels which is not achieved with a percentage of 30%.

Therefore, because the number of product defects reaches a very large number compared to other defects. Types defects in the form of defects in leaks need to be used as the main focus and priority so that appropriate handling can be carried out to reduce defects in the future.

5.2 Proportion Control Map

One of the tools used in the company's quality control method is to use a control chart. This map aims to provide control over the quality of production owned by the company so that it can produce quality products.

Table 3. Proportion Pump

Month	*Defect*	Number of Products Checked	Proporsi	UCL	CL	LCL	Unstable	Leakage	Unachived
ESP PUMP									
1	4	15	0,266667	0,542	0,220	-0,101	2	1	1
2	1	15	0,06667	0,542	0,220	-0,101	0	1	0
3	3	10	0,3	0,614	0,220	-0,173	1	1	1
4	2	6	0,3333	0,728	0,220	-0,287	0	1	1
5	2	12	0,1667	0,579	0,220	-0,139	1	1	0
6	2	7	0,2829	0,691	0,220	-0,250	1	0	1
7	5	12	0,4167	0,579	0,220	-0,139	2	1	2
8	3	12	0,25	0,579	0,220	-0,139	2	1	0
9	1	9	0,1111	0,635	0,220	-0,194	1	0	0
10	1	10	0,1	0,614	0,220	-0,173	0	1	0
11	2	9	0,2222	0,635	0,220	-0,194	1	1	0
12	2	10	0,2	0,614	0,220	-0,173	0	0	2

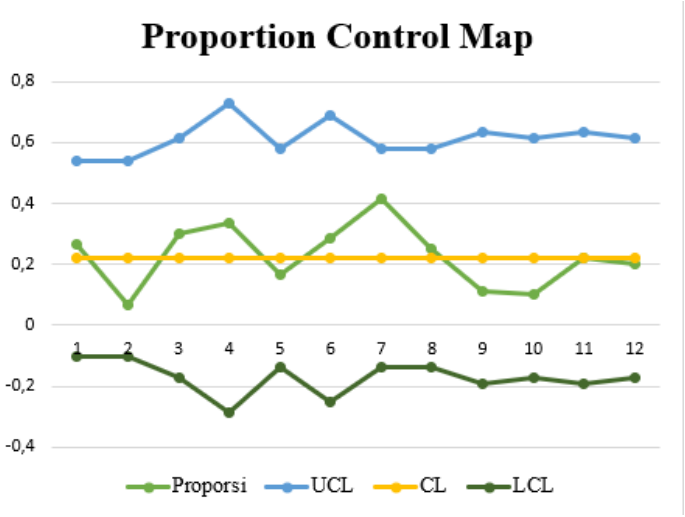


Figure 3. Proportion Control Map

The following is the formula used in the proportion control chart diagram at PT.XYZ, among others, are as follows:

Proportion $= \frac{number\ of\ defective\ products}{number\ of\ products\ inspected} = \frac{x}{n}$

Centerline (CL) $= \bar{p} = \frac{total\ number\ of\ defective\ products}{total\ number\ of\ products\ inspected} = \frac{\sum x}{\sum n}$

Upper Control Limit (UCL) $= \bar{p} + 3\sqrt{\frac{\bar{p}\,(1-\bar{p})}{n}}$

Lower Control Limit (UCL) $= \bar{p} - 3\sqrt{\frac{\bar{p}\,(1-\bar{p})}{n}}$

Description:

P = Propotion	CL = Centerline
x = number of defective products	UCL = Upper Control Limit
n = number of products inspected	LCL = Lower Control Limit

The following is an example of the calculation of the ESP-Pump product in the 1st data used in the proportion control chart diagram (P-Chart) at PT. XYZ include the following:

Proportion $= \frac{number\ of\ defective\ products}{number\ of\ products\ inspected}$

$= \frac{4}{15}$

$= 0{,}266667$

5.3 *Fishbone* Diagram

The following is a fishbone diagram analysis on each type of product defect at PT. XYZ includes the following:

a. Unstable Pump Pressure

The following is a fishbone diagram analysis of hazardous products which can be seen in Figure 4.

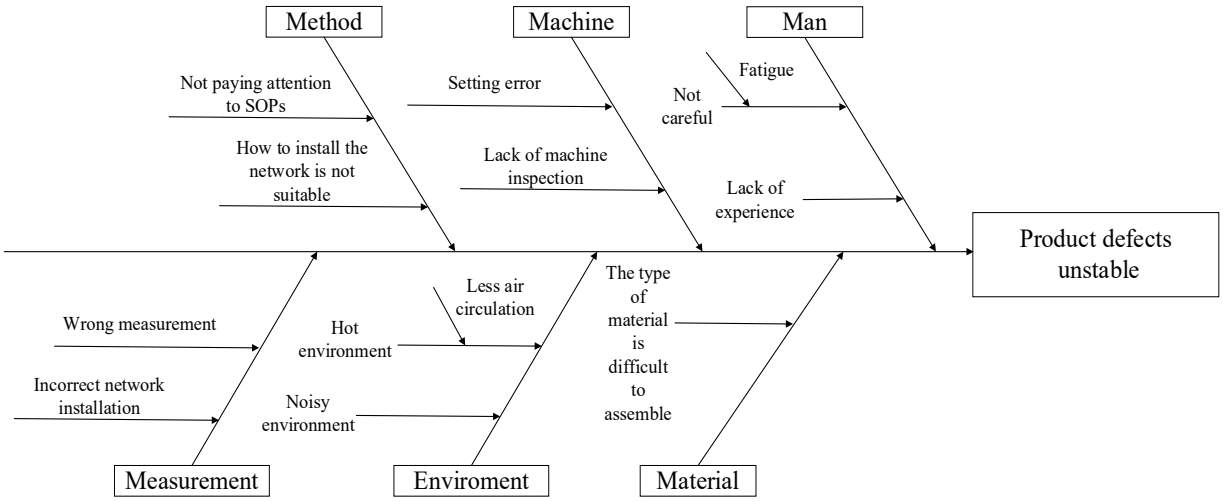


Figure 4. Unstable Pump Pressure Fishbone Diagram

b. Pump Leak
The following is an analysis of a fishbone diagram on a product that has a leak, which can be seen in Figure 5.

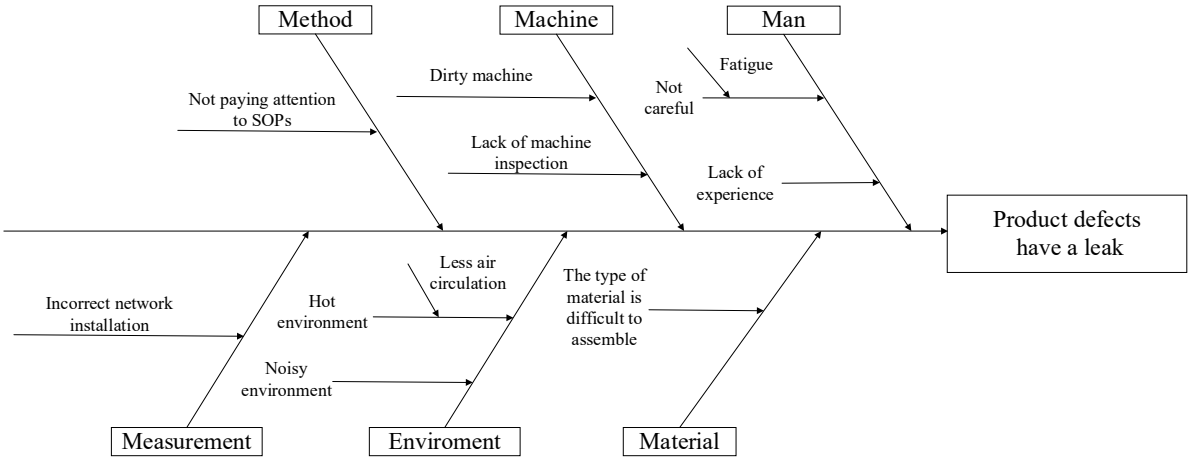


Figure 5. Pump Leak Fishbone Diagram

c. Pump not Reached
The following is a fishbone diagram analysis on a product whose pressure is not achieved, as shown in Figure 6.

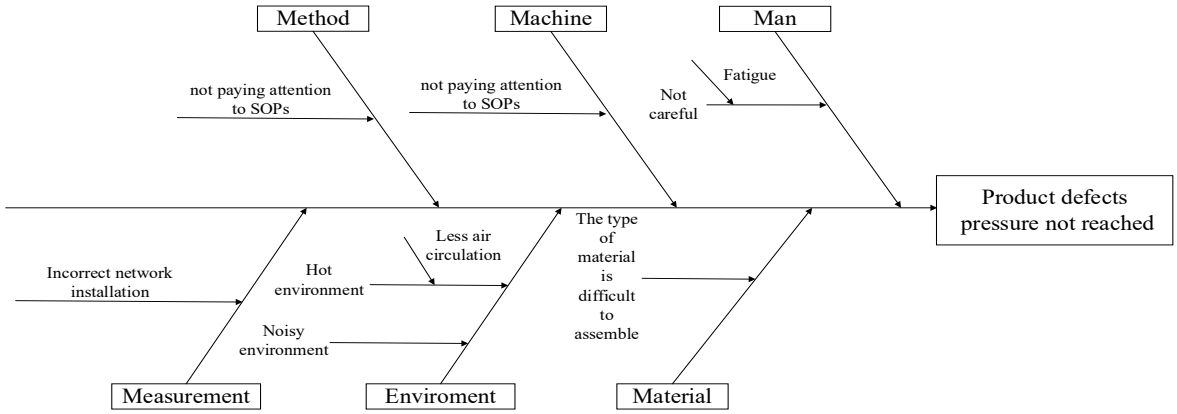


Figure 6. Pump not Reached Fishone Diagram

5.4 House of Quality

5.4.1 Characteristics of Respondents

In this study, the main data collection method used a questionnaire of as many as five people consisting of managers, HRD, and operators from PT. XYZ. Based on the results, all questionnaires have been filled in according to their function.

5.4.2 Voice of Customer

Identification of user needs is made by using a random questionnaire to workers. In knowing its importance, the author sets out several questions that several workers will ask to vote to consist of 2 HRD, one manager, and two operators. The following are questions asked to be used as questions on the questionnaire, as shown in table 4.

Table 4. Voice of Customer

No.	Questions
1.	Safety in product use
2.	Designed with strong materials
3.	Pressure speed in product
4.	Product price is affordable

5.4.3 Quality Function Deployment (QFD)

a. Matrix House of Quality (HOQ) "WHAT"

Matrix House of Quality (HoQ) is the most familiar form of QFD representation. This matrix consists of two main parts, the horizontal part of the matrix contains information related to customers and is called the customer table. The vertical part and the matrix containing technical information in response to consumer input and called the technical table. The two main aspects of the House of Quality Matrix are "what" and "how". In the house of quality table (what) they must fill a requirement, which makes a list according to their priority in the order of 1 to 4 which is placed or filled in the weight / importance table. Table 5 is the result of the order based on consumer needs.

Table 5. "WHAT"

Weight/Importance Row	*WHAT*
1	Safety
3	Strong Material
2	Pressure Speed
4	Price
10	**Total**

b. Level of Importance

Filling in the level of importance is by filling the level of importance:

Table 6. Level of Importance

Average	*Relative Weight Row*	*Weight/Importance Row*	*WHAT*
1	10	1,0	Safety
1	30	3,0	Strong Material
1	20	2,0	Pressure Speed
1	40	4,0	Price
Row		10	**Total**

Determine relative weight row (RWR) :

RWR = WIR per line : Total WIR X 100

Description:
RWR = *Relative Weight Row*
WIR = *Weight Importance Row*

After determining *relative weight row*, next determine *average* with formula:

Average = RWR : WIR

Description:
RWR = Relative Weight Row
WIR = Weight/Importance Row

c. Voice of Organization "HOWS"

One way to do this is to provide solutions to what consumers need.

Table 7. "HOWS"

HOW				
Using the highest quality materials	An affordable price	Products delivered according to the agreement	Product completion on time	Safe packaging during delivery

From the table above, it can be seen how PT. XYZ will carry out the settlement to what consumers need. At this stage, the relationship between technical aspects in the product requirements matrix will be determined.

d. Relationship Matrix

This part of the relationship matrix provides a set of relationship symbols form consumers need and provides solutions to what consumers need. At the time of giving the symbol this relationship is determined by a certain pre-determined score. The symbol that will be used in its technical analysis with consumer needs is marked with (●) for as strong relationship with a value of 9. the sign with a symbol (○) is for a moderate relationship. sign with symbol (Δ) for relationship small value 1.

Table 8. Relationship Matrix

Average	*Relative Weight Row*	*Weight/ Importance Row*	*What*	*How*				
				Using the highest quality materials	**An affordable price**	**Products delivered according to the agreement**	**Product completion on time**	***Safe packaging during delivery***
1	10	1,0	Safety	●	△	●	△	●
1	30	3,0	Strong Material	●	●	●	△	○
1	20	2,0	Pressure Speed	●	○	●	○	△
1	40	4,0	Price	●	●	○	△	△
Row		10,0						

e. Importance Matrix

In this section the existing values can be seen, where the highest value must be prioritized better to improve product quality at PT. XYZ. In determining the importance matrix, several steps need to be done, the weight importance column and the relative weight column.

Table 9. Importance Matrix

Average	*Relative Weight Row*	*Weight/ Importance Row*	*What*	*How*				
				Using the highest quality materials	**An affordable price**	**Products delivered according to the agreement**	**Product completion on time**	***Safe packaging during delivery***
1	10	1	Safety	9	1	9	1	9
1	30	3	Strong Material	27	27	27	3	9
1	20	2	Pressure Speed	18	9	18	6	2
1	40	4	Price	36	36	12	4	4
Row		10	Total	90	73	66	14	24
Max Relationship Value in Coloum				9	9	9	9	9
Weight/Relationship Column				17,1	73	30,9	14	24
Relative Weight Coloumn				33,70%	27,34%	24,71%	5,24%	8,98%

Formula *weight relationship Importance Column*

WIC = Average per line x Total Row

Description:
WIC = *Weight Importance Column*
Average = average value per line
Total Row = the number of each item in the table *HOW*

Formula *relative weight column*

$$RWC = \frac{\text{Total } Row \text{ per line}}{\text{Total Row all}} \; x \; 100\%$$

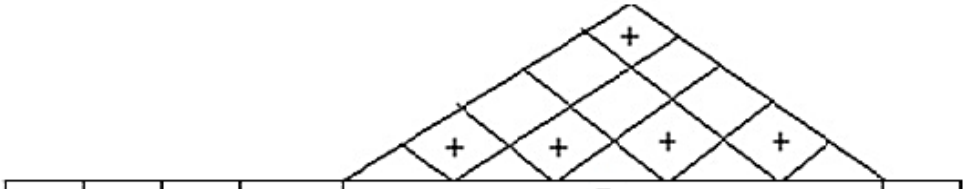
Description:
RWC = *Relative Weight Column*
Total *ROW* = the number of each item in the table *HOW*
Total *ROW* all = total number of items in the table *HOW*

f. Technical Correlation

The next step of house quality is to fill in the matrix section on the roof or roof. The section in this characteristic contains correlations between items that indicate an influence on decision making.
Several forms of matrices are combined together, where each matrix provides different specific information. By combining these matrices into a single unit, a relationship will be obtained between

one information and another regarding the attributes or quality characteristics of a product. The product development process begins with the formation of a product planning matrix, called the House of Quality with several spaces.

After calculating the value of the importance level of the House of Quality, the highest value technical parameter was obtained using the material with the best quality (33.70%). Price so that it greatly affects the final product of this pump. If the process of making this pump is not good, then the results of this pump product will not be good and even something undesirable will happen. And the smallest value correlation is the timely completion of the product (5.24%). This condition happened because the correlation with the attributes listed must be in as much detail as possible, so that repeated checks become the obstacle. Then, regarding the placement of numbers in one of the examples of the security column with rows using the highest quality materials, it is a possible relationship between consumer and technical needs. The picture can be seen in figure 7.



Average	*Relative Weight Row*	*Weight/ Importance Row*	*What*	*How*					
				Using the highest quality materials	**An affordable price**	**Products delivered according to the agreement**	**Product completion on time**	***Safe packaging during delivery***	
1	10	1	Safety	9	1	9	1	9	
1	30	3	Strong Material	27	27	27	3	9	
1	20	2	Pressure Speed	18	9	18	6	2	
1	40	4	Price	36	36	12	4	4	
Row		10	Total	90	73	66	14	24	267
Max Relationship Value in Coloum				9	9	9	9	9	
Weight/Relationship Column				17,1	73	30,9	14	24	
Relative Weight Coloumn				33,70%	27,34%	24,71%	5,24%	8,98%	

Figure 7. House of Quality

6. Conclusion

As a result of this research, it can be concluded that:

1. Analysis was conducted to determine defects in PT. XYZ using Pareto diagrams, proportion control charts, fishbone diagrams, and House of Quality.
2. Products that have a high defect rate are the pump leaks (38%), the pressure is not stable (32%), and the pump is not pumped as desired (30%).
3. Types of leakage defects, unstable pressure, and inappropriate pumping are the dominant types of defects in the circuit, causing losses in cost, time, and process efficiency.
4. Based on the data on HoQ, the best quality material is the main thing to fulfill. The pump must be made of the best quality material.

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Biography

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