

# The Product Quality Improvement to a New Product's Survey in ABCtronics

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## ABSTRACT

Customer satisfaction and product quality play important roles in the company's product sales. Higher product quality and customer confidence promote better corporate governance. ABCtronics has declined in product sales in recent years and received frequent complaints from customers. In order to find out the specific reasons and seek better improvement plans, the company conducted customer questionnaire surveys, collected relevant data, which can conduct robustness test and established multiple linear regression models more reliable to discover relevant factors that affecting customer satisfaction and the company's product sales. Through the test results, which concluded that both overall market demand (in millions) and price per chip (in \$) are negatively correlated with ABCtronics' sales volume. However, the economic condition shows a positive relationship with it. In conclusion, it is significant to propose relevant strategies and methods for the company to improve product quality and enhance customer loyalty.

**Keywords:** *ABCtronics' sales volume, Customer questionnaire surveys, Robustness test, Multiple linear regression models*

## 1. INTRODUCTION

Selcen Ozturkcan et al. [1] pointed that in many industries, the provision of quality services, customer satisfaction and customer loyalty has become the most important parameters. Customer satisfaction is the guiding principle of the company's future development and product quality, and its prominent role cannot be ignored. In recent years, due to the continuous improvement of customers' status in the whole consumer service, many products with defects have been "abandoned". Some companies that have not adopted any response policies will quickly expose their own disadvantages, be eliminated in the competition, and the company's economic benefits will continue to decline, and eventually even withdraw from the market. Therefore, customer service requirements for products are constantly changing and upgrading, and it is particularly important to understand customer needs in time. Mayuram S. Krishnan [2] pointed out that the evaluation of products by customers is beneficial to the development of enterprises in line with the times and is the main driving force. Therefore, regular research on

customer satisfaction can effectively seek a better development plan for the company.

As ABCtronics has experienced frequent sales volume drop and customer complaints during its development in recent years, the research motivation of this paper is to better understand customer satisfaction, find out the root cause of product problems from the customers' essential needs, timely improve the products' own problems, and promote the timely adjustment of the company's management policies, so as to better adapt to the expectations of the product market, restore customer loyalty, regain the company's market share, and provide important support for promoting the company's economic development.

Therefore, in order to help this company increase sales and profits, we must pay attention to product quality and customer satisfaction. Customer satisfaction plays an important role in improving a company's sales and profits. Singh [3] pointed that a satisfied customer is the foundation of any successful business, because when a customer is satisfied with your product, he will buy it again and build brand loyalty. Hamzah [4] said in the study that customer satisfaction plays an important role in

the survival and sustainable development of enterprises. No matter how big a company or organization is, it needs to maintain the number of customers in a stable state, so as to ensure the current market share. In addition, we can also take the level and trend of customer satisfaction of banks as an example. Eklof et al. [5] pointed out in their study that customer satisfaction and loyalty play a positive role in the profitability of banks. It can be seen that if a company or enterprise wants to have sustained and rising profit development and sales, improving customer satisfaction is an important factor. And the quality of products cannot be ignored. Product quality will directly affect customer loyalty. Jahanshahi et al. [6] studied the importance of product quality to customer satisfaction and found that most loyal customers are those who use high-quality products. In addition, Suchanek et al. [7] also pointed out that based on customer requirements, the company must constantly improve product quality to ensure customer satisfaction. It can be seen that the two relations complement each other and jointly affect the sales volume and future development of the company.

Also, in this study, we also use multiple regression analysis to predict the factors that affect the company's sales volume and profit. We know that the multiple linear regression model can evaluate and analyze multiple independent variables, and many scholars use this model to predict the relationship between various factors, so as to draw conclusions. For example, Uyanık and Güler [8] went through the analysis of 240 undergraduate students in the autumn semester in the comprehensive performance of various subjects and the overall quality test to obtain the final results of multiple linear regression equation for KPSS score estimation. Sousa et al. [9] have used multiple linear regression to predict the ozone concentration in ambient air because it can provide early warning and help people raise awareness. Mistry and Bora [10] evaluated the possible effects of three climate variables (temperature, precipitation, and solar radiation) on spring wheat yields in North Dakota by building a multiple regression model. Camdevyren et al. [11] used this method to analyze and study the relationship between chlorophyll-a and 16 chemical, physical and biological water quality variables in a reservoir in Turkey, and successfully predicted the level of chlorophyll-a in the reservoir. And Wicki and Parlow [12] also used a multiple linear regression model to analyze the observed dependence of land surface temperature on land cover. It can be seen that the use of this analysis method can better predict the relationship between multiple independent variables and dependent variables.

In this article, we find out the key factors causing sales to decrease, and come up with a new method of product quality inspection method, aiming at improving customer satisfactions thus improving the sales level and profit of the firm. We respectively analyse the influence of 4 factors (product quality, appearance, practicability,

and durability) on customer satisfactions, and find out that the key factor that affects customer satisfaction is product quality. Therefore, we find the new quality inspection method, ICTM, to detect the product quality. We then find that the ICTM method has a higher detection rate when compared with the old method (LATM) and can identify the defective products more precisely, so that send them back for repair. Finally, we collect the data in recent years of the firm and do the linear regression analysis, which helps the firm stop decreasing sales volume.

The organizational structure of the remaining part of the paper is as follows: Section 2 describes the problems that the company was encountering; Section 3 conducts a stability test through a questionnaire survey and constructs a multiple linear regression analysis model to draw specific relationship conclusions. The last part summarizes the explanation and summarizes the relevant conclusions.

## **2. PROBLEM DESCRIPTION**

ABCtronics, as a semiconductor manufacturing company, was affected by the economic crisis in 2008-2009, causing its own economic downturn and slow development of the company. Despite the continuous recovery of the market economy and further expansion of the market in 2010, compared with the sales volume of the previous year, ABCtronics did not meet reasonable expectations. During this period, the company received many consumer reports, and too much negative news made the loyalty of consumers decrease. Some consumers chose to purchase other better products, and to a large extent, it also affected the attitude of XYZsoft, which is the largest customer of ABCtronics.

In order to find out the root cause of the problem, more accurately understand the core needs of consumers, improve product quality, and help enterprises to obtain a core position in the product and consumer market, therefore, the purpose of this study is to propose relevant methods for improving product quality and testing through the use of questionnaires, and draw relevant conclusions based on stability testing and regression model construction, so that the management of the company can timely identify the defects existing in the company's products, re-formulate relevant product strategies, reasonably price the products, and finally re-launch the improved products into the market to promote the recovery of consumer confidence.

Therefore, we will conduct research and analysis through the following process. First of all, we describe the problem, briefly explain the current situation of the firm and the main problems it is facing. Moreover, we elaborate on three issues including reduced customer loyalty, reduced product quality and the reduced sales volume. We analyse these three problems and then find out solutions by using the questionnaire, stability testing

and multilinear regression model. Finally, we help the firm correct its methods and strategies in time and improve product quality and customer satisfaction. In

addition, the whole research process of this paper will be described in Figure 1.

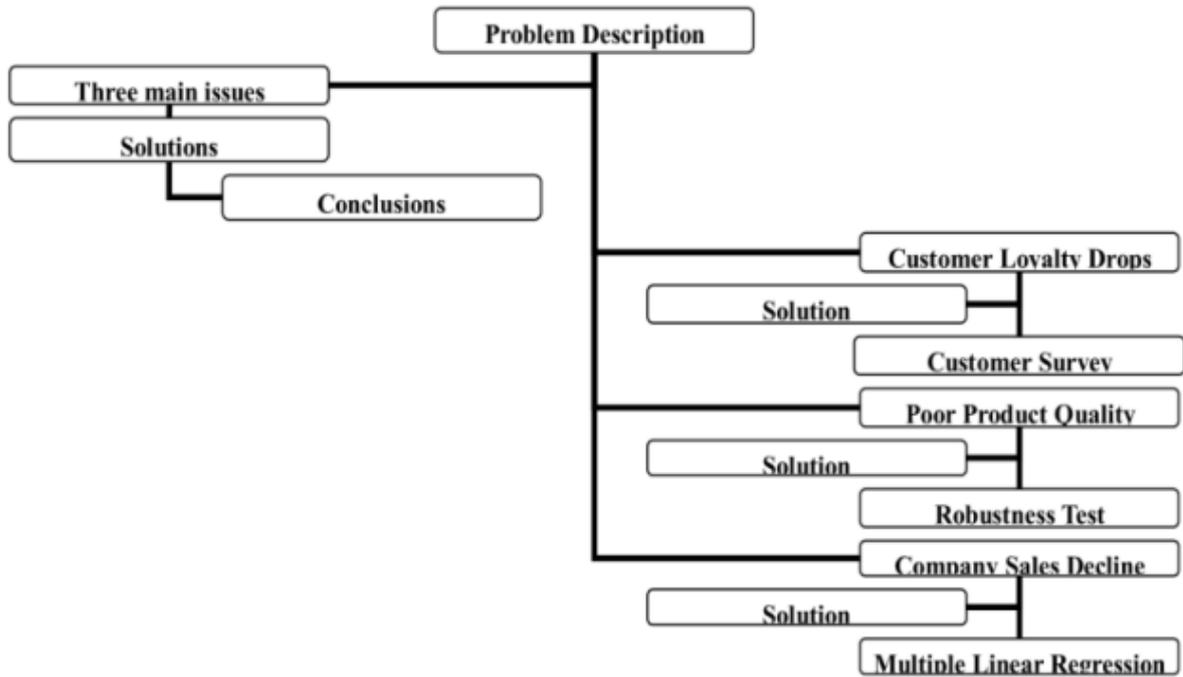


Figure1. The whole research process

### 3. METHOD AND ANALYSIS

#### 3.1 The Questionnaire Survey

ABCtronics is a semiconductor manufacturer, and as a middle-size enterprise, is highly affected by the cyclical

demand pattern, facing huge market demand and focused extensively. Thus, we evaluate the product from 4 aspects, including product quality, appearance, practicability, and durability, and distribute the questionnaires to a random sample of 40 customers. The result of the survey is shown below in Table 1.

Table 1. Custer Score Sheet

Sl. No.	Customer name	Customer score	Range
1	Customer A	79	Needs improvement
2	Customer B	56	Needs improvement
3	Customer C	33	Needs improvement
4	Customer D	79	Needs improvement
5	Customer E	66	Needs improvement
6	Customer F	49	Needs improvement
7	Customer G	47	Needs improvement
8	Customer H	34	Needs improvement
9	Customer I	88	Good

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10	Customer G	77	Needs improvement
11	Customer K	67	Needs improvement
12	Customer L	51	Needs improvement
13	Customer M	53	Needs improvement
14	Customer N	74	Needs improvement
15	Customer O	85	Good
16	Customer P	56	Needs improvement
17	Customer Q	39	Needs improvement
18	Customer R	51	Needs improvement
19	Customer S	26	Needs improvement
20	Customer T	43	Needs improvement
21	Customer U	77	Needs improvement
22	Customer V	97	Good
23	Customer W	73	Needs improvement
24	Customer X	57	Needs improvement
25	Customer Y	66	Needs improvement
26	Customer Z	45	Needs improvement
27	Customer AA	28	Needs improvement
28	Customer AB	33	Needs improvement
29	Customer AC	56	Needs improvement
30	Customer AD	68	Needs improvement
31	Customer AE	32	Needs improvement
32	Customer AF	93	Good
33	Customer AG	60	Needs improvement
34	Customer AH	29	Needs improvement
35	Customer AI	41	Needs improvement
36	Customer AJ	42	Needs improvement
37	Customer AK	72	Needs improvement
38	Customer AL	48	Needs improvement

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39	Customer AM	59	Needs improvement
40	Customer AN	47	Needs improvement

Note: Customer Score Range is defined as follows—Below 80: Needs improvement, 80-100: Good

Through the customer feedback analysis, it is found that only 10% of people are satisfied with the product, while the remaining 90% are not. Besides, we also used

Minitab for descriptive statistical analysis and obtained the following Table 2.

**Table 2.** Descriptive Statistics Analysis results

Descriptive Statistics: Customer score							
Variable	Range	Mean	SEMean	StDev	Minimum	Medium	Maximum
Customer Score	Good	90.75	2.66	5.32	85.00	90.50	97.00
	Needs Improvement	53.14	2.65	15.92	26.00	52.00	79.00

Through the above statistical analysis, we know that the mean of good customer satisfaction is 90.75, while the mean value that needs to be improved is just 53.14. Such a large difference makes the company have to take measures to improve customer satisfaction. It requires the company to strictly monitor the product quality and improve the production utilization rate when producing and testing the product IC chips.

**3.2 The Method of Improving Product Quality Inspection**

The company currently use the Lot Acceptance Testing Method (LATM) to detect defective chips. LATM method requires that the automatic machine randomly draw 25 samples from 500 chips, without replacement, which is similar to sampling without replacement. The probability of every sample to be drawn is different, because the population decreases by one every time.

Suppose that the probability of a chip to be defective is 10% and use LATM method to do the sampling investigation of the sample, thus test the detection rate on defective chips. Let x be the number of detective products in the 25 samples.

**Table 3.** Cumulative Distribution Function results by using LATM

Cumulative Distribution Function	
Hypergeometric with N = 500, M = 50, and n = 25	
x	P(X ≤ x)
0	0.263594

$P(x <= 1) = 0.263594$ , from which we can know that the probability of detecting a defective IC chip is  $1 - 0.263594 = 0.736406$ .

However, due to the backward detection method, many products have been put into the market before reaching the standard. So, they have received many customer complaints and caused the dissatisfaction of most consumers. To solve this problem, the company put forward a new product quality testing method.

Quality and reliability team (QRT) has proposed a new quality testing method to the company – Individual Chip Testing Method (ICTM). This method requires drawing 25 integrated IC chips from 500 chips, with replacement. If there is a defective chip found, it should be immediately repaired. This detection method is similar to sampling with replacement. We use the hypothesis to calculate the probability and the result is shown below in Table 4.

**Table 4.** Cumulative Distribution Function results by using ICTM

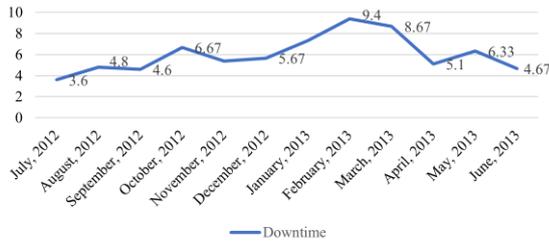
Cumulative Distribution Function	
Binomial with n = 25 and p = 0.1	
x	P(X ≤ x)
0	0.0717898

$P(x < 0) = 0.0717898$ , so we know that the probability of detecting a defective chip is  $1 - 0.0717898 = 0.9282102$  (92.82%)

By comparing the two probabilities, we can see that the detection rate of ICTM is higher than LAMT. In addition, we noticed that the second method can directly rework the defective IC chip when it is detected. In other words, with the second method, we have a higher detection rate, we get a higher quality chip, and the company gets fewer customer complaints.

### 3.3 Robustness Test

The company have experimented with the new product again in order to draw more accurate conclusions. We have measured product downtime for each month of the year from July 2012 to June 2013. Because equipment downtime is a concern for semiconductor companies, minimizing downtime leads to increased operational efficiency. The statistical data are shown in Figure 2.



**Figure 2.** Data on monthly downtime of ion implantation (for one year)

As shown in the statistics above, the average downtime of the equipment is only 6 hours, which helps the company to improve product efficiency, thus improving customer satisfaction.

### 3.4 Establishment of Multiple Linear Regression Model

The following summarizes the relevant data obtained through the overall market demand, economic situation, ABCtronics' sales volume and product per chip. The specific situation is shown in Table 5.

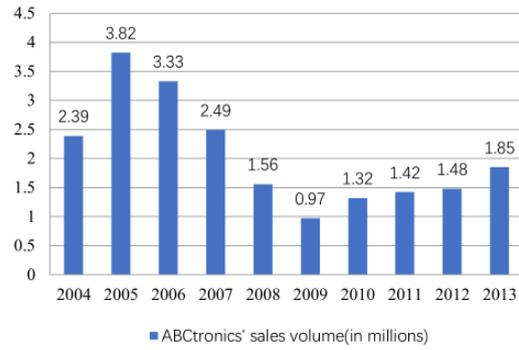
**Table 5.** Statistical table of maximum value, minimum value and mean value of each variable

Type	ABCtronics' sales volume(in millions)	Overall market demand(in millions)	Price per chip (in \$)	Economic condition*
Maximum	3.82	332	1.368	/
Minimum	0.97	93	0.832	/
Mean	2.063	213.2	1.1345	/

Note: Economic condition\* : 1 signifies favorable market condition and 0 signifies otherwise.

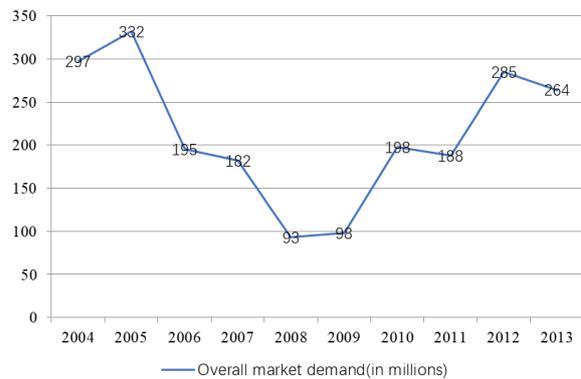
It can be seen from the above table that the maximum and minimum sales volume of the company is 3.82 million and 0.97 million respectively, and the mean is 2.063 million. The maximum total market demand is 332 million, while the minimum is less than 100 million, and the average of the overall market is 213.2 million. According to this information, which can be seen that whether it is the sales volume of the entire market or the sales volume of the ABCtronics company, in recent years, the sales gap has been more obvious, and the market has fluctuated greatly. In addition, for the company's product pricing, the gap is also quite

prominent. The maximum and minimum product unit prices are \$1.368 and \$0.832, respectively, with an average price is \$1.1345. Thus, we understand that the product price between the company's sales volume and overall market demand probably have a strong and specific relationship.



**Figure 3.** ABCtronics' sales volume (2004-2013)

According to the collection of sales volume of ABCtronics from 2004 to 2013, Figure 3 was drawn. From this figure, it can be clearly seen that due to both the good product quality and the corporate promotion, the ABCtronics' sales volume was 2.39 million in 2004 and reached a maximum of 3.82 million in 2005. However, after that time, product quality has become unstable and customer confidence has declined. As a result, product sales have also fallen sharply. By 2009, the company's sales were only 0.97 million, so it can be seen that the company's product sales are facing a huge crisis. Following continuous improvement, the company's sales volume has grown slowly since 2009, but it is still on a downward trend compared to the first few years. Therefore, it is particularly important to further improve products and reshape consumer confidence.



**Figure 4.** The condition of overall market demand (2004-2013)

From the schematic diagram of the entire market demand in Figure 4, it can be found that the global market demand for products fluctuates greatly. In 2004, because the rapid development of the global economy, and

diversified global exchanges promoted the continuous expansion of the demand for this product, which increased from 297 million in 2004 to the largest 332million in 2005. Since then, it continued to drop to the lowest, and did not exceed 100 million for between 2008 and 2009, which occupied 93million and 98million respectively, after that, the demand rebounded continuously, which reached the highest point is 285million since 2009.

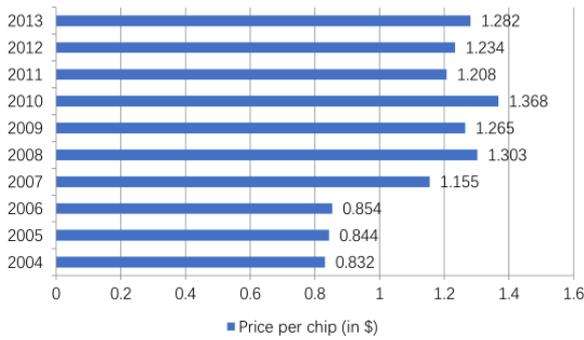


Figure 5. Price per chip of ABCtronics' product

Finally, according to Figure 5, the company's product unit price can be found that the company's product price has risen overall, from \$0.832 in 2004 to \$1.282 in 2013. The product prices have stabilized at around \$0.8 in the first three years. Afterwards, due to the large market demand in 2007, the demand exceeds supply. Therefore, the product prices have risen significantly at this time, from \$1.155 to a rapid increase, and the company's product unit price reached the maximum value of \$1.368 in 2010, then the price gradually stabilized.

In conclusion, combining figures and the table, which can be seen that ABCtronics' sales volume (in millions) decreased obviously, the company's maximum sales volume was 3.82 million in 2005. However, after 2005, the company showed a sharp downward trend and the company arrived at the minimum sales volume which was 0.97 million in 2009. At this time, the overall market demand is also in a very low position although it has recovered. From 2008 to 2009, the annual global market demand is less than 100 million, and the way that company's product pricing is quite high which has a significant increase compared with previous years, so the company's sales have been greatly affected so far. In addition, although the average annual sales volume of the company is 2.063 million, in fact, the number of years exceeding the average is less than 1/2. It can be seen that the total sales volume of the company in recent years has a significant gap. The reason is mainly due to product quality, which was caused by many factors such as customer preference and market demand.

Then we establish the regression model to investigate the relationship between sale volume, and overall market demand (in millions), Price per chip (in \$) and economic

condition. ABCtronics' sales volume (in millions) is regarded as the dependent variable and set to Y, while the overall market demand (in millions), Price per chip (in \$) and economic condition are regarded as the independent variable, set to  $X_1, X_2, X_3$ , then the linear regression model is as follows:

$$Y = \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3,$$

Among them,  $\beta_1$ ,  $\beta_2$  and  $\beta_3$  are coefficients to be estimated. By using Stata data software, construct a multiple linear regression model, the results obtained are as shown in the figure below:

Table 6. Multiple linear regression empirical analysis results

Volume	Coef.	Std.Err	t	P> t	[95% Conf. Interval]
Demand	0.00523880	0.00258370	-2.03	0.089	0.0010834
Price	5.50541100	0.88136150	-6.25	0.001	-3.348797
Condition	1.13018300	0.34207130	3.30	0.016	1.967201
_Cons	8.86071100	1.34829100	6.57	0.001	12.15986

It can be seen from the above results that the error of the model is very small, and the correlation between price per chip and ABCtronics' sales volume is obvious, and the revised R-squared is 0.9976. In addition, we can also find from the analysis chart that when the demand increased by one unit, the sales volume of the firm will correspondingly decrease by 0.0052 units, when the unit price increases by one unit, the sales volume will decrease by 5.5054 units. On the contrary, when economic conditions and cons increase by one unit, the sales volume will increase accordingly, by 1.1302 units and 8.8607 units respectively.

Thus, we can understand that both overall market demand (in millions) and price per chip (in \$) have a negative correlation with the ABCtronics' sales volume while the economic condition\* is positive. In addition, from the calculation results of the p-value, it can be concluded that the relationship between the dependent variable and the independent variable is strong and significant.

This chapter first conducts research on customer satisfaction and product testing, and finds that the main reason for the decline in customer loyalty is the poor quality of the products obtained by customers. Most customers believe that product quality has more room for improvement. The investigation of methods to improve product quality testing shows that the company's product quality inspection methods and frequency need to be changed, which are extremely important to shorten the testing time and improve the testing accuracy. In addition, in order to better explain the problems that the company is facing now and find a more appropriate solution, we collected the 2004-2013 years overall market demand (in millions), price per chip (in \$), ABCtronics' sales volume and economic condition\* related data of the four variables, and used stata software to construct a multiple

linear regression model. Through system calculation results, it is found that there is a high correlation between the four, namely overall market demand (in millions), price per chip (in \$) has a negative ratio to ABCtronics' sales volume, while economic condition\* has a positive ratio to ABCtronics' sales volume. Therefore, this further promotes the company's determination to change product quality.

#### 4. CONCLUSION

In this paper, the primary goal is to help ABCtronics improve customer satisfaction. We have learned that the company has received a large number of customer complaints in recent years, and its sales have gradually declined, which has had a negative impact on the company's sales. So we do the customer satisfaction survey towards ABCtronics, test the product quality, and analysis the quality based on the stability testing and regression model, in order to help the company improve product quality and customer acceptance, and in the meantime, lower the complaint rate.

First of all, we design the questionnaire, including the investigation of product quality, appearance, practicability, and durability. After comprehensively analyzing the result of the questionnaire, we find that there are 90% of customers are unsatisfied with the product. They became increasingly disappointed with the company's products and decided not to buy any more. This leads directly to the company's sales decreased. Some customers have even filed complaints directly against the company, arguing that ABCtronics' products do not guarantee customers' rights, a blow to the company's profits and reputation. To solve this problem, the firm develops a new quality inspection method, which is called ICTM. This method is similar to resampling, in which the relevant departments of the company conduct tests under the condition of ensuring the same probability each time. Also, they compare the new method with the old one, LAMT, and do the stability testing at the same time. Then they conclude that the new inspection method has a higher detection rate, ensuring higher quality ongoing products. Therefore, the new method will be a great help to the company. Because for a semiconductor company, only the production of product quality standards, can be recognized by the market. We use the multi-regression model to analyze that the market demand and chip unit price are negative to the company's sales volume. The company's sales and economic conditions are positive to the sales volume, which provides the strategic decision-making direction for the company to change the product quality. Through the above case analysis, we provide the basic goals and direction for the company and help them solve the problem of product quality and customer satisfaction.

However, this paper also has some shortcomings. When setting up the questionnaire, we only considered

the influence of four factors, which did not reflect the comprehensiveness to some extent. In addition, we did not take into account the personality, preference, and choice of customers in the survey, and the selected survey objects were also limited to some extent. At present, the company is considering further improvement, to carry out a more convincing investigation including customers' habits and values as important factors in the survey and to find out the factors affecting the company's sales and correct them in time.

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