

CUMCM-2024 Problem B

Strategy-Generating in the Production Process

When a company produces a best-selling electronic product, two parts (part 1 and part 2) are purchased and assembled into the final product. If either part is unqualified, the assembled product will be deemed unqualified. Even if both parts are qualified, there is still a chance that the assembled product may be unqualified. In the case of unqualified products, the company can either discard them or disassemble them. The disassembling process does not damage two parts but does incur disassembling costs.

Please establish mathematical models to solve the following problems:

Problem 1 The supplier has assured that the defective rate of a batch of parts (part 1 or part 2) will not exceed a specific nominal value. The company intends to use a sampling test method to determine whether or not to accept this batch of parts. The testing cost is born by the company. Please develop a sampling test method for the company with as few tests as possible.

If the nominal value is 10%, according to your sampling test method, please provide the specific results for two following scenarios:

- (1) The batch of parts will be rejected if the defective rate of parts exceeds the nominal value with 95% reliability;
- (2) The batch will be accepted if the defective rate does not exceed the nominal value with 90% reliability.

Problem 2 Assume that the defective rates of two kinds of parts and assembled products are known, please make decisions for each stage of the production process of the company:

- (1) Whether or not each part (part 1 and/or part 2) is tested. If not, the parts will enter the assembly link directly. Otherwise, the detected defective parts will be discarded;
- (2) Whether or not each assembled product is tested. If not, the assembled products will enter the market directly. Otherwise, only the products that pass the test will enter the market;
- (3) Whether or not to disassemble the detected defective products. If not, discard the defective products directly. Otherwise, for the disassembled parts, repeat step (1) and step (2);
- (4) The company will unconditionally replace the defective products purchased by the user and incur specific replacement losses (e.g. logistics costs, corporate reputation, etc.). For the returned defective products, repeat step (3).

According to your decisions, please provide specific plans for the situations in Table 1, as well as the reasons for the plan and the corresponding indicators.

Table 1 Some situations encountered in the production process by the company (Problem 2)

Situation	Part 1			Part 2			Product				Defective Product	
	Defective Rate	Unit Price	Test Cost	Defective rate	Unit Price	Test Cost	Defective Rate	Assembly Cost	Test Cost	Marketing Price	Replacement Loss	Disassembling Cost

1	10%	4	2	10%	18	3	10%	6	3	56	6	5
2	20%	4	2	20%	18	3	20%	6	3	56	6	5
3	10%	4	2	10%	18	3	10%	6	3	56	30	5
4	20%	4	1	20%	18	1	20%	6	2	56	30	5
5	10%	4	8	20%	18	1	10%	6	2	56	10	5
6	5%	4	2	5%	18	3	5%	6	3	56	10	40

Problem 3 For m processes and n parts, if the defective rates of the parts, semi-finished products, and finished products are given, please repeat Problem 2, and provide a strategy plan for the production processes. Figure 1 illustrates a situation involving 2 processes and 8 parts, with specific values provided in Table 2.

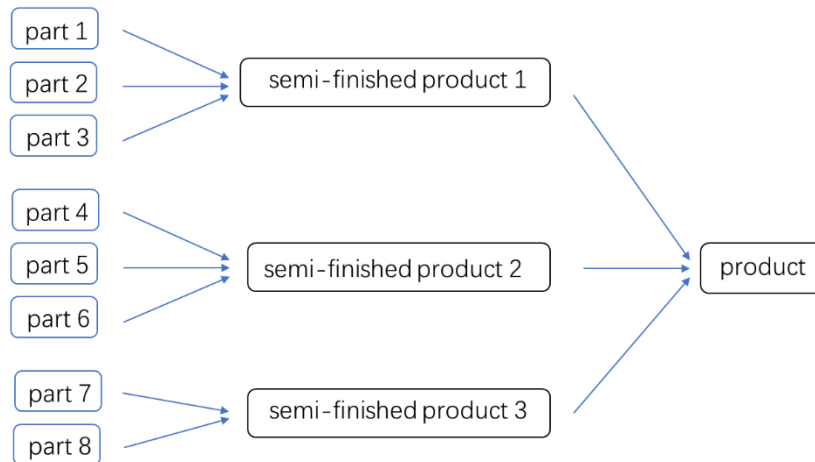


Figure 1 A situation involving 8 parts in 2 processes

Table 2 Some situations encountered in the production process by the company (Problem 3)

Part	Defective Rate	Unit Price	Test Cost	Semi-Finished Product	Defective Rate	Assembly Cost	Test Cost	Disassembling Cost
1	10%	2	1	1	10%	8	4	6
2	10%	8	1	2	10%	8	4	6
3	10%	12	2	3	10%	8	4	6
4	10%	2	1					
5	10%	8	1	Product	10%	8	6	10
6	10%	12	2					
7	10%	8	1		Marketing Price		Replacement Loss	
8	10%	12	2	Product	200		40	

For the above situation, please give a specific strategy plan, as well as the reasons for the plan and corresponding indicators.

Problem 4 Assume that the defective rates of parts, semi-finished products, and products in Problem 2 and Problem 3 are obtained by the sampling testing methods (e.g., the method you used in Problem 1), please repeat Problem 2 and Problem 3.

Appendix Notes

- (1) The defective rates of semi-finished products and products are the defective rates of products after the assembly of qualified parts (or semi-finished products);
- (2) The replacement loss in the unqualified product refers to the loss in addition to the replacement of defective products (e.g. logistics cost, corporate reputation, etc.).
- (3) The unit purchase price, testing cost, assembly cost, marketing price, replacement loss, and disassembling cost are all yuan/piece.