

---

# **Adversarial Practice**

## **Software Engineering Economics**

**Group 11**

**Xu Manxin 1953474**

**Zhai Chenhao 1952216**

**Zhang Shiduo 1950444**

**Dai Yuzhuo 1952335**

**June 2022**

# Contents

<b>1 BUSINESS CASE</b>	<b>1</b>
1.1 PROJECT BACKGROUND	1
1.2 BUSINESS OBJECTIVE	1
1.3 MEASURABLE ORGANIZATIONAL VALUE	1
1.4 CURRENT SITUATION AND PROBLEM / OPPORTUNITY STATEMENT	2
1.5 CRITICAL ASSUMPTION AND CONSTRAINTS	2
1.6 OPTIONS / ALTERNATIVES	2
1.7 FEASIBILITY AND RISK ANALYSIS OF OPTIONS	3
1.7.1 Option 1: Outsource	3
1.7.2 Option 2: Purchase and Specialize	3
1.7.3 Option 3: In-House	4
1.8 PRELIMINARY PROJECT REQUIREMENTS	4
1.9 BUDGET ESTIMATE AND FINANCIAL ANALYSIS	4
1.10 SCHEDULE ESTIMATE	5
1.11 POTENTIAL RISKS	5
<b>2 COST ESTIMATION</b>	<b>6</b>
2.1 SOFTWARE SIZE ESTIMATION	6
2.1.1 Method	6
2.1.2 Function module list	6
2.1.3 Crude Function Points(CFP)	6
2.1.4 Relative Complexity Adjustment Factor(RCAF)	9
2.1.5 Function Points(FP)	10
2.2 SOFTWARE EFFORT ESTIMATION	10
2.3 SOFTWARE DEVELOPMENT COST ESTIMATION	12
2.3.1 Based on monthly cost rate	12
2.3.2 Based on unit price	13
2.3.3 Cross-validation	13
<b>3 BUDGET</b>	<b>14</b>
3.1 BUDGET ASSUMPTIONS	14
3.2 INVESTMENT ESTIMATION STATEMENT	15
<b>4 PRICING STRATEGY</b>	<b>17</b>

4.1 FACTOR ANALYSIS.....	17
4.2 STRATEGY ANALYSIS AND CHOICE .....	17
4.2.1 Pricing Objectives.....	17
4.2.2 Determine Demand.....	17
4.2.3 Pricing Method.....	18
4.2.4 Pricing Strategy Choice .....	18
<b>5 FINANCIAL ANALYSIS .....</b>	<b>21</b>
5.1 DEPRECIATION AND AMORTIZATION .....	21
5.1.1 Depreciation of fixed assets.....	21
5.1.2 Amortization of intangible assets .....	21
5.2 LIQUIDITY ESTIMATION STATEMENT .....	22
5.3 FUND SOURCES AND UTILIZATION STATEMENT .....	22
5.4 TOTAL COST ESTIMATION STATEMENT .....	23
5.5 SALES, SALE TAX AND SURTAX ESTIMATION STATEMENT.....	24
5.6 DEBT REPAYING STATEMENT .....	25
5.7 CASH FLOW.....	26
5.7.1 Operating cash flow.....	27
5.7.2 Investing cash flow.....	28
5.7.3 Financing cash flow.....	29
5.8 LOSS AND PROFIT APPROPRIATION STATEMENT .....	29
5.9 BALANCE STATEMENT.....	30
<b>6 RISK ANALYSIS.....</b>	<b>32</b>
<b>7 DECISION UNDER UNCERTAINTY .....</b>	<b>35</b>
7.1 STATES ELABORATION .....	35
7.2 ALTERNATIVE CHOICE .....	35
7.3 PAYOFF MATRIX COMPUTATION .....	35
7.4 FINAL ALTERNATIVE DETERMINATION .....	36
<b>8 MULTIPLE ATTRIBUTE DECISIONS .....</b>	<b>37</b>
8.1 PROBLEM ELABORATION .....	37
8.2 DIFFERENT ATTRIBUTES ANALYSIS.....	37
8.3 DECISION TECH ANALYSIS AND CHOICE .....	38

# 1 Business Case

## 1.1 Project Background

University courses are rich in content. Often students lack timely review and struggle to grasp key points. Through timely assessment and adversarial practice, students can compare themselves with their classmates to understand the degree of mastery of the course, so as to better study. On the other hand, teachers can also understand the students' learning situation through the students' answers, and then adjust the teaching plan, and at the same time, they can also check attendance.

## 1.2 Business Objective

The objectives of the adversarial practice are as follows:

1. **Develop an adversarial practice program based on WeChat applet.** Taking into account the portability and convenience of mobile phones and the good cross-platform features of WeChat mini-programs (Android, IOS, PC, Mac, etc.), the team plans to use the WeChat mini-program framework to develop adversarial practice programs. More specifically, the corresponding UI interface is developed for two kinds of users (students and teachers) to achieve the required functions. For teachers, its functions include question bank management and assessment management; for students, it is to participate in assessments and view results.
2. **Help students review and feedback their learning results in a timely manner.** For students, there are many university courses, and there is a lack of timely review and difficulty in grasping the key points. Providing students with timely assessment will help students understand their own learning situation and adjust their learning plans and methods for better learning.
3. **Help teachers understand students' learning and check attendance.** By viewing students' assessment results, teachers can quickly understand what students are learning, so they can adjust lesson plans to improve teaching. At the same time, a large number of subjects are enrolled in a course, and checking attendance at the same time as students participate in the assessment will greatly reduce the burden on teachers.

## 1.3 Measurable Organizational Value

**MOV:** Complete the front-end and back-end development and integrate it into the microservice architecture within three months, and complete the testing and deployment at the same time. The system needs to support at least 200 people concurrently participating in

adversarial exercises (WebSocket requests) and 1000 people making HTTP requests concurrently. It will be tested and promoted in this school within one year, and will be promoted to more colleges and universities within three years. After two years, active users will reach 10,000. Development costs will recover within three years with an initial benefit.

## **1.4 Current Situation and Problem / Opportunity Statement**

The current teaching in the university has the following problems: First, teachers usually check attendance manually, which usually takes a lot of time to perform one attendance in a class with hundreds of students. This time will take up the student's normal school time, but it is not very meaningful. Secondly, there is a lot of course content in each class of the university and students often lack timely review. At the same time, it is often difficult to grasp the key points of the course. As time progresses, a vicious cycle is formed that is not conducive to sustainable learning for students. Third, course learning requires a long period of time, and students often do not get timely feedback to understand their own learning. It is difficult to make adjustments and improvements in a timely manner.

At the same time, the programs with adversarial practice function on the market are mainly in the education of party history, and have not been invested in university education on a large scale. Therefore, on the one hand, the project can refer to the design of adversarial practice in party history education (including team formation strategies, scoring strategies, etc.). On the other hand, the initial competition is small. More experimentation and promotion can be carried out in the higher education enterprise to improve efficiency and reduce the burden of education.

## **1.5 Critical Assumption and Constraints**

- ✧ The project manager leads the team to work together efficiently and effectively to complete the project.
- ✧ The system is easy to use and has a comfortable UI design.
- ✧ The system is safe and will not reveal other users' information.
- ✧ There are enough hardware resources to satisfy fault tolerance and high concurrency.
- ✧ The overall system architecture supports the integration of this project.
- ✧ In the short term, the system can be operated and maintained on a non-profit basis.

## **1.6 Options / Alternatives**

There are three options for addressing this opportunity:

- ✧ Outsourcing: After communicating and negotiating with users to determine the

requirements, the project is entrusted to a third party for development.

- **Partial outsourcing:** Except for the core algorithm and the part involving information security developed by the team itself, the rest, such as interface development is entrusted to third-party development.
- **Full outsourcing:** The system is completely outsourced to a third party.
- ✧ **Purchase and specialize:** Purchase mature commercial software from the market and conduct custom development to meet user needs.
- ✧ **In-house development:** From requirements analysis to system design, development, delivery and maintenance are performed by the team itself.

## **1.7 Feasibility and Risk Analysis of Options**

### **1.7.1 Option 1: Outsource**

#### **1.7.1.1 Option 1.1: Full Outsourcing**

Full outsourcing is possible, but there are some risks. First, the team will need to overcome many difficulties when performing system upgrades and maintenance in the future, such as understanding the code from scratch and adapting it. At the same time, system problems are difficult to locate. Second, since the system has no equivalent application in the education industry, outsourcing is likely to cause more competition. Third, system security is likely to experience risk due to outsourcing.

#### **1.7.1.2 Option 1.2: Partial Outsourcing**

Partial outsourcing solves the problem of information security to a certain extent and retains competitiveness. But since the two teams are working together, the integration of the system will be difficult. Similarly, when changes and maintenance occur, effective communication and collaboration between the two teams is required, and the cost is not small.

### **1.7.2 Option 2: Purchase and Specialize**

The feasibility of this option is very small. Since there is no mature application in the education industry, it is difficult for the existing software to have corresponding functions such as checking attendance. Furthermore, the existing software on the market is difficult to meet our needs, which requires us to make a lot of modifications to the purchased software, which is not conducive to the stability of the software.

### 1.7.3 Option 3: In-House

- ✧ **Economic feasibility:** Since the development is carried out within the team, the development cost will be greatly saved.
- ✧ **Technical feasibility:** The technical difficulties mainly include front-end, back-end development and WebSocket programming. The team has accumulated a lot of experience in front-end and back-end development. At the same time, the team has done a lot of research on WebSocket programming, and the conclusion is that related algorithms can be implemented. Therefore, it is technically possible.
- ✧ **Organizational feasibility:** The team members have had many cooperative development experiences before, so they will be more efficient in communication and collaboration. At the same time, there is no need for cross-team collaboration, which increases efficiency.
- ✧ **Other feasibility:** Internal development will ensure information security. At the same time, it will be easier and less costly to upgrade, maintain, and locate errors in the future.

Based on the above feasibility analysis, the internal development has the smallest risk and the greatest feasibility, and the team chooses the internal development.

## 1.8 Preliminary Project Requirements

**Note:** Since this project cooperates with other projects to form a complete system, the feature points listed below may appear incomplete because the related features are developed by other teams.

The system is divided into two types of users, students and teachers.

For students, the main functions are grouping, answering questions, and viewing test results.

For teachers, the main functions are question bank management and test management. Question bank management includes uploading question banks and viewing question banks. Test management includes making test reservations, viewing, modifying, deleting tests, and exporting test results.

## 1.9 Budget Estimate and Financial Analysis

- ✧ Expenses used by the team for normal operation, including system development, requirements exploration, system design, prototyping, etc., and employee compensation.
- ✧ Hardware costs, including the purchase of hardware facilities (servers, networks, hard drives, etc.) for software deployment.
- ✧ Expenses for purchasing tools, software and hardware required for development, as well

as venues for conferences and development activities.

- ✧ The operation and maintenance costs of the system after it goes online.

## **1.10 Schedule Estimate**

The project started on March 12 and is expected to last for three months, with completion around June 1.

## **1.11 Potential Risks**

- ✧ Commercial risk: It is not profitable in the early stage of the project, so the project may not be able to proceed due to insufficient funds.
- ✧ Technical risk and resource: High concurrency is difficult to achieve.
- ✧ Business risk: There are a large number of strong competitors, and it is difficult to compete due to resource constraints.



## 2 Cost Estimation

### 2.1 Software Size Estimation

#### 2.1.1 Method

We use IFPUB method to estimate software size.

IFPUB is an estimation method based on function points. For specific standards, please refer to:

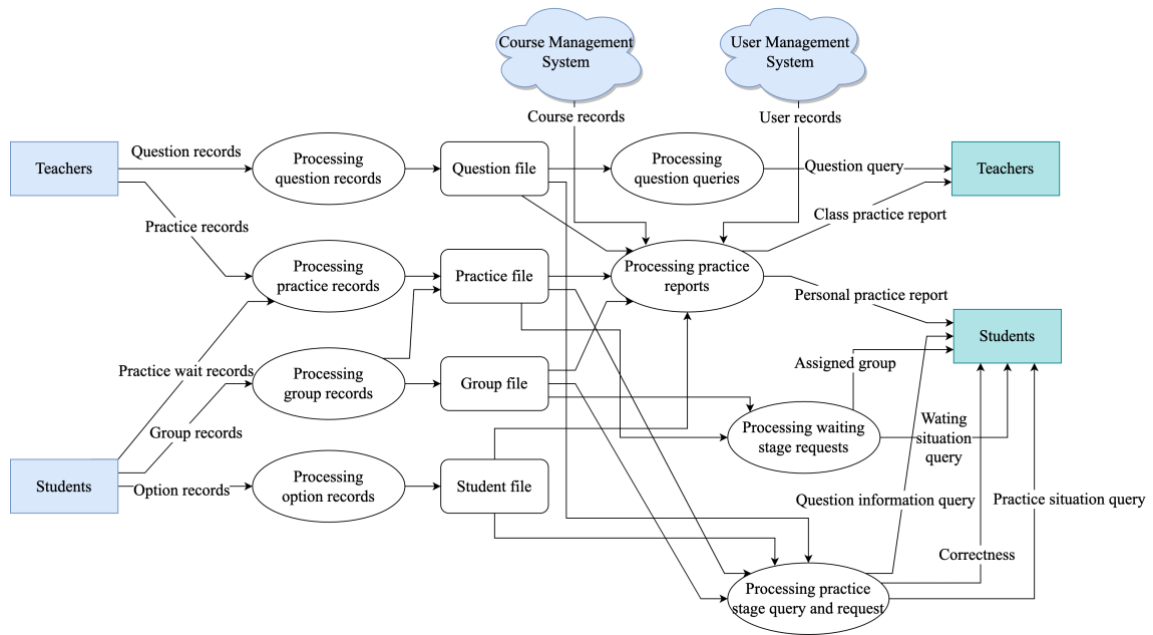
- ✧ ISO/IEC 20926:2009 Software and systems engineering-Software measurement-IFPUG functional size measurement method.
- ✧ <https://www.iso.org/standard/51717.html>

#### 2.1.2 Function module list

ID	Module Name	Functional Description
M1	Question Management Module	This module is mainly responsible for managing the questions during practice, including querying questions, importing questions, modifying questions, etc.
M2	Practice Management Module	This module is mainly responsible for managing practice information, including querying practice results, booking practice, modifying practice, etc.
M3	Online Practice Module	This module is mainly responsible for providing online practice functions, including helping multiple students to conduct adversarial practice online, simulating robot opponents, and saving practice records, etc.

#### 2.1.3 Crude Function Points(CFP)

According to the functional requirements of the project, we draw a data flow diagram of the project:



Analysis of the software system as presented in the DFD summarizes the number of the various components:

- ✧ Number of logical files(ILF) - 4
- ✧ Number of external interfaces(ELF) - 2
- ✧ Number of user inputs(EI) - 5
- ✧ Number of user outputs(EO) - 4
- ✧ Number of user online queries(EQ) - 4
- ✧ The degree of complexity (simple, average or complex) was evaluated for each component:
- ✧ ILF:

Name	RET	DET	Complexity Level
Question file	3	7	Average
Practice file	2	10	Simple
Group file	3	4	Average
Student file	2	7	Simple

- ✧ ELF:

Name	RET	DET	Complexity Level
Course Management System	1	2	Simple
User Management System	1	2	Simple

✧ EI:

Name	FTR	DET	Complexity Level
Question records	1	7	Simple
Practice records	1	10	Simple
Practice wait records	1	2	Simple
Group records	2	3	Simple
Option records	1	5	Simple

✧ EO

Name	FTR	DET	Complexity Level
Class practice report	4	20	Complex
Personal practice report	4	20	Complex
Assigned group	2	3	Simple
Correctness	4	6	Complex

✧ EQ

Name	FTR	DET	Complexity Level
Question query	1	7	Simple
Waiting situation query	2	3	Simple
Question information query	4	6	Complex
Practice situation query	4	7	Complex

According to the above table and the calculation methods specified in the standard, a crude

function points estimation can be obtained as shown in the following table:

Software	Complexity level									Total CFP
system	Simple			Average			Complex			
components	Count	Weight Factor	Points	Count	Weight Factor	Points	Count	Weight Factor	Points	
	A	B	C=AxB	D	E	F=DxE	G	H	I=GxH	
ILF	2	7	14	2	10	20	0	15	0	34
ELF	2	5	10	0	7	0	0	10	0	10
EI	5	3	15	0	4	0	0	6	0	15
EO	1	4	4	0	5	0	3	7	21	25
EQ	2	3	6	0	4	0	2	6	12	18
Total CFP										102

The total number of crude function points(CFP) of the project is 102.

## 2.1.4 Relative Complexity Adjustment Factor(RCAF)

The relative complexity adjustment factor (RCAF) summarizes the complexity characteristics of the software system and varies between 0 and 70. RCAF is the sum of grades regarding the 14 subjects. Give each subject a grade(0 to 5) according to the characteristics of our project:

No.	Subject	Grade
1	Requirement for reliable backup and recovery	5
2	Requirement for data communication	5
3	Extent of distributed processing	4
4	Performance requirements	5
5	Expected operational environment	1
6	Extent of online data entries	3
7	Extent of multi-screen or multi-operation online data input	2
8	Extent of online updating of master files	5
9	Extent of complex inputs, outputs, online queries and files	2
10	Extent of complex data processing	2
11	Extent that currently developed code can be designed for reuse	1
12	Extent of conversion and installation included in the design	3
13	Extent of multiple installations in an organization and variety of customer organizations	2
14	Extent of change and focus on ease of use	3
	Total = RCAF	43

### 2.1.5 Function Points(FP)

$$FP = CFP \times (0.65 + 0.01 \times RCAF) = 102 \times (0.65 + 0.01 \times 43) = 110.16$$

## 2.2 Software Effort Estimation

According to the latest release of CSBMK-202110, we can derive industry-wide software development productivity benchmark data. The details of software development productivity are as follows:

Software development productivity details (unit: man-hour/function point)				
P10	P25	P50	P75	P90
2.25	3.97	7.04	12.52	17.41

According to the recommendation of the national standard(GB/T 36963-2018) and the group standard(T/BSCEA 002-2019), we use the equation method to estimate the software effort. The calculation formula is as follows:

$$\text{Software Effort} = \text{Function Points} \times \text{Productivity} \times \text{Software Adjustment Factor} \times \text{Development Adjustment Factor}.$$

Among them, the productivity is assigned to "pessimistic productivity", "average productivity", "optimistic productivity" according to the quartiles in the software development productivity details mentioned above, and the development adjustment factor defaults to 1.

The productivity values are as follows:

Productivity (unit: person-hour/function point)		
Optimistic	Average	Pessimistic
3.97	7.04	12.52

The software adjustment factors are as follows:

Software Adjustment Factor	
Business field	1
Application field	1
Integrity level	1
Quality requirements	1
Software adjustment factor	1

According to the formula, the adjusted software effort (person-month) is obtained as follows:

Software Effort (unit: person-month)		
Optimistic	Average	Pessimistic
2.733345	4.84704	8.62002

## 2.3 Software Development Cost Estimation

### 2.3.1 Based on monthly cost rate

According to the latest release of CSBMK-202110, the monthly cost rate of Shanghai is ¥30778, which will be used in subsequent calculations.

In order to calculate the software development cost, it is necessary to estimate the direct non-labor costs:

- ✧ Office fee: ¥6000
- ✧ Travel fee: ¥3000
- ✧ Training fee: ¥2000
- ✧ Purchase fee: ¥8000
- ✧ Review fee: ¥2000
- ✧ Business fee: ¥3000
- ✧ Others: ¥3000
- ✧ Total: ¥27000

After obtaining the monthly cost rate and direct non-labor costs, combined with the software effort calculated in the previous step, we can calculate the software development cost through the following formula:

$$\text{Software Development Cost} = \text{Software Effort} \times \text{Monthly Cost Rate} + \text{Direct NonLabour Costs}$$

The calculated software development costs are shown in the table below:

Software Development Cost (unit: ¥ten thousand)		
Optimistic	Average	Pessimistic
11.112689	17.618312	29.230698

### 2.3.2 Based on unit price

According to the latest release of CSBMK-202110, the benchmark unit price of a function point in Beijing is ¥1250.43. At the same time, according to the relevant calculation rules, the average unit price of function points in other cities can be calculated based on the average unit price of function points in Beijing area and the benchmark monthly rate, so the following formula can be obtained:

$$\frac{\text{Average unit price of function points in Beijing}}{\text{Benchmark monthly cost rate in Beijing}} = \frac{\text{Average unit price of function points in Shanghai}}{\text{Benchmark monthly cost rate in Shanghai}}$$

According to the above formula, we calculate that the unit price of function points in Shanghai is ¥1245.25.

Same as before, we take the value of direct non-labor costs as 27000¥. We can also get the software development cost by the following formula:

$$\begin{aligned} \text{Software Development cost} &= \text{Unit Price} \times \text{Function Point} + \\ \text{DirectNonLabour cost} &= 1245.25 \times 110.16 + 27000 = ¥164176.74. \end{aligned}$$

### 2.3.3 Cross-validation

The software development costs calculated by the two formulas are respectively ¥176183.12 and ¥164176.74. We believe that the error between the results of the two methods of estimation is within the allowable range, indicating that the results of the development cost estimation are valid.

In the end, we chose to use the result obtained by the method based on monthly cost rate, which is ¥176183.12, because the data used in this method directly refers to CSBMK-2021, which is more reliable.



## 3 Budget

### 3.1 Budget assumptions

1. In the cost estimation process, we are based on the adversarial practice project developed by the group, and our adversarial practice project is a module of the whole virtual simulation experiment teaching system, and there are inevitably parts of the finance that intersect with other modules, and these parts are difficult to delineate clearly, so we take the whole virtual simulation experiment teaching system as the object of analysis in the subsequent finance-related analysis.
2. The plan forecasts a one-year development and deployment period and a four-year operation and maintenance period.
3. All working capital in the project comes from cash, which is sourced from own funds and is not obtained through loans.
4. In the development and deployment period, the investment of own funds in the first year is 6,409,800 yuan and the rest is long-term loans. The annual interest rate of the loan is 4.75% according to the realistic bank lending rate.

国家开发银行人民币贷款利率表

项 目	年 利 率 (%)
一、短期贷款	
六个月 (含)	4.35
六个月至一年 (含)	4.35
二、中长期贷款	
一至五年 (含)	4.75
三至五年 (含)	4.90
五年以上	4.90

注：

1. 本表利率自2015年10月24日起执行。
2. 具体利率执行情况请咨询当地开发银行。

## 3.2 Investment Estimation Statement

The investment in this project is mainly construction investment, which refers to the sum of all the actual costs invested in the development and deployment of the project as well as the operation and maintenance at a later stage.

Construction projects can be divided into productive construction projects and non-productive construction projects according to their use. This project is a non-production project. In this project, the construction investment includes software development and operation and maintenance costs, equipment purchase, basic preparatory costs and other costs required for the project.

The estimated construction investment table for the project is shown below:

Supporting Statement 1 Investment Estimation Statement		(Unit: Ten thousand yuan)				
No.	Project/Year	1	2	3	4	5
<b>1</b>	<b>Construction investment</b>	<b>840.98</b>	<b>144.00</b>	<b>144.00</b>	<b>144.00</b>	<b>144.00</b>
<b>1.1</b>	<b>Software development and operation and maintenance fees</b>	<b>706.30</b>	<b>144.00</b>	<b>144.00</b>	<b>144.00</b>	<b>144.00</b>
1.1.1	Software platform and application development fees	706.30				
1.1.1.1	Purchase of software for the development of the required system	166.30				
1.1.1.2	Development cost	540.00				
1.1.1.2	Software enhancement development and operation and maintenance fees	0.00	144.00	144.00	144.00	144.00
<b>1.2</b>	<b>Purchase of equipment and utensils</b>	<b>30.00</b>				
<b>1.3</b>	<b>Other costs of construction</b>	<b>28.22</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>
1.3.1	Project start-up costs	15.00				
1.3.2	Construction unit management fees	13.22				
<b>1.4</b>	<b>Basic reserve fees</b>	<b>76.45</b>				
<b>2</b>	<b>Total project construction investment</b>	<b>840.98</b>	<b>144.00</b>	<b>144.00</b>	<b>144.00</b>	<b>144.00</b>

Of which:

- software development and operation and maintenance costs (1.1) include software platform and application software development costs (1.1.1) and software enhancement development and operation and maintenance costs (1.1.2), and software platform and application software development costs are further subdivided into the cost of purchasing the system software required for development (1.1.1.1) and the costs required for development (1.1.1.2).

Of this amount, the cost of purchasing the system software required for development (1.1.1.1) is expected to be ¥ 1,663,000 for the development deployment period.

- For the calculation of other amounts, the following table is available:

	Year	1	2	3	4	5
Number of development staff on board (person/year)		15	4	4	4	4
Comprehensive labor cost (10,000 yuan/person-year)	36					
Purchase of equipment and utensils		30				
Secondary fit-out and wiring of office space (360 sqm, 200 yuan/sqm)		7.2				
Computer and network equipment (10,000 yuan/station)		19				
Furniture for daily office and conference use (2000 yuan/static)		3.8				
Project start-up costs		15				
Construction unit management fees		13.22				
Basic reserve fees		76.45				

- ✧ The project is expected to have a headcount of 15 people during the development and deployment period and 4 people for each year of operation and maintenance.

The combined annual labor cost for one person is ¥ 360,000 (including five insurance and one contribution). This gives a development cost requirement (1.1.1.2) of ¥ 5.4 million. The cost of software enhancement development and operation and maintenance (1.1.2) for each year of the operation and maintenance period is ¥ 1.44 million.

✧ Equipment and utensils acquisition costs (1.2) are divided into three components, namely secondary renovation and cabling of office space, computer and network equipment and furniture for daily office and meeting use. The estimated cost is calculated to be ¥ 300,000.

3. Other costs for construction (1.3) include project start-up costs (1.3.1) and construction unit management fees (1.3.2), with an estimated expenditure of ¥ 150,000 for project start-up costs and ¥ 132,200 for construction unit management fees. According to the "Regulations on Construction Cost Management of Capital Construction Projects" Cai Jian [2016] No. 504, the annual construction unit management fee is based on the following table which the rates were determined and calculated to obtain.

单位：万元

工程总概算	费率 (%)	算例	
		工程总概算	项目建设管理费
1000以下	2	1000	$1000 \times 2\% = 20$
1001-5000	1.5	5000	$20 + (5000 - 1000) \times 1.5\% = 80$
5001-10000	1.2	10000	$80 + (10000 - 5000) \times 1.2\% = 140$
10001-50000	1	50000	$140 + (50000 - 10000) \times 1\% = 540$
50001-100000	0.8	100000	$540 + (100000 - 50000) \times 0.8\% = 940$
100000以上	0.4	200000	$940 + (200000 - 100000) \times 0.4\% = 1340$

4. The basic reserve fee is mainly to address the increase in investment arising from design changes and national policy adjustments approved by higher authorities during the construction process as well as the increase in engineering items and costs arising from measures taken to address contingencies. For software product development projects, the basic reserve rate is generally 5%-10% . Here 10% is taken. Therefore, the basic reserve cost in this table = (software development and operation and maintenance costs + equipment and utensil purchase costs + other costs of engineering construction)\*10%。

## 4 Pricing Strategy

### 4.1 Factor Analysis

There are many factors affecting pricing and to determine the price of our product, we must first consider factors affecting pricing. According to the course content, there are 8 factors that are supposed to be taken into account :

- ✧ Organizational and marketing objectives
- ✧ Pricing objectives
- ✧ Costs
- ✧ Other marketing mix variables
- ✧ Channel member expectations
- ✧ Customer interpretation and response
- ✧ Competition
- ✧ Legal and regulatory issues

### 4.2 Strategy Analysis and Choice

#### 4.2.1 Pricing Objectives

- ✧ Long term survival

The primary goal of our software is to remain in operation and maintenance for as long as possible and to be able to be used in the market for a long time

- ✧ Maximize profit.

Take as much market share as possible while ensuring survival. The degree to which this goal is accomplished has a very large impact on future earnings.

- ✧ Larger market share

Since there are many companies of the same type, we consider occupying market share first, which is helpful to increase future sales.

#### 4.2.2 Determine Demand

- ✧ Market demand may be constantly changing
- ✧ We face a lot of competition in the market. There may be various experimental teaching

management platforms in all platforms.

### 4.2.3 Pricing Method

There are three methods we can choose from for pricing. They have different application scenarios. The analysis is as follows.

✧ Cost addition method.

The target profit is calculated by estimating the number of products to be produced and sold, as well as the total cost, and then setting a profit percentage. The total cost and target profit are apportioned to the unit product that constitutes the selling price of the product.

✧ Buyer-based method.

Set product prices by calculating consumer surplus to increase users' willingness to use and purchase probability.

✧ Competition-based method.

If competition is the primary consideration, the price factor of the same type of product needs to be fully considered, taking into account the position of different pricing in the competitive relationship.

After a comprehensive analysis of the position of our products in terms of cost, user willingness to use, and competitive market relations, we decided to use the buyer-based method.

### 4.2.4 Pricing Strategy Choice

There are five pricing strategies we can use in product pricing:

1. Personalized pricing: Different product features and personalized pricing settings can be provided according to the different needs of different individuals for the product and their differentiated spending power.
2. Group pricing: Different pricing strategies according to the needs and spending power of different groups.
3. Versioning pricing: By dividing the version with different functions, the version with more functions and better quality can set a higher price, and the version with less functions and less quality can set a lower price.
4. Bundling pricing: Bundle products from the same company, the total price of which is lower than the sum of the individual prices of the two products, thus helping to increase the sales of the products.

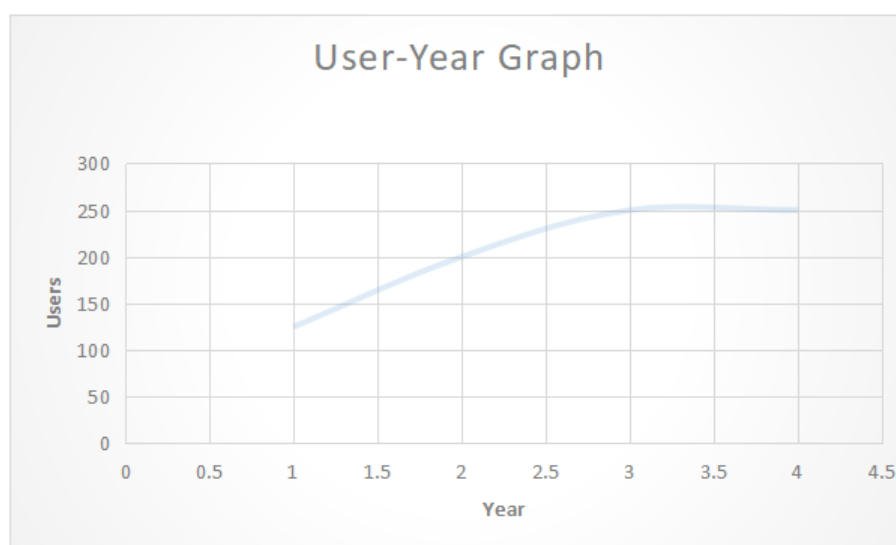
5. Usage-based pricing: This pricing strategy charges users according to the level of use of the product, such as the number of uses, traffic resources.

#### **Specific analysis of our own product:**

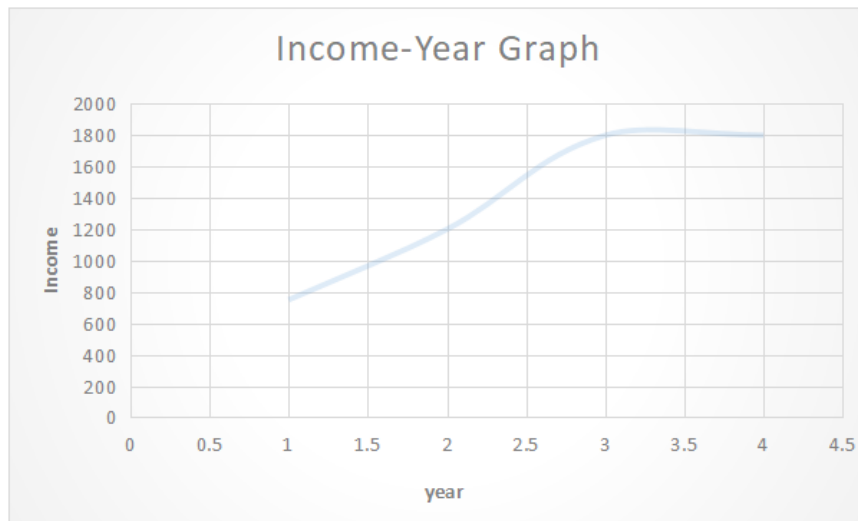
- ✧ Our project is a virtual simulation experiment teaching software, which mainly provides technical support for classroom teaching and after-school practice in schools. The system can match four random students into a quiz room to practice against each other. Our core competence lies in the user experience, which is not only reflected in the good user interactivity and powerful question answering function, but also in the backend's good handling of multi-user concurrent online.
- ✧ We have different quality performance for different models in different functions. We can also adjust the quality of the generated images by modifying the model parameters and training data. Therefore, we can open the common functions for free, and for the core functions such as face trial makeup we can use membership fee and per-use fee. Meanwhile, in the free features, members can enjoy richer templates and higher-quality result images.

#### **So, we choose dynamic pricing strategy as our price strategy. The whole strategy is as follows:**

- ✧ Our platform is mainly for university users and we expect to have 250 schools as our partner customers out of 3,000 universities in the domestic market after pre-launch publicity and promotion. The price of our products will change with the actual situation, and we will use lower price in the initial stage of investment. And as the users and the market stabilize, we will adjust the product price dynamically.
- ✧ We assume the number of users grows according to the S-curve. This diagram shows the growth of our user group, and we assume that our users will increase rapidly in the first several months after the program is put into market. To be specific, the users include school numbers.



- ✧ We choose dynamic pricing strategy to set the price for our project. In the beginning phase, we will charge schools using our software ¥60000 per year. After the promotion, we will charge the school using our software ¥72000 per year.



- ✧ We expect the number of users to grow by a certain percentage each year. Our estimated operating cost is about ¥ 1440000 per year and in the first few months, our income may be lower than the average operation cost. After our user group is estimated, the income increases rapidly and goes up to more than ¥ 7500000 per year at the end of year 1, so our pricing is appropriate.

## 5 Financial Analysis

Financial analysis is used to predict, estimate and evaluate the financial feasibility of software engineering projects, project profitability, and post-evaluation of the project's effectiveness after it is put into production.

1. Auxiliary report - 8
2. Basic statements (financial analysis and evaluation through basic statements) - 5

### 5.1 Depreciation and Amortization

#### 5.1.1 Depreciation of fixed assets

Depreciation of fixed assets is apportioned over the useful life of the fixed assets in accordance with a determined method corresponding to the depreciation amount. Useful life is the period over which the fixed asset is expected to be used and the depreciation accrual is the original cost of the fixed asset to be depreciated, less the net residual value. If provision for impairment is made for fixed assets, the accumulated amount of provision for impairment of fixed assets already made should also be deducted.

Depreciation of fixed assets is calculated using the straight-line method, with fixed assets purchased during the development and deployment period and put into use during the operation and maintenance period. Depreciation is provided over a period of 5 years with a residual value of 5%.

Supporting Statement 4 Depreciation of fixed assets		(Unit: Ten thousand yuan)				
No.	Project/Year	1	2	3	4	5
1	Equipment and utensils					
1.1	The original value of new fixed assets in the current year	30.00	0.00	0.00	0.00	0.00
1.2	Depreciation expense for the year	0.00	5.70	5.70	5.70	5.70
1.3	Fixed assets-net value	30.00	24.30	18.60	12.90	7.20
2	Total annual depreciation expense	0.00	5.70	5.70	5.70	5.70
3	Fixed assets-net value at the end of the year	30.00	24.30	18.60	12.90	7.20

#### 5.1.2 Amortization of intangible assets

Amortization of intangible assets is the systematic and rational allocation of the amortizable amounts of intangible assets with finite useful lives over their useful lives. The intangible assets of the project include software platform and application development costs, software enhancement development and operation and maintenance costs and other costs of construction.

The intangible assets of the project are calculated using the straight-line method, with amortization starting five years after the operation and maintenance period has been put into use, with no residual value.



Supporting Statement 5 Amortization of intangible assets		(Unit: Ten thousand yuan)				
No.	Project/Year	1	2	3	4	5
1	Software platform and application development fees					
1.1	The original value of new intangible assets in the current year	706.30	0.00	0.00	0.00	0.00
1.2	Annual amortization expense	0.00	141.26	141.26	141.26	141.26
1.3	Net intangible assets	706.30	565.04	423.78	282.52	141.26
2	Software enhancement development and operation and maintenance fees					
2.1	The original value of new intangible assets in the current year	0.00	144.00	144.00	144.00	144.00
2.2	Annual amortization expense	0.00	28.80	57.60	86.40	115.20
2.3	Net intangible assets	0.00	115.20	201.60	259.20	288.00
3	Other costs of construction					
3.1	Newly added expenses to be amortized in the current year	28.22	0.00	0.00	0.00	0.00
3.2	Annual amortization expense	0.00	5.64	5.64	5.64	5.64
3.3	Net intangible assets	28.22	22.58	16.93	11.29	5.64
4	Total annual amortization expense	0.00	175.70	204.50	233.30	262.10
5	Net intangible assets at the end of the year	734.52	702.82	642.31	553.01	434.90

## 5.2 Liquidity Estimation Statement

Liquidity is commonly referred to as the source of funds to sustain the development and operation and maintenance of the project in the absence of revenue. It has been stipulated in the assumptions that all liquidity in the project will come from cash, which will be sourced from own funds and not through loans.

Here, the initial liquidity is set at ¥ 2 million and subsequent liquidity growth is ¥ 300,000 per year (for the first three years). This liquidity will ensure that the project can sustain normal development and operation and maintenance for several months when there is no revenue.

Supporting Statement 2 Liquidity Estimation Statement		(Unit: Ten thousand yuan)				
No.	Project/Year	1	2	3	4	5
1	<b>Current assets</b>	<b>200.00</b>	<b>230.00</b>	<b>260.00</b>	<b>290.00</b>	<b>290.00</b>
1.1	Cash	200.00	230.00	260.00	290.00	290.00
1.2	Accounts Receivable (Sales Security Deposit)	0.00	0.00	0.00	0.00	0.00
2	<b>Current liabilities</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>
2.1	Accounts payable					
3	<b>Liquidity</b>	<b>200.00</b>	<b>230.00</b>	<b>260.00</b>	<b>290.00</b>	<b>290.00</b>
4	Annual increase in liquidity	200.00	30.00	30.00	30.00	0.00

## 5.3 Fund sources and utilization statement

- ✧ Project funding source: construction investment of RMB 10,409,800, including own funds investment of RMB 6,409,800 (capital) and long-term loan of RMB 4,000,000 (loan period of 5 years), in line with the assumptions.
- ✧ The project operation and maintenance funds and the increased liquidity come from the project capital investment of the project sponsor.

The following table shows the use of funds and financing of the project:

Supporting Statement 3 Fund sources and utilization statement		(Unit: Ten thousand yuan)				
No.	Project/Year	1	2	3	4	5
<b>1</b>	<b>Total investment</b>	<b>1040.98</b>	<b>174.00</b>	<b>174.00</b>	<b>174.00</b>	<b>144.00</b>
1.1	Construction investment	840.98	144.00	144.00	144.00	144.00
1.2	Liquidity	200.00	30.00	30.00	30.00	0.00
<b>2</b>	<b>Sources of funding</b>	<b>1040.98</b>	<b>174.00</b>	<b>174.00</b>	<b>174.00</b>	<b>144.00</b>
2.1	Capital	640.98	174.00	174.00	174.00	144.00
2.1.1	Capital balance	640.98	814.98	988.98	1162.98	1306.98
2.2	Loans	400.00	0.00	0.00	0.00	0.00
2.2.1	Loan balance	400.00	400.00	400.00	400.00	0.00
2.3	Short-term borrowings	85.00	0.00	0.00	0.00	0.00
2.3.1	Short-term borrowing balance	85.00	0.00	0.00	0.00	0.00

## 5.4 Total cost estimation statement

✧ Total cost estimation is the total cost incurred to produce a product or provide a service and is equal to the sum of operating costs and financial costs such as depreciation, amortization and interest.

1. Marketing expenses are charged at 25% of annual sales revenue.
2. Administrative office expenses are the usual expenses such as rent for rented space, utilities and property costs. It is estimated here as follows, assuming that each year's administrative office expenses are 1.1 times those of the previous year:

Administrative office expenses estimation table	1	2	3	4	5
Monthly administrative office expenses rate(Ten thousand yuan/month)	6	7	7	8	9

3. The salary distribution of the marketing and management staff is as follows, plus five insurances and one contribution, which is 45.5% of the base salary per person.

Salaries and benefits(Marketing and Management Department base salary)	1	2	3	4	5
Marketing staff					
Average number of employees per year	0.00	10.00	15.00	20.00	20.00
Basic salary per capita(7.2 Ten thousand yuan/year)	0.00	72.00	108.00	144.00	144.00
Additional five insurances and one housing fund(45.5%)	0.00	32.76	49.14	65.52	65.52
Management staff					
Average number of employees per year	0.00	2.00	4.00	5.00	5.00
Basic salary per capita(9.6 Ten thousand yuan/year)	0.00	19.20	38.40	48.00	48.00
Additional five insurances and one housing fund(45.5%)	0.00	8.74	17.47	21.84	21.84
Total base salary rates	0.00	91.20	146.40	192.00	192.00
Total additional five insurances and one housing fund	0.00	41.50	66.61	87.36	87.36

The total cost of the project is estimated as follows:

Supporting Statement 6 Total cost estimation statement		(Unit: Ten thousand yuan)				
No.	Project/Year	1	2	3	4	5
1	Cost of purchased raw materials	0.00	0.00	0.00	0.00	0.00
2	External fuel power costs	0.00	0.00	0.00	0.00	0.00
3	Salaries and benefits	0.00	132.70	213.01	279.36	279.36
4	Repair costs	0.00	0.00	0.00	0.00	0.00
5	Marketing costs	0.00	187.50	300.00	450.00	450.00
6	Administrative office expenses	72.00	79.20	87.12	95.83	105.42
7	Operating Costs(1+2+3+4+5+6)	72.00	399.40	600.13	825.19	834.78
8	Depreciation expense	0.00	5.70	5.70	5.70	5.70
9	Amortization expense	0.00	175.70	204.50	233.30	262.10
10	Interest expense	11.35	22.70	19.00	19.00	19.00
11	Total cost(7+8+9+10)	83.35	603.50	829.34	1083.20	1121.58

## 5.5 Sales, sale tax and surtax estimation statement

### 1. Description of the tax rate and the basis for calculating the tax.

- VAT is calculated at 6% of sales revenue.
- VAT is calculated as:  $VAT = \text{Sales tax} - \text{Input tax}$
- Urban construction and maintenance tax is calculated at 7% of VAT.
- Education surcharge is calculated at 3% of VAT.
- VAT input tax rate is calculated at 13%.

### 2. Basis of operating income forecast

The project's strategy for estimating operating income is as follows: the end users of the product are teachers and students, but these two users have a limited ability to pay for the product themselves and cannot charge for it. Therefore, after a survey of consumers and an analysis of the market situation and the company's products, it was decided that the product would be free for students and teachers to use, but would need to be purchased in advance by the school. According to the pricing strategy, schools are charged a certain amount of money for purchasing the product. The entire operating revenue forecast is detailed below:

Operating Income Calculation Table	1	2	3	4	5
Number of schools that purchased the product	0	125	200	250	250
Product unit price(Ten thousand yuan)	0	6	6	7.2	7.2
Operating Income(Ten thousand yuan)	0	750	1200	1800	1800

### 3. Basis for projection of input tax

- As the company has no purchased raw materials and fuel and power costs, the input tax credit is zero.
- According to the Announcement on Policies Relating to the Deepening of VAT Reform (Announcement No. 39 of 2019 by the Ministry of Finance, the General Administration of Taxation and the General Administration of Customs), "V. With effect from 1 April 2019, point 1 of Article 1(4) and point 1 of Article 2(1) of the Regulations on Matters Relating to the Pilot Conversion of Business Tax into VAT (issued by Cai Shui [2016] No. 36) shall cease to be implemented and the taxpayers shall be subject to the taxation of the tax. The implementation of point 1 of Article 1 (4) and point 1 of Article 2 (1) shall cease, and the input tax on the acquisition of real estate or construction in progress of real estate by taxpayers shall no longer be deducted in 2 years. The input tax to be deducted that has not been deducted in accordance with the above provisions can be deducted from the output tax from April 2019 onwards. From 1 April 2019, a one-off deduction will be allowed for the input tax accounted for by the enterprise for the purchase of fixed assets. Therefore, the

input tax deductible in the first period of operation = 30\*13% = ¥ 39,000 and the output tax in the first year is ¥ 360,000, leaving ¥ 321,000 after deductions.

The Sales, sale tax and surtax estimation statement are tabulated below.

Supporting Statement 7 Sales, sale tax and surtax estimation statement		(Unit: Ten thousand yuan)				
No.	Project/Year	1	2	3	4	5
1	Operating Income	0.00	750.00	1200.00	1800.00	1800.00
2	Taxes and surcharges	0.00	45.21	79.20	118.80	118.80
2.1	Value Added Tax	0.00	41.10	72.00	108.00	108.00
2.1.1	Value Added Tax output tax	0.00	45.00	72.00	108.00	108.00
2.1.2	Value Added Tax input tax	0.00	3.90	0.00	0.00	0.00
2.2	Sale tax	0.00	0.00	0.00	0.00	0.00
2.3	Urban Maintenance and Construction Tax	0.00	2.88	5.04	7.56	7.56
2.4	Education Fee Surcharge	0.00	1.23	2.16	3.24	3.24

## 5.6 Debt repaying statement

1. The financial cost of the project is the interest rate on the loan, which is specified as 4.75% for long-term loans and 4.35% for short-term borrowings, based on existing bank rates.
2. The loan of \$4 million borrowed at the time of financing has a term of five years and is scheduled to be repaid in one lump sum in the final year of the loan period.
3. To ensure a positive net cash flow and to keep the development and O&M process healthy, short-term borrowing is planned in the event of a negative net cash flow. The short-term borrowing will be repaid in one lump sum in the following year.
4. Interest on the project is estimated during the development deployment and O&M period based on the following interest calculation formula:

$$Q = \sum_{j=1}^n (P_{j-1} + \frac{1}{2}A_j) * i$$

where Q is the accrued interest;  $P_{j-1}$  is the sum of the accumulated loan amount and the accumulated interest amount at the end of year j-1;  $A_j$  is the loan amount in year j; and i is the annual interest rate of the loan.

The final debt service schedule was obtained as:

Supporting Statement 8 Debt repaying statement		(Unit: Ten thousand yuan)				
No.	Project/Year	1	2	3	4	5
1	Borrowings					
1.1	Loan principal balance at the beginning of the year	0.00	400.00	400.00	400.00	400.00
1.2	Short-term loan principal balance at the beginning of the year	0.00	85.00	0.00	0.00	0.00
1.3	Current year loans	400.00	0.00	0.00	0.00	0.00
1.4	Short-term borrowings during the year	85.00	0.00	0.00	0.00	0.00
1.5	Interest accrued during the year	11.35	22.70	19.00	19.00	19.00
1.6	Current year loans debt repayments					
	Of which: Repayment of capital	0.00	0.00	0.00	0.00	400.00
	Interest payment	9.50	19.00	19.00	19.00	19.00
1.7	Current year short-term borrowings debt repayments					
	Of which: Repayment of capital	0.00	85.00	0.00	0.00	0.00
	Interest payment	1.85	3.70	0.00	0.00	0.00
1.8	Loan principal balance at the end of the year	400.00	400.00	400.00	400.00	0.00
1.9	Short-term loan principal balance at the end of the year	85.00	0.00	0.00	0.00	0.00
2	Capital repayment funds					
2.1	Profits	-83.35	133.54	308.94	600.10	567.48
2.2	Depreciation	0.00	5.70	5.70	5.70	5.70
2.3	Amortization	0.00	175.70	204.50	233.30	262.10
2.4	Short-term borrowings	85.00	0.00	0.00	0.00	0.00
3	Total capital repayment funds	1.65	314.94	519.15	839.11	835.28
	Calculation of indicators:					
	Interest Coverage Ratio	-6.34	15.27	31.19	50.74	50.23
	Debt Service Coverage Ratio	-6.34	3.14	28.32	45.16	2.04

## 5.7 Cash Flow

Cash flow is the total amount of cash outflows and cash inflows received and paid throughout the life of the investment project.

Cash flow is essential information for evaluating the economic efficiency of an investment program. Specific elements include:

- ✧ Cash outflow: Cash outflow is the total capital expenditure of an investment project. It includes the following:
  - Construction Investment: All capital expenditures for the acquisition or construction of projects, including fixed assets and intangible assets.
  - Liquidity: Including cash, inventory, accounts receivable, marketable securities, prepayments, etc.
  - Operating Costs: Production costs, overhead and marketing expenses incurred in the course of the project's operation
- ✧ Cash inflow: The cash inflow is the total financial income incurred by the project and it includes:
  - Operating income: Income from sales of products sold in the course of business.
  - Residual value recovery of fixed assets and intangible assets.
  - Liquidity recovery: The original liquidity recovered at the end of the project life.

The cash flow contains 3 parts:

- ✧ Operating cash flow

- ✧ Investing cash flow
- ✧ Financing cash flow

The cash flow is calculated at the end of the year.

### 5.7.1 Operating cash flow

The operating cash flow statement reflects the cash flow incurred by the company for investment activities such as fixed assets. Without considering project financing, the project investment is used as the basis of calculation to calculate the evaluation indicators such as internal rate of return before and after income tax, net present value(NPV) and payback period to examine the profitability of the project investment.

1. Cash outflow:
  - a) Origin investment: Including construction investment and liquidity.
  - b) Operating Costs
  - c) Tax
2. Cash inflow:
  - a) Operating income
  - b) Subsidy income
  - c) Residual value recovery of fixed assets and intangible assets.
  - d) Liquidity recovery

This is operating cash flow statement of our project.

Basic Statement 1 Operating Cash Flow Statement		(Unit: Ten thousand yuan)				
No.	Project/Year	1	2	3	4	5
1	Cash inflows	0.00	750.00	1200.00	1800.00	2532.10
1.1	Operating Income	0.00	750.00	1200.00	1800.00	1800.00
1.2	Recovery of residual value of fixed assets					7.20
1.3	Recovery of residual value of intangible assets					434.90
1.4	Recovery of liquidity					290.00
2	Cash outflows	1112.98	618.61	853.33	1117.99	1097.58
2.1	Construction investment(Excluding construction period interest)	840.98	144.00	144.00	144.00	144.00
2.2	Liquidity	200.00	30.00	30.00	30.00	0.00
2.3	Operating Costs	72.00	399.40	600.13	825.19	834.78
2.4	Operating taxes and surcharges	0.00	45.21	79.20	118.80	118.80
2.5	Maintain operating investments					
3	Net cash flows before income taxes(1-2)	-1112.98	131.39	346.67	682.01	1434.53
4	Cumulative net cash flows before income taxes	-1112.98	-981.58	-634.91	47.09	1481.62
5	Adjustment of income tax	0.00	8.86	54.52	105.90	100.14
6	Net cash flows after income taxes	-1112.98	122.54	292.15	576.11	1334.39
7	Cumulative Net cash flows after income taxes	-1112.98	-990.44	-698.29	-122.18	1212.20
	Present-worth factor	1.0000	0.9259	0.8573	0.7938	0.7350

We can calculate the internal rate of return before and after income tax, net present value and payback period by using net cash flow.

These evaluation indicators are calculated as follows.

Before income tax	Internal Rate of Return (IRR)	30.22%
	Net Present Value(NPV)	901.72 ten thousand yuan
	Static Payback Period(Including construction period)	4.03 years
	Dynamic Payback Period(DPP)(Including construction period)	4.02 years
After income tax	Internal Rate of Return (IRR)	25.48%
	Net Present Value(NPV)	689.10 ten thousand yuan
	Static Payback Period(Including construction period))	4.09 years
	Dynamic Payback Period(DPP)(Including construction period)	4.05 years

These evaluation indicators show that our internal rate of return before and after income tax is greater than the expected rate of return (i.e., 8%), the net present value is greater than 0, and the payback period (including the construction period) is shorter than the project evaluation period.

Therefore, our project is economically reasonable from an overall perspective.

## 5.7.2 Investing cash flow

Capital is the funds owned by investors themselves. This statement is from the perspective of investors. And it examines the project capital by calculating evaluation indexes such as internal rate of return(IRR) and net present value(NPV) on capital.

This is investing cash flow statement of our project.

Basic Statement 2 Investing Cash Flow Statement		(Unit: Ten thousand yuan)				
No.	Project/Year	1	2	3	4	5
1	Cash inflows	0.00	750.00	1200.00	1800.00	2532.10
1.1	Operating Income	0.00	750.00	1200.00	1800.00	1800.00
1.2	Recovery of residual value of fixed assets and intangible assets					442.10
1.3	Recovery of liquidity					290.00
2	Cash outflows	724.33	735.16	926.85	1242.89	1616.72
2.1	Project Capital Funds	640.98	174.00	174.00	174.00	144.00
2.2	Borrowing principal repayment	0.00	85.00	0.00	0.00	400.00
2.2.1	Construction funding loan principal repayment	0.00	0.00	0.00	0.00	400.00
2.2.2	Short-term Borrowing principal repayment	0.00	85.00	0.00	0.00	0.00
2.3	Borrowing interest payment	11.35	22.70	19.00	19.00	19.00
2.4	Operating Costs	72.00	399.40	600.13	825.19	834.78
2.5	Taxes and surcharges	0.00	45.21	79.20	118.80	118.80
2.6	Income Tax	0.00	8.86	54.52	105.90	100.14
3	Net Cash Flow	-724.33	14.84	273.15	557.11	915.39
3.1	Cumulative net cash flow	-724.33	-709.49	-436.34	120.77	1036.15

We can get the evaluation indexes by calculating net cash flow.

These evaluation indicators are calculated as follows.

Internal Rate of Return (IRR)	31.27%
Net Present Value(NPV)(i=8%)	638.68 ten thousand yuan

We can see that the IRR is greater than the expected rate of return(8%), and the NPV is greater than 0, which indicates that the project capital can be profitable.

So, from the perspective of the investors, our project is economically reasonable.

### 5.7.3 Financing cash flow

The table is mainly used to analyze the financial analysis ability of the project.

This is the financing cash flow statement.

Basic Statement 4 Financing cash flow		(Unit: Ten thousand yuan)				
No.	Project/Year	1	2	3	4	5
<b>1</b>	<b>Net Cash Flow of Operating Activities</b>	<b>-72.00</b>	<b>337.64</b>	<b>538.15</b>	<b>858.11</b>	<b>854.28</b>
1.1	Cash inflows	0.00	750.00	1200.00	1800.00	1800.00
1.1.1	Operating Income	0.00	750.00	1200.00	1800.00	1800.00
1.1.2	Subsidy income					
1.1.3	Other inflows					
1.2	Cash outflows	72.00	412.36	661.85	941.89	945.72
1.2.1	Operating Costs	72.00	399.40	600.13	825.19	834.78
1.2.2	Taxes and surcharges(net of VAT)	0.00	4.11	7.20	10.80	10.80
1.2.3	Income Tax	0.00	8.86	54.52	105.90	100.14
1.2.4	Other outflows					
<b>2</b>	<b>Net Cash Flow of Investment Activities</b>	<b>-1040.98</b>	<b>-174.00</b>	<b>-174.00</b>	<b>-174.00</b>	<b>-144.00</b>
2.1	Cash inflows	0.00	0.00	0.00	0.00	0.00
2.2	Cash outflows	1040.98	174.00	174.00	174.00	144.00
2.2.1	Construction investment	840.98	144.00	144.00	144.00	144.00
2.2.2	Maintain operating investments					
2.2.3	Liquidity	200.00	30.00	30.00	30.00	0.00
2.2.4	Other outflows					
<b>3</b>	<b>Net Cash Flow of Fund-raising activities</b>	<b>1114.63</b>	<b>66.30</b>	<b>155.00</b>	<b>155.00</b>	<b>-275.00</b>
3.1	Cash inflows	1125.98	174.00	174.00	174.00	144.00
3.1.1	Project Capital Funds	640.98	174.00	174.00	174.00	144.00
3.1.2	Loans	400.00	0.00	0.00	0.00	0.00
3.1.3	Bonds					
3.1.4	Short-term borrowings	85.00	0.00	0.00	0.00	0.00
3.1.5	Other inflows					
3.2	Cash outflows	11.35	107.70	19.00	19.00	419.00
3.2.1	Various interest expenses	11.35	22.70	19.00	19.00	19.00
3.2.2	Principal repayment of debt	0.00	85.00	0.00	0.00	400.00
3.2.2.1	Repayment of loan principal	0.00	0.00	0.00	0.00	400.00
3.2.2.2	Repayment of principal of short-term borrowings	0.00	85.00	0.00	0.00	0.00
3.2.3	Profit Payable	0.00	0.00	0.00	0.00	0.00
3.2.4	Other outflows					
<b>4</b>	<b>Net Cash Flow(1+2+3)</b>	<b>1.65</b>	<b>229.94</b>	<b>519.15</b>	<b>839.11</b>	<b>435.28</b>
<b>5</b>	<b>Cumulative Surplus Funds</b>	<b>1.65</b>	<b>231.59</b>	<b>750.74</b>	<b>1589.85</b>	<b>2025.13</b>

We can see that the project's accumulated surplus funds are consistently greater than 0, indicating that the project has some financial viability.

## 5.8 Loss and profit Appropriation Statement

This table is used to reflect the financial statements of a company that has realized profits (or incurred losses) in a certain period. It can provide the reader of the statement with relevant



information needed to make reasonable economic decisions, and can be used to analyze the reasons for changes in profits, to evaluate the value of investments, etc.

The legal reserve is 10% of distributable profit, and the arbitrary reserve is 10% of distributable profit and 15% of income tax.

Basic Statement 3 Loss and profit Appropriation Statement (Unit: Ten thousand yuan)							
No.	Project/Year	1	2	3	4	5	合计
1	Operating Income	0.00	750.00	1200.00	1800.00	1800.00	
2	Taxes and surcharges(Net of VAT)	0.00	4.11	7.20	10.80	10.80	32.91
3	Total Cost	83.35	603.50	829.34	1083.20	1121.58	
4	Subsidy income	0.00	0.00	0.00	0.00	0.00	
5	Total profit(1-2-3+4)	-83.35	142.39	363.46	706.00	667.62	
6	Make up prior years' losses	0.00	83.35	0.00	0.00	0.00	
7	Taxable income(5-6)	-83.35	59.04	363.46	706.00	667.62	
8	Income Tax	0.00	8.86	54.52	105.90	100.14	269.42
9	Net Profit(5-8)	-83.35	133.54	308.94	600.10	567.48	1526.71
10	Unallocated profit at the beginning of the period	0.00	-83.35	40.15	279.27	703.50	
11	Profit available for distribution(9+10)	-83.35	50.19	349.09	879.38	1270.98	
12	Withdrawal of legal reserve	0.00	5.02	34.91	87.94	127.10	
12.1	Accumulated legal reserve	0.00	5.02	39.93	127.87	254.96	
13	Profit available for distribution to investors(11-12)	-83.35	45.17	314.18	791.44	1143.88	
14	Dividends payable on preferred stock	0.00	0.00	0.00	0.00	0.00	
15	Withdrawal of any surplus reserves	0.00	5.02	34.91	87.94	127.10	
15.1	Accumulated accumulated earnings from any surplus	0.00	5.02	39.93	127.87	254.96	
16	Dividends payable on common stock	0.00	0.00	0.00	0.00	0.00	
17	Profit distribution by each investor	0.00	0.00	0.00	0.00	0.00	
18	Undistributed profit(9-12-14-15-16-17)	-83.35	123.50	239.13	424.23	313.28	
18.1	Accumulated Undistributed profit	-83.35	40.15	279.27	703.50	1016.78	
19	Earnings before interest and tax(Total profit+Interest expense)	-83.35	144.88	331.64	619.10	586.48	
20	Profits before interest, taxes, depreciation and amortization(Earnings before interest and taxes)	-83.35	326.29	541.85	858.11	854.28	

And we calculate some evaluation indexes by these formulas:

*Average Investment Profit Margin*

$$= ( \text{Total Average Annual profit} / \text{Total Investment} ) \times 100\%$$

*Average Annual Investment Profit Tax Rate*

$$= \frac{\text{Annual Average Total Profit and Tax}}{\text{Total Investment}} \times 100\%$$

And these evaluations are as follows:

Average Investment Profit Margin	29.33%
Average Annual Investment Profit Tax Rate	35.14%
Total Return on Investment	45.66%
Net Profit Margin on Capital Funds	23.36%

This shows that the profitability of the project and the total return on investment are both relatively impressive.

## 5.9 Balance Statement

This table represents the primary accounting statement of the financial position of the enterprise as of a given date.

The table uses the accounting balance principle to classify assets, liabilities, and owners' equity that are consistent with accounting principles into assets and liabilities and owners' equity.

Basic Statement 5 Balance Statement		(Unit: Ten thousand yuan)				
No.	Project/Year	1	2	3	4	5
<b>1</b>	<b>Assets</b>	<b>1042.63</b>	<b>1265.17</b>	<b>1748.11</b>	<b>2522.21</b>	<b>2833.69</b>
1.1	Current assets	278.11	538.05	1087.20	1956.30	2391.58
1.1.1	Cash	200.00	230.00	260.00	290.00	290.00
1.1.2	Receivables	0.00	0.00	0.00	0.00	0.00
1.1.3	Basic reserve fees	76.45	76.45	76.45	76.45	76.45
1.1.4	Accumulated surplus funds	1.65	231.59	750.74	1589.85	2025.13
1.2	Net value of fixed assets	30.00	24.30	18.60	12.90	7.20
1.3	Net intangible assets	734.52	702.82	642.31	553.01	434.90
<b>2</b>	<b>Liabilities and owners' equity</b>	<b>1042.63</b>	<b>1265.17</b>	<b>1748.11</b>	<b>2522.21</b>	<b>2833.69</b>
2.1	Liabilities	485.00	400.00	400.00	400.00	0.00
2.1.1	Short-term borrowing balance	85.00	0.00	0.00	0.00	0.00
2.1.2	Loans	400.00	400.00	400.00	400.00	0.00
2.2	Owner's Equity	557.63	865.17	1348.11	2122.21	2833.69
2.2.1	Capital	640.98	814.98	988.98	1162.98	1306.98
2.2.2	Capital surplus					
2.2.3	Accumulated legal reserve	0.00	5.02	39.93	127.87	254.96
2.2.4	Accumulation of arbitrary surplus public benefit	0.00	5.02	39.93	127.87	254.96
2.2.5	Accumulated balance of unappropriated earnings	-83.35	40.15	279.27	703.50	1016.78

We can get the Average debt ratio by Total liabilities / Total Assets.

Gearing Ratio (5-year average)	17.90%
--------------------------------	--------

Our annual average gearing ratio is 17.90%, which is relatively low, and there is no risk of breaking the capital chain due to excessive debt.

## 6 Risk Analysis

Sensitivity analysis mainly analyzes the corresponding changes of economic evaluation indicators when the main factors of the project change. It is related to whether the project is a profitable project.

At the same time, there are some major factors in our project, such as operating income, construction investment, operation and so on. We chose four factors as the targets of our sensitivity analysis, which are operating income, construction investment, operation and maintenance costs and personnel costs. And we chose to use the project operating internal rate of return(IRR) as the economic evaluation index for sensitivity analysis, and the variable range of each variable is -15% ~ 15%.

The results we analyzed are as shown in the following table.

### ✧ Operating Income

Uncertainty	Operating Income						
Rate of change of Uncertainty	-15%	-10%	-5%	0%	5%	10%	15%
Internal Rate of Return(IRR)	19.29%	23.01%	26.65%	30.22%	33.73%	37.17%	40.56%
Yield Change	-10.93%	-7.21%	-3.57%	0.00%	3.51%	6.95%	10.34%
Percentage Change	-36.17%	-23.86%	-11.81%	0.00%	11.61%	23.00%	34.22%

### ✧ Construction Investment

Uncertainty	Construction Investment						
Rate of change of Uncertainty	-15%	-10%	-5%	0%	5%	10%	15%
Internal Rate of Return(IRR)	37.37%	34.85%	32.47%	30.22%	28.10%	26.08%	24.15%
Yield Change	7.15%	4.63%	2.25%	0.00%	-2.12%	-4.14%	-6.07%
Percentage Change	23.66%	15.32%	7.45%	0.00%	-7.02%	-13.70%	-20.09%

### ✧ Operation and Maintenance Costs

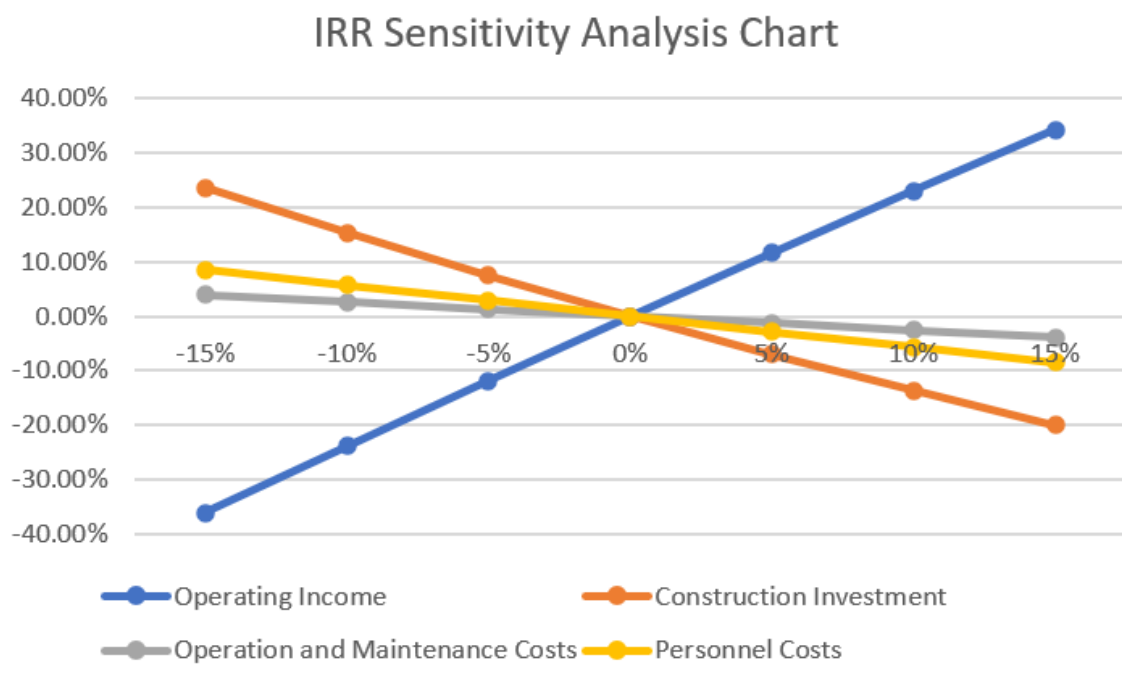
Uncertainty	Operation and Maintenance Costs						
Rate of change of Uncertainty	-15%	-10%	-5%	0%	5%	10%	15%
Internal Rate of Return(IRR)	31.43%	31.03%	30.62%	30.22%	29.83%	29.43%	29.03%
Yield Change	1.21%	0.81%	0.40%	0.00%	-0.39%	-0.79%	-1.19%
Percentage Change	4.00%	2.68%	1.32%	0.00%	-1.29%	-2.61%	-3.94%

#### ✧ Personnel Costs

Uncertainty	Personnel Costs						
Rate of change of Uncertainty	-15%	-10%	-5%	0%	5%	10%	15%
Internal Rate of Return(IRR)	32.78%	31.93%	31.08%	30.22%	29.37%	28.51%	27.64%
Yield Change	2.56%	1.71%	0.86%	0.00%	-0.85%	-1.71%	-2.58%
Percentage Change	8.47%	5.66%	2.85%	0.00%	-2.81%	-5.66%	-8.54%

#### ✧ Sensitivity Analysis Chart

Combining the results of the analysis of each of the above variables, we obtained the IRR sensitivity analysis graph shown below.



The above table of analysis of changes in each variable and the IRR sensitivity analysis chart

show that the sensitivity factors of the main variables are ranked as follows: operating income > construction investment > personnel costs > operation and maintenance costs.

Among them, the most sensitive variable is operating income, i.e., the change in operating income has the greatest impact on the change in IRR. After a 15% reduction in operating income, the IRR decreases by 10.93% to 19.29% > 8%, which is still higher than the minimum expected rate of return, so the project is still feasible, indicating that the overall risk of our project income is low and the project is more risk-resistant.

At the same time, the change in construction investment also has a large impact on the project IRR, which needs our attention.

## 7 Decision Under Uncertainty

### 7.1 States Elaboration

In our development of the core functionality, we take into account the uncertainties that may arise in the market in the future. For example, after the product launch, online and offline classes use our product differently, and the national university classroom format receives multiple influences as an uncertainty. Also, competitors' reactions are also worth watching.

State ID/State Attributes	Online/Offline Course	Competitors' reactions
S1	Online	Competition
S2	Offline	Competition
S3	Online	No reaction
S4	Offline	No reaction

### 7.2 Alternative choice

We have three alternatives for our project, which are listed as follows:

ID	Alternatives in detail
Alternative1	Increase product promotion, expand market share and keep in touch with more potential customers
Alternative2	Maintain existing functions and launch products with simplified functions and low prices.
Alternative3	Add additional functions to the basic version and launch a pro version with more functions such as real-time monitor and charge more.

The three alternatives are quite different with respect to the use of budgets and established costs, and the post-release profitability and resilience to uncertainties are quite different. And they will perform differently in different states mentioned above.

### 7.3 Payoff Matrix Computation

There are five methods to compute payoff matrix, which are Laplace, Maximin, Maximax, Hurwicz, Minimax regret.

Maximin is an extremely cautious method and Maximax is an extreme method, both of which have a larger possibility to cause a negative effect.

If we choose Hurwicz, the weight is hard to set. So, we finally choose Laplace method to

compute payoff matrix. And the Payoff Matrix is as follows.

	S1	S2	S3	S4
Alternative1	¥ 5.4 million	¥ 4.2 million	¥ 8.6 million	¥ 6.7 million
Alternative2	¥ 3.3 million	¥ 2.5 million	¥ 9.1 million	¥ 7.2 million
Alternative3	¥ 8.8 million	¥ 6.7 million	¥ 5.4 million	¥ 4.3 million

Computation result of my payoff matrix by Laplace method:

	Average Value
Alternative1	¥ 6.225 million
Alternative2	¥ 5.525 million
Alternative3	¥ 6.3 million

## 7.4 Final Alternative Determination

After calculation, we finally determined the current alternative by evaluating several different evaluation methods. We do not want to be very pessimistic and optimistic about uncertain situations, so we give priority to the results of Laplace method instead of Maximax, Maximin ,and Minmax Regret methods.

We ultimately chose to make the technology as complete as possible to handle greater user throughput, as well as to address some key monitoring issues for online use in response to the difficulty of determining different competitor responses and the general situation in the domestic environment determine a final alternative.

## 8 Multiple Attribute Decisions

### 8.1 Problem Elaboration

During the development of our project, we were faced with the choice of development platform. The platforms we can choose from include the web side, iOS side, Android side and WeChat side. The development method, development environment and even syntax knowledge of different platforms may be very different, and because project members are not uniformly familiar with different platforms, the development of different platforms may lead to very different development costs. In addition, because the audience of different platforms is not exactly the same, as well as the frequency of use of the Web side, App side and WeChat side there are also differences, may lead to a large difference in the users of different platforms.

So how do we choose a platform to develop our project? Obviously, this is a multi-attribute decision problem and we will give out a decision with the knowledge of our course.

### 8.2 Different Attributes Analysis

#### ✧ **Cost**

The four development platforms have different cost overheads.

On the one hand, as project team members are familiar with the four development methods, for example, they are more familiar with the development of the Web side, but relatively unfamiliar with the development of the IOS side, which leads to the implementation of the same function of the project to different platforms which may vary greatly in time, resulting in the delay of the development period or the increase of development costs.

On the other hand, different platforms use different development environments and resources, so the cost of learning and training also varies with the difficulty of development and the maturity of the development method or toolkit.

#### ✧ **Maintainability**

Differences in development and testing platforms lead to large differences in O&M costs and maintainability across platforms. Then in the subsequent operation, the maintainability of different platforms is also a factor that we need to focus on.

#### ✧ **Convenience**

We evaluate the user convenience of different platforms and take it as one of the influencing factors



### ✧ Potential User Numbers

As the number of active users varies greatly from platform to platform, the number of active users on a platform can directly affect the profitability of a project. Rationally speaking, the number of users of WeChat platform can be said to be the most extensive, Android platform and iOS platform are closer, especially for the student group. web side has better adaptability for students, but the operation of PC side is not as convenient as the mobile side.

## 8.3 Decision Tech Analysis and Choice

As mentioned above, we have four alternatives under current resources:

- ✧ Develop on Web.
- ✧ Develop on Android.
- ✧ Develop on IOS.
- ✧ Develop on WeChat.
- ✧ Develop on both Android and IOS.

First, list the value of those attributes of different alternatives.

	Cost	Maintainability	Convenience	Potential User Numbers
Alternative1	¥ 150,000	1	0.7	200
Alternative2	¥ 200,000	0.9	0.9	150
Alternative3	¥ 250,000	0.8	0.9	150
Alternative4	¥ 180,000	0.9	1	250
Alternative4	¥ 600,000	0.7	1	300

Then we scale the matrix into range(0,1). The scaling function is:

$$Rating = Range * \frac{WorstValue - CurrentValue}{WorstValue - BestValue}$$

Scale range setting is one:

	Cost	Maintainability	Convenience	Potential User Numbers
Alternative1	1	1	0.7	0.67
Alternative2	0.67	0.9	0.9	0.5
Alternative3	0.6	0.8	0.9	0.5
Alternative4	0.83	0.9	1	0.83
Alternative4	0.25	0.7	1	1

Then we use the method of additive weighting, and the weight of above four attributes are 0.3, 0.2, 0.1, 0.4 respectively.

So, we calculate the weighted score of each alternative:

Alternative	Score
1	$0.3+0.2+0.07+0.27=0.84$
2	$0.2+0.18+0.09+0.2=0.67$
3	$0.18+0.16+0.09+0.2=0.63$
4	$0.25+0.18+0.1+0.33=0.86$
5	$0.075+0.14+0.1+0.4=0.715$

The maximum value is 0.86, so we choose alternative four as our core technology development method. That is to say, we choose the WeChat platform as our development environment.