

## **Economical Quality Analysis For Industrial Enterprises**

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In modern era, many system theories and methods have been applied in the industrial enterprises. It is obvious that the quality problems, as one aspect of system, is the one deserving much more important considerations.

There are many reasons for studying the quality problem as a system. For example, the enterprises pursued benefits by the way of high quality, although over — done quality is not the best. We should consider it as a system problem. There are many modern management theories such as IE(Industrial Engineering), QC(Quality Control), OR (Operation Research), ZD(zero—defect), PERT(Program Evaluation and Review Technique). If these theories and methods can be applied under the thoughts of Economical Quality System Analysis, it will show the great potentiality.

This paper applying the SD theory and method, declares the concept of EQS, attempting to achieve three goals:

1. To analyze the relationship among the Quality — Cost — Profit, and seek the best combination of these two factors: Quality and Benefits.
2. To discuss, in the appropriate quality level, the combination of Quality and benefit in the process of product design, manufacturing, and sales.
3. To study the internal feedback structure, and the model of quality and benefit of industrial enterprises.

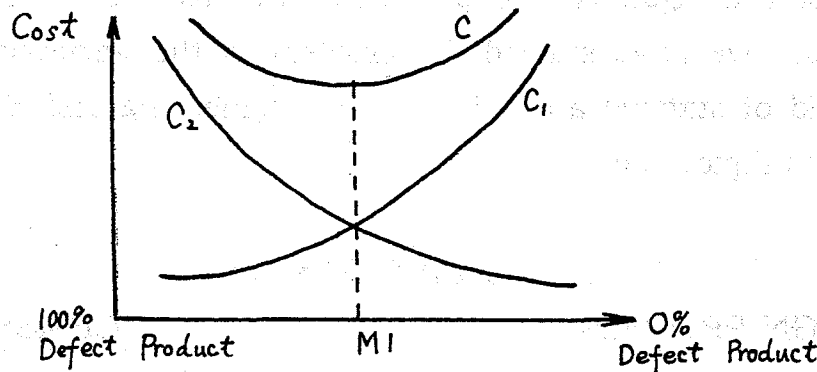
### **A. Quality — Cost — Profit Analysis**

In practice, studying the enterprise's quality problem is often related with the technique objects without paying much attention to

benefit. However, improving the quality is the best way to gain a higher benefit, and a better payback should be based on sound quality.

### 1. Quality and Cost

There are the relations between Quality and Cost in our factory products:



$C_1$ : cost of quality gurantee (exponential growth)

$C_2$ : cost of quality lost (exponential decay)

$C$ : total cost ( =  $C_1 + C_2$  )

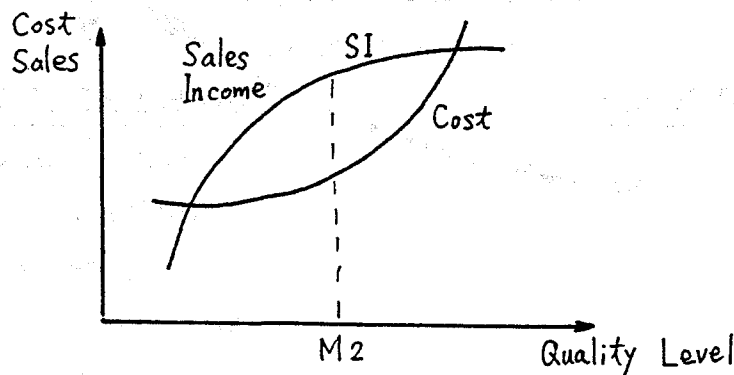
Point  $M1$  is the product quality level which has the lowest cost.

### 2. Quality and benefit

The relation between quality and benefit are list below:

Improved quality leads to more product sales, and the salesincome.

However, on the other side, the cost of improvingproduct quality will also grow, adn lead to a higher price, in the end , the sales growth will surely down and finally decline.



$C$ : cost of product quality

SI: sales income

M2: the product quality level which has the maximum profit

3. Model of Quality—Cost—Profit

There exist one best combination of quality and benefit, which is the Economical Quality Level called by us. For the sake of combination, we have studied the problem in the variety quality level with the aid of statistic analysis, Value Engineering and Break—even analysis technique, etc.

**B. Economical Quality Analysis**

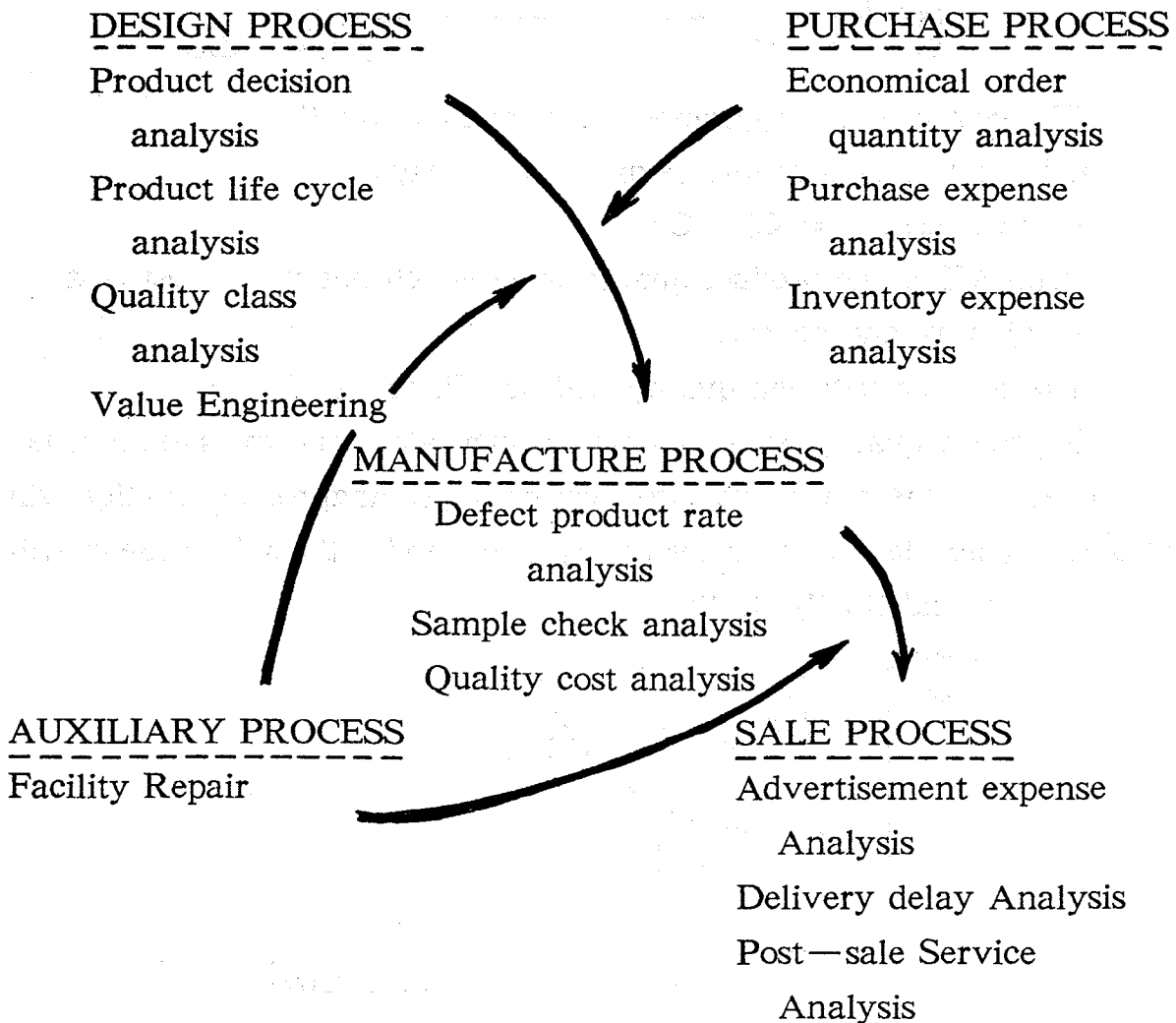


Figure: EQS in every process

1. Design process
  1. 1 Product decision analysis

PDA ( Product decision analysis ) means making the product quality level choices, which starts from the " rational or appropriate quality level" which satisfies the demand of clients, enterprise and society, and fulfils the goal — — " market quality " that means the quality level leads to a dynamic equilibrium in the market.

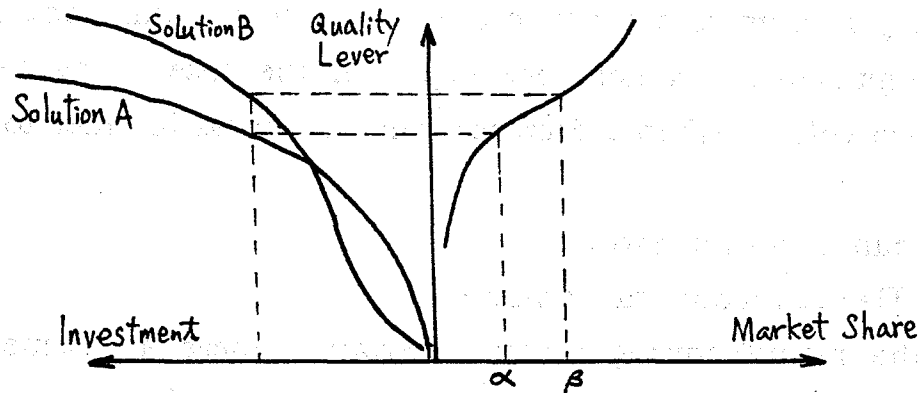
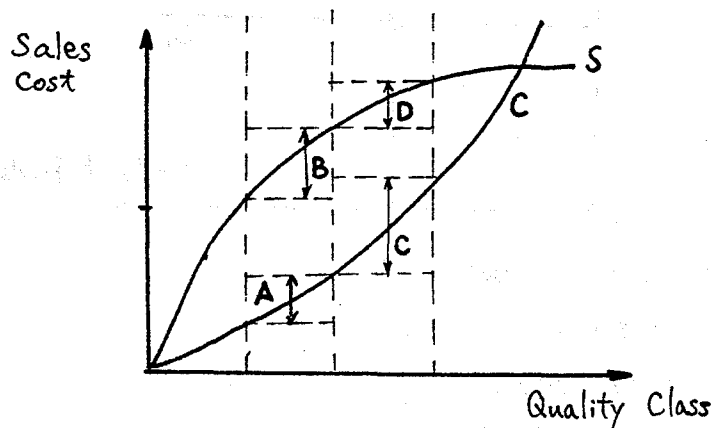


Figure above shows the solution B is better than solution A. (for in the same investments)

1. 2 Quality level analysis

The quality level was often divided into several classes to make the analysis more convenient. The reason is that, in practice, you cannot check every level s cost and benefit. We need to simplify the problem.



C: cost S: benefit

B, D: benefit delta A, E: cost delta

Because  $B > A$ , so it is acceptable that quality is improved from level 3 to level 2, but  $E > D$ , it is not quite good to be from level 2 to level 1.

### 1. 3 Quality improvement analysis

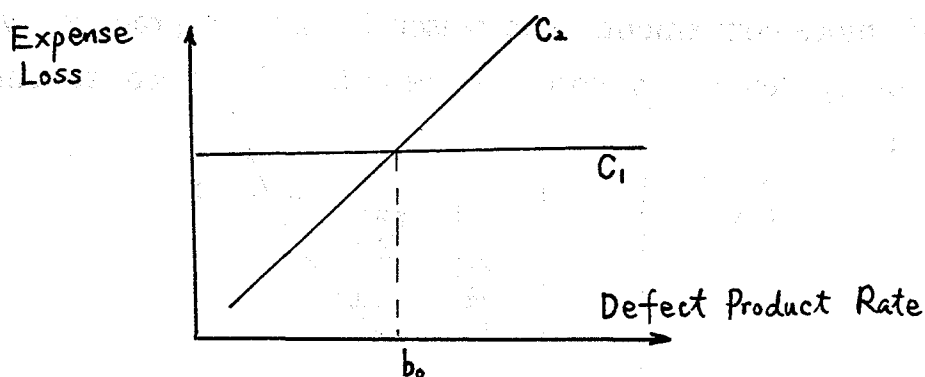
Quality improvement includes characteristics which are sensitive to client and play a important role in product image and function, and the cost of improvement is not very high. In the case of over — done quality, we will, perhaps, decrease some standards in order to reduce cost.

## 2. Manufacturing Process

### 2. 1 Defect product rate analysis

In the manufacturing process, certainly there are some defect products. If you control the defect rate over — strictly, maybe it will cause some side — effects: reducing productivity and benefits. In the long time practice, we have found that the minimum product rate is not the best solution to the comprehensive benefits of enterprises.

### 2. 2 Sample check analysis



$C_1$ : sample check expense

$C_2$ : no sample check lost

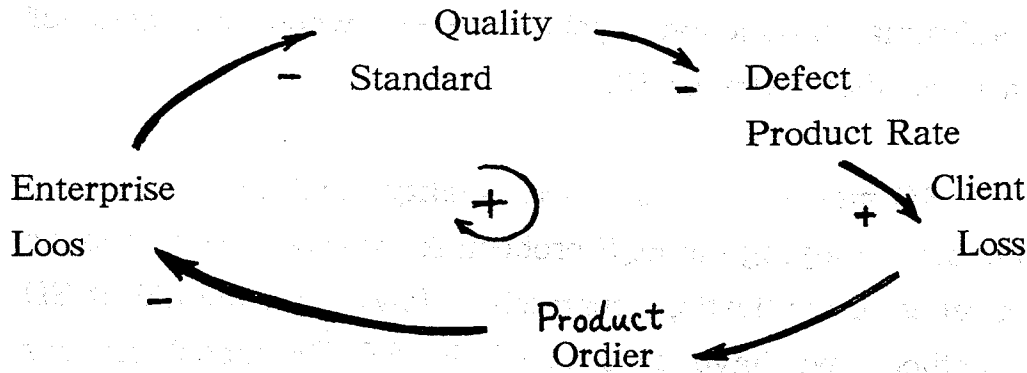
If  $b > b_0$ , check

$b < b_0$ , no check

b0 is the economical checking point

### 2.3 Quality control analysis

Strictness of quality control affects the loss of clients and enterprise, so it is very important to establish appropriate quality control criteria.



Causal loop of Quality control analysis

### 3. Sales process

#### 3.1 Advertisement expense analysis

The advertisement expense is decided by three factors: market demand, production capacity and sales amount.

There are some rules about advertisement in our enterprises:

- (1) no advertisement — — — when production capacity lower than minimum market demand
- (2) advertisement — — — when the benefits the advertisement can bring are greater than or equal to advertisement expenses.
- (3) best advertisement — — — when the marginal benefits of advertisement expense is the highest.

#### 3.2 Delivery delay analysis

Although there are many factors affecting the delivery delay, such as shortage of raw material supply, transportation delay, but the production cycle is the key factor.

The longer the production cycle is, the lower the productivity is.

The shorter the production cycle is, the higher defect rate is.

In fact, there is a most economical production cycle.

When client offers an urgent order with extra payment, we may consider to offer a shorter production cycle under following conditions:

(1) overtime — — — when overtime expenses are less than extra profits

(2) adjusting production cycle — — — when expenses of adjustment are less than extra profits

### C. SD model for Economical Quality Analysis

We have been studying the EQS problem for several years, and we have made a series of application separately. Now, with the aid of SD theory and method, we have constructed the SDGM model for our enterprises, which combines all analysis methods and other analysis techniques.

The important principles, to which we have paid much attention in the process of model construction, are listed below:

(1) We must set up a dynamic quality standard considering both client and enterprise's behalf.

We do not allow the many defect product to be handed to client, and ruin the enterprise image in the same time. But we also do not want the over—done quality level to absorb too much benefits of enterprises.

(2) The evaluation indexes of SDGM model are benefits and cost. Our goals are maximum benefits or minimum cost in the appropriate quality level.

(3) We have dedicated our efforts to judge the state and policy variables, and have studied their relations in every case carefully.

After three year application, we have achieved a great success. Within the past three years, our enterprise had nearly doubled the sales income while production cost decreased 15 per cent, and improved our

image in domestic and overseas market.

Not only have we made use of SDGM in our enterprise, but also we have propagated it to our neighbour enterprise, and it made a great success, too.

The detail contents about model variable, equation are ignored here because of the limit of paper. it of paper.

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modeling...  
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equations...  
SDGM...  
enterprise...

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