

大连理工大学软件学院

2018-2019 学年度《工程经济学》大作业

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## 《工程经济学》大作业工作量分配表

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组员 3：（姓名+工作量百分比）

张孟泽 20%

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组员 4：（姓名+工作量百分比）

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# 1 Introduction

## 1.1 Project Background Information

Dalian is an important central city, port and tourist city in the northern coastal areas of China. Dalian is located on the east coast of Eurasia, the southernmost point of the Liaodong Peninsula in northeast China, the Yellow Sea in the east, the Bohai Sea in the west, the Shandong Peninsula across the sea in the south, and the vast northeast plain in the north. It is an important sea gateway in northern China. With the rapid development of regional social economy, the population of Dalian has been increasing. At the end of 2014, the city's registered population was about 5.943 million. The resident population was mainly concentrated in the central city and related peripheral streets, with about 4.1 million people, of which the permanent population in the core area accounted for more than 65% of the permanent population in the central city.<sup>[1]</sup>

As the growth rate of transportation demand is higher than the construction speed of transportation facilities, road resources and public transportation facilities cannot meet the travel demand, and the contradiction between supply and demand is prominent. Dalian is committed to developing public transportation to alleviate this pressure. In order to solve the current problems in Dalian's transportation, adapt to the needs of urban economic growth and development, and adapt to the sustainable development of urban transportation, the Dalian People's Government compiled and completed the Dalian Urban Rail Transit Network Planning. (2015-2020) and Dalian Urban Rail Transit Construction Planning (2015-2020), (hereinafter referred to as Construction Planning). According to the "Construction Plan", the third phase of the Metro Line 1, Line 4, Line 5 (hereinafter referred to as "Metro Line 5") and Phase II of the R4 Line will be built from 2015 to 2020.

## 1.2 Innovation

Metro Line 5 is the first rail transit investment project in Dalian that uses the whole process of cooperation between the government and the social capital. The social capital procurement, contract negotiation and project company registration are being completed.

## 1.3 Necessity

From a qualitative point of view, the project adopts the PPP model to increase public supply, optimize risk allocation, improve efficiency, promote management innovation and fair competition, and effectively implement government procurement policies compared with the traditional government investment and procurement model; Can also effectively alleviate the traffic pressure in Dalian From a quantitative point of view, the value-for-value evaluation value and the value-for-money index of the project are both greater than zero, and the PPP mode is suitable.

## 2 Research Project content

### 2.1 Research content

Dalian Metro Line 5 has a total length of 24.484 kilometers. It is laid by underground line, with 18 stations (including 6 interchange stations), 1 vehicle section, 1 control center and 2 main substations. The main construction contents include stations, sections, depots, control centers and related equipment and facilities. Dalian Metro Group and the project company signed a Franchise Agreement to grant the project company a franchise right; the project company is responsible for the investment and financing of the projects, construction, operation, renewal and maintenance work.

Metro Line 5 is connected in series with the core carrier of Qingniwa and Shuttle Fish Bay. It connects Dalian Railway Station and Dalian New Airport to two external transportation hubs. It breaks the bay against Qingniwa, the Bayu Bay area and even the old Ganjingzi. The blockage of the area has changed the single westward passage of the Ganjingzi area in the past, providing a new way of travel for the Ganjingzi area. The capacity of Dalian Express Rail Line 3 (R3) is close to saturation and is expanding. According to the current passenger flow section analysis of the fast track No. 3 line, the post-salt to the railway station is the area with the largest passenger flow pressure on the R3 line, while the subway line 5 is transferred twice at the train station and the post-salt and fast-track line 3, which can be effective. Relieve passenger flow pressure in the core area of Fast Track Line 3.

### 2.2 Plan content

According to the plan, Metro Line 5 starts from the Ocean Plaza at the intersection of Binhai East Road and Hutan Road in Hutan New District in the south, and passes through the Tiger Beach Park to the west and then to the east side of the Labor Park along the Jiefang Road in the northwest. Entering the friendly street to the north, after crossing the Harbin-Dalian Railway, go to the Dalian Railway Station North Square, cross the bay and enter the Barracuda Bay area, go north along the Ganjingzi Road to the spring water, post-salt, and wear the Shenhai Expressway. After the 202 National Highway, the terminal is located at Houguancun Station, and the new extension is connected to the north extension of Dalian Metro Line 1. The route map is showed in figure



Figure 1: The Route Map

### 3 Project economic analysis

#### 3.1 Demand analysis

The key factor for the rapid development of the urban rail market is the continuous establishment and opening of the new line. Since 2014, the demand for the urban rail market including subways, trams, and light rails has gradually been released. The major first-tier and second-tier cities have basically obtained the qualifications for urban rail construction and began to enter the stage of intensive construction period. Rail transportation helps to enrich residents' travel modes, establish an efficient, flexible and environmentally friendly urban transport system, also help to increase the price of land assets along the line and activate urban development. Another factor is the increasement in the density of existing urban rail transit lines. This is because the substitution of urban rail for public transportation and other modes of travel is gradually increasing, and the passenger flow intensity of the line often increases with the extension of operation time. In the early days of line operation, the number of residents who chose urban rail transportation was lower because traditional travel habits had not been reversed. With the maturity of urban rail operations and the increasing dependence of residents on the urban rail system, the passenger flow density will gradually increase.<sup>[2]</sup> The data shows that the passenger flow intensity is inversely related to the minimum departure interval during the peak period, and has a significant positive correlation with the distribution density. That is, the greater the operational intensity and the higher the daily average passenger flow intensity per kilometer, the higher the distribution density.

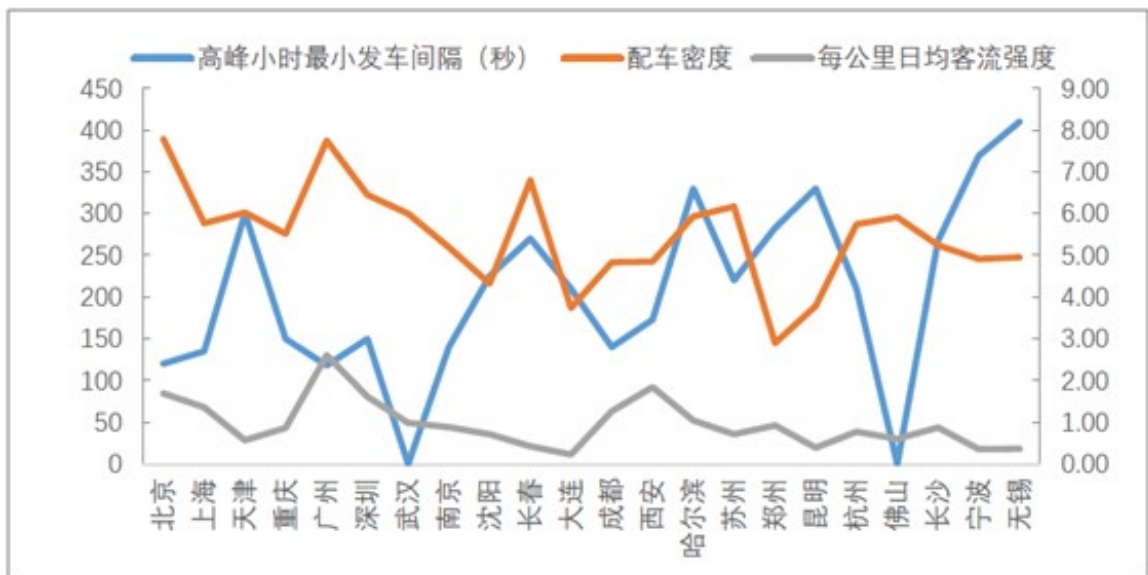


Figure 2: command analysis

Above all, with the increasing flow of passengers, the lines need to be put into construction urgently.

## 3.2 Cost analysis

### 3.2.1 Found raising plan

The shareholders of the limited liability company shall be responsible for the company within the limits of the capital contribution they have subscribed. Since the project is a major infrastructure project in Dalian, the investment amount is huge and the life cycle is long, which faces many unpredictable during the construction and operation of the project. Various types of risks, appropriate increase of project capital ratio is conducive to better prevention of risks; at the same time, when the project capital ratio is low, the project company has a higher financing risk, considering the reasonable profit of the project company and the bank financing cost (long-term benchmark Interest rate 4.9%) and other domestic similar project experience data, under the premise of the internal rate of return of project capital of 8%, the capital ratio of the project is considered at 40% of the total investment, and the remaining 60% of the funds are considered solving by bank loans. The loans used for construction investment and construction period interest are considered based on the long-term loan interest rate. The loan period is 24.5 years, the grace period is 5.5 years, and the repayment period is 19 years. The interest rate based on the current 5-year long-term loan annual benchmark interest rate issued by the Peoples Bank of China is 4.9%. The loan used by working capital is a short-term loan, and the interest rate is calculated based on the current one-year short-term loan annual interest rate issued by the People's Bank of China, which is 4.35%.<sup>[3]</sup>

### 3.2.2 Total cost

- **Power costs.** Refer to all traction, power, and lighting. Refer to the domestic subway operation data and domestic similar project data in combination with the local price level. The project is temporarily calculated according to 5.5 degrees / car kilometers (including tax), the electricity price is calculated according to the current Dalian Metro agreement electricity price of 0.695 yuan/kWh (including tax).
- **Repair costs.** Include vehicle repair costs, mechanical and electrical equipment repair costs, and major repairs and daily maintenance costs for tunnels, building construction, and reference to domestic subway operating data and domestic similar project data combined with local price levels. The project is temporarily calculated at 3.5 yuan / car kilometers (including tax).
- **Operating expenses.** Operating expenses refer to the expenses related to operations, including water, transportation, accident, metering, ticket printing, cleaning, etc. According to the domestic subway operation data, the project is calculated at 1.5 yuan/car km.
- **Labor Wages.** Personnel's salary is based on the feasibility study report. The initial, near and long-term quotas of the project are 56 persons/km, 59 persons/km, and 57 persons/km respectively. According to the approval of the Dalian Financial Department, the average salary of the subway operation company in 2016 was 67,600 yuan (before tax), and the welfare expenses were 40.1% of the salary.



According to this calculation, the initial period of the staff salary (including welfare) is 94,700 yuan/year [ $9.47 = 6.76 * (1 + 40.1\%)$ ]

- **Management fee.** The management fee is considered as 10% of the above sum.
- **Operating cost adjustment.** The above-mentioned operating cost adjustment is the operating cost of the project. Considering the cost increase, the estimated operating cost is increased by the annual average of 3% inflation coefficient.

### 3.3 Income analysis

- **Ticket income** The ticket price for the Dalian Metro fare is implemented as follows: The fare standard is as follows:
- **Fare adjustment** Considering the fare adjustment of the subway, the average fare of the project is adjusted every five years according to the annual average 2% fare growth rate.
- **Non-ticket revenue** Non-ticket revenue is estimated at 20% of the ticket revenue.
- **Subsidy income (Also calculate tax)** The subsidy income is divided into two parts: First, the annual construction cost subsidy, that is, the construction cost subsidy paid by the government in each year of the operation period, including the total construction investment (including other construction costs, construction period interest), operating period interest, taxes and fees. Reasonable return (annual construction cost subsidy is PPP trademark, that is, social capital quote) The second is the operational feasibility gap subsidy (fare compensation), which is the passenger difference between the agreed per capita fare (PPP bidding, the quoted social capital) and the predicted per capita fare.
- **Turnover tax and surcharge** Urban maintenance and construction tax: According to national regulations, it is calculated as 7% of value-added tax. Education surcharge: According to national regulations, it is 3% of value-added tax. Local education surcharge: According to national regulations, 2% of the value-added tax. The above four taxes are listed in the VAT and additional items.

## 4 Financial Analysis

### 4.1 Investment Analysis

In table **Table 1**.Notations will be used are defined.

We first collected the detail data of the project, it is composed by four parts I, II, III and IV. Each part is composed by some projects and some of these subjects are composed by sub-projects. For example, in part I, the investment of project 1 is the sum of subproject 1.1, 1.2 and 1.3.

Table 1: Notations

Symbol	Definition
$k$	Serial Number of Subproject Investment
$n$	Serial Number of Project Investment
$m$	Serial Number of Part Investment
$y$	Year Number
$SPI_k$	Subproject Investment of k Subproject
$PPI_n$	Project Investment of n Project
$PI_m$	Part Investment of m Part
$TI$	Total Investment
$IFIR$	Inflection-free Interest Rate
$IR$	Inflation Rate
$MR$	Market Rate
$PTI_{2016}$	2016 Present Total Interestment
$PTI_{2021}$	2021 Present Total Interestment
$AWC$	Additional Working Capita
$AMWC$	Amount of Working Capital
$IRR$	Internal Rate of Return
$PW$	Present Value

- 1. Use formula (1) to calculate  $PPI_n$ :

$$PPI_n = \sum SPI_k \quad (1)$$

- 2. Use formula (2) to calculate  $PI_m$ :

$$PI_m = \sum PPI_n \quad (2)$$

- 3. Use formula (3) to calculate the year  $y$  's total investment  $TI_y$ :

$$TI_y = \sum PI_m \quad (3)$$

- 4. Use **Present Value Analysis** to find the Present Value of 2016  $PTI_{2016}$ , which is composed by the **initial present value** and **calculated present value**  $PTI_{2016}$ . The *Excel* function *NPV* is used to calculate *PresentWorse* in 2016 it can be treated as **calculated present value**:

$$PTI_{2016} = NPV(MR, [SI_k]) + PTI_{2016} \quad (4)$$

- 5. Use formula(5) to calculate  $MR$ :

$$MR = IFIR + IR + IFIR \times IR \quad (5)$$

- 6. The investment  $PTI_{2021}$  is based on  $PTI_{2016}$  is affected by  $MR$ ,  $PTI_{2021}$  use formula(6) to calculate  $PTI_{2021}$ :

$$PTI_{2021} = PTI_{2016} \times (1 + MR)^5 \quad (6)$$

## 4.2 Cash Flow Statement Analysis

Cash Flow Statement consists of three parts which are Operating Activities, Investment Activities and Financing Activities.

**1. In Operating Activities** There are net income and depreciation. Both these two items are calculated in Income Statement Table.

**2. In Investment Activities** There are investment of equipment and infrastructure, Salvage Value, Gain Taxes and Working capital.

Investment of **Equipment and Infrastructure** is estimated in the Project Investment Table. The investment from 2016 to 2021 is converted to the investment in 2021. The total investment of equipment and infrastructure is 2, 105, 264 according to the calculating result in the Project Investment Table. Since the investment is the cash outflow, it is -2, 105, 265.

**Salvage Value** is estimated according to the types and number of equipment. Since the salvage value is the residual value that expected to be recovered when an asset expires, it is 700, 000 at the inflation rate of %3.74.

*GainTaxes* is related to depreciation and salvage value. The formula is as formula(7)

$$Gains\ Taxes = (Slavage\ Value - Book\ Value_n) * (Tax\ Rate) \quad (7)$$

In which book value is:

$$BookVlaue = BasisCost - \sum Depreciation \quad (8)$$

In which Tax Rate is the same as the tax rate in the Income Statement Table, which is 33%. In *Excel* The Book Value is calculated according to the Depreciation Table. The function is

$$BookValue = 1746548 - (SUM(D1, D2, \dots, D10)) = 1746548 - 1068020 = 678528 \quad (9)$$

And the Gains taxes is

$$GainsTaxes = (700000 - 678528) * 0.33 = 7086 \quad (10)$$

**Working capital** is the amount money available for the daily use and turnover in the operation of rail transportation. Its estimated according to other transportation project with the same scale. The working capital of 2021 is -45,000. Taken the inflation rate of 3.74% into consideration, the additional working capita(*AWC*) of each following year is calculated as follows:

$$AWC_{2022} = -45000 * 3.74\% = -1683 \quad (11)$$

$$AWC_{i+1} = AWC_i * (1 + 3.74\%) \quad (12)$$

$$AWC_{2023} = AWC_{2022} * 1 + 3.74\% = -1683 * 1 + 3.74\% = -1,746 \quad (13)$$

...

$$AWC_{2030} = AWC_{2029} * (1 + 3.74\%) = -2,176 * (1 + 3.74\%) = -2,258 \quad (14)$$

As this project is a 10-year project, it needs to retrieve all the working capital in the end of 10th year. Therefore, the amount of working capital( $AMWC$ ) this project invested is

$$AMWC = \sum_{i=2021}^{2030} -AWC_i \quad (15)$$

**3. Financing Activities**, there are borrowed funds and principle repayment. **Borrowed Funds** is 660,688 in 2021 according to the Loan Repayment Table. **Principle Repayment** is also calculated in the Loan Repayment Table.

**4. Net Cash Flow** of each year is the sum of the items above of that year.

**5. Internal Rate of Return ( $IRR$ )** is the interest rate when the present value equals to zero, which means the amount of cash inflow is equal to outflow. Use the fomula in Excel:

$$IRR(values, guessrate) \quad (16)$$

The  $IRR$  can be calculated as  $-1\%$ . Because we assume the project period is only 10 years. However, the project life can be 20 years or even more. Consider the  $IRR$  of more than 10 years, it may be positive.

**6. Present Value** based on the current interest rate, use the formula as following:

$$PW = NPV(MarketInterestRate, CashFlow_{1,2,...,n}) + CashFlow_0 \quad (17)$$

In which current Market Interest rate is  $8.823\%$  according to the Project Investment Table.  $PW$  is calculated as  $-770567$ .

Table 2: Total Project Investment Analysis

Total Project Investment (Unit: 10,000 yuan)							
k	Name	2016	2017	2018	2019	2020	2021
I	Project costs	53,427	186,913	221,360	259,021	273,198	186,577
1	Station engineering	26,028	55,687	55,687	63,677	53,629	47,940
1.1	Construction	1,816	7,264	7,264	7,264	9,079	3,632
1.2	Equipment				7,990	8,232	7,990
1.3	structure	24,212	48,424	48,424	48,424	36,318	36,318
2	District engineering	18,690	74,762	74,762	74,762	74,762	56,071
3	Track engineering	2,518	10,070	10,070	10,070	10,070	7,553
4	Wanted system		3,757	7,514	9,392	13,149	3,757
5	Nickname system		3,398	6,796	8,495	11,893	3,398
6	Power supply system		13,541	27,082	33,853	47,394	13,541
7	Practice and control		697	1,395	1,744	2,441	697
8	Prevention alarm		1,733	3,466	4,333	6,066	1,733
9	Security control		689	1,378	1,723	2,412	689
10	Ventilation		1,991	3,982	4,978	6,969	1,991
11	Water supply		1,502	3,005	3,756	5,258	1,502
12	Sales inspection						13,759
13	Station attached equip				10,987	10,987	11,320
14	Control center	1,135	3,405	5,999	6,486	7,945	7,459
14	Construction	195	584	778	778	778	778
14	Quality equipment			389	519	908	778
14	Electrical Equipment			1,070	1,427	2,497	2,140
14	structure	940	2,821	3,762	3,762	3,762	3,762
15	Depot & practice base	4,544	13,631	18,175	22,719	18,175	13,631
15	Special vehicles	727	2,181	2,908	3,635	2,908	2,181
15	structure	3,817	11,450	15,267	19,084	15,267	11,450
16	Civil air defense	512	2,048	2,048	2,048	2,048	1,536
II	Other costs	142,681	28,536	28,536	28,536	28,536	28,536
III	Reserve fee	19,611	21,545	24,990	28,756	30,173	21,511
IV	Vehicle purchase fee						117,000
	Number of vehicles						
	Unit price						
	Construction Invest.	215,719	236,992	274,885	316,315	331,907	353,624
	IR=3.74%						
	IFIR=4.9%						
	MIR=8.82326%			8.82326%			
	2016-Present Value			1,379,424.8			
	2021-Present Vlaue			-2,105,264.6			



### 4.3 Income Statement Analysis

The income statement primarily focuses on company's revenues and expenses during a particular period.

First, we got the details of revenue expense from the official website of Dalian Railway<sup>[4]</sup> and made an assumption of the inflation rate at 3.74%.

**1. In Depreciation**, the investment in year zero is 1,746,548. The project life is 10 years while the equipment life is 20 years, so we should figure out the depreciation based on 20-year ownership. We can calculate the accurate depreciation of every year by *MACRS*.

$$\text{The first half year : } \frac{1}{2} \times DDB = 2 \times \frac{1}{2} \times \frac{1}{20} = 5\% \quad (18)$$

$$\text{The second year : } DDB = 2 \times \frac{1}{20} \times (1 - 5\%) = 9.5\% \quad (19)$$

$$\text{The third year : } DDB = 2 \times \frac{1}{20} \times (1 - 5\% - 9.5\%) = 8.55\% \quad (20)$$

$$\text{The fourth year : } DDB = 2 \times \frac{1}{20} \times (1 - 5\% - 9.5\% - 8.55\%) = 7.695\% \quad (21)$$

...

$$\text{The ninth year : } DDB = 2 \times \frac{1}{20} \times (1 - 5\% - \dots - 5.05\%) = 4.544\% \quad (22)$$

$$\text{The last half year : } \frac{1}{2} \times DDB = 2 \times \frac{1}{2} \times \frac{1}{20} \times (1 - 5\% - \dots - 4.544\%) = 2.045\% \quad (23)$$

Additionally, the first 10-year depreciations are all *DDB* method because those rates are greater than *SL* methods results. In the further calculation, we switch to *SL* in the 12<sup>th</sup> year, where *SL* rate is 3.487% and the *DDB* rate is 3.312%.

**2. Income taxes** in this project the income tax rate is 33% due to the law of China.<sup>[5]</sup> If the taxable income of the current year is greater than zero, we can calculate the income tax. Otherwise, the taxes should be zero for financial deficit.

$$\text{Income taxes} = \text{Taxable income} \times 33\% \quad (24)$$

**3. Net income** can be figure out easily by the last two rows. We should notice that, from 2023 to 2025, the net incomes all are negative due to the large amount of depreciation. It also implies the feature of this project: it needs a huge investment at the beginning and recover for a long period.

### 4.4 Loan Repayment Analysis

The loan repayment sheet contains the items of debt and repayment in the interest period. This is a table to tell others how much money should be paid annually and

whether it is wise or not to pay all the rest loan ahead if one has enough money. There are four kinds of loan in this table which have different meanings and rates. The key to calculate this sheet is know the interest rate( $i$ ), the period( $n$ ) and the present money( $P$ ) of every loan. Once we got all those, we can easily figure out the annual repayment( $A$ ) by:

$$A = P(A/F, i, n) \quad (25)$$

In this project,  $i$  is 4.9% annually. For Instance, the period of long-term loan is 9 years and the initial loan is 660,688. With the help of Excel, we can calculate the annual payment, interest payment and principal payment by the embedded formula  $PMT$ ,  $IPMT$  and  $PPMT$ . Therefore, we can calculate other loan with this method. The result is showed in table (4).

Table 4: Loan Repayment Analysis

Loan Repayment Table											
	Item	Period									
		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
I	Repayment of Long-term Construction										
1	Beginning Debt	660688	600523	537410	471204	401754	328902	252479	172312	88216	
2	Current Repayment	92539	92539	92539	92539	92539	92539	92539	92539	92539	
	Principal Repayment	60165	63113	66206	69450	72853	76423	80167	84095	88216	
	Debt Interest	32374	29426	26333	23089	19686	16116	12371	8443	4323	
3	End-of-term Debt	600523	537410	471204	401754	328902	252479	172312	88216	0	
II	Addition of Vehicle Capital Loan Repayment										
1	Beginning Debt				21344	17473	13413	9154	4687		
2	Current Repayment				4916	4916	4916	4916	4916		
	Principal Repayment				3870	4060	4259	4468	4687		
	Debt Interest				1046	856	657	449	230		
3	End-of-term Debt				17473	13413	9154	4687	0		
III	Update of Long-term Loan Repayment										
1	Beginning Debt					92339	75594	58030	39604	20276	
2	Current Repayment					21269	21269	21269	21269	21269	
	Principal Repayment					16744	17565	13426	19328	20276	
	Debt Interest					4525	3704	2843	1941	994	
3	End-of-term Debt					75594	58030	39604	20276	0	
IV	Short-term Loan Repayment										
1	Beginning Debt	0	0	0	0	0	0	0	0	0	0
2	Current Repayment	0	0	0	0	0	0	0	0	0	0
	Principal Repayment	0	0	0	0	0	0	0	0	0	0
	Debt Interest	0	0	0	0	0	0	0	0	0	0
3	End-of-term Debt	0	0	0	0	0	0	0	0	0	0
V	Aggregate of Loan Repayment										
1	Beginning Debt	660688	600523	537410	492548	511566	417909	319663	216603	108492	0
2	Current Repayment	92539	92539	92539	97455	118724	118724	118724	118724	113808	0
	Principal Repayment	60165	63113	66206	73320	93657	98247	98061	108110	108492	0
	Debt Interest	35185	35186	35187	35188	35189	35190	35191	35192	35193	0
3	End-of-term Debt	600523	537410	471204	419227	417909	319663	216603	108492	0	0



## 5 Scenario Analysis

### 5.1 Definition

When we are using the Scenario analysis, we have examined 20 years of data and choose the average values of every items as the values for the most likely case; the highest number of passenger flow and ticket price as the value for the best case the lowest number for the worst case; the lowest number of wages and power fees as the values for the best case and the highest number for the worst case. And based on our searching results, we choose 3%,5%,8% as the market growth rate for the worst case, the most likely case and the best case respectively. About salvage value, we choose 120% of the present one as the salvage value for the best case and 80% of the present one as the worst case, the present one as the most likely case.<sup>[6]</sup>

Table 5: Scenario Analysis Definition

Scenario Analysis			
Variable Considered	Worst-Case Scenario	Most-Likely-Case Scenario	Best-Case-Scenario
passenger flow(10000 person times)	9833	13318.2	17447
Actual average fare(after adjustment)	2,245	2.4161	2.786
Market Growth Rate	3%	5%	8%
wages	10098.81	12623.51	15148.21
Power	4991.98	6239.97	7487.96
salvage value	560000	700000	840000

## 5.2 Worst Condition

### 5.2.1 Income Statement

Table 6: Worst Condition Income Statement

End of Year	Inflation rate	Income Statement									
		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Revenue	3.74%	227,796.33	229,826.03	231,983.24	234,281.31	237,387.11	240,034.04	242,851.04	245,849.68	249,114.15	252,860.35
Passenger flow(10000 person times)		9,833.00	10,127.99	10,431.83	10,744.78	11,067.13	11,399.14	11,741.12	12,093.35	12,456.15	12,829.83
Actual average fare(after adjustment)	3.74%	2,245	2,329	2,416	2,506	2,600	2,697	2,798	2,903	3,012	3,124
Operating income(Passenger flow * actual average fare)	3.74%	22,075	23,588	25,204	26,931	28,776	30,748	32,855	35,106	37,512	40,082
Subsidy income	3.74%	195365	195475	195592	195716	196072	196229	196395	196572	196761	196440
VAT	3.74%	465	565	673	792	1312	1478	1658	1853	2127	3129
Attach	3.74%	56	68	80	95	157	177	199	222	255	376
Power	3.74%	4991.98	5,178.68	5,372.36	5,573.29	5,781.73	5,997.97	6,222.29	6,455.00	6,696.42	6,946.87
Repair	3.74%	5,710.90	5,926.18	6,150.43	6,380.66	6,622.85	6,871.02	7,131.15	7,400.25	7,531.81	7,666.36
Operation	3.74%	2,444.80	2,536.96	2,632.96	2,731.52	2,835.20	2,941.44	3,052.80	3,168.00	3,224.32	3,281.92
Wages		10098.81	10098.81	10098.81	10098.81	10098.81	10098.81	10098.81	10098.81	10098.81	10098.81
Management	3.74%	2,703.00	2,804.09	2,908.97	3,017.76	3,130.62	3,247.71	3,369.17	3,495.18	3,625.90	3,761.51
Financial expenses	3.74%	55,249.00	53,422.00	51,505.00	49,494.00	47,385.00	45,173.00	42,852.00	42,137.00	39,426.00	36,583.00
Debt interest		35,185.00	35,186.00	35,187.00	35,188.00	35,189.00	35,190.00	35,191.00	35,192.00	35,193.00	0.00
Depreciation		87,327.40	165,922.06	149,329.85	134,396.87	120,957.18	108,861.46	97,975.32	88,177.79	79,360.01	35,712.00
Taxable income		24,085.44	-51,248.75	-31,202.14	-12,599.60	5,386.72	21,652.63	36,958.50	49,725.65	63,957.88	148,809.88
Income tax rate (33%)		7,948.20	0.00	0.00	0.00	0.00	7,145.37	12,196.31	16,409.46	21,106.10	49,107.26
Net Income		16,137.24	-51,248.75	-31,202.14	-12,599.60	5,386.72	14,507.26	24,762.20	33,316.19	42,851.78	99,702.62

## 5.2.2 Cash Flow Statement

Table 7: Worst Condition Cash Flow Statement

End of year	Inflation rate	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
<b>Worst Condition Cash Flow Statement</b>												
Operating Activities:												
Net Income			16,137.24	-51,248.75	-31,202.14	-12,599.60	5,386.72	14,507.26	24,762.20	33,316.19	42,851.78	99,702.62
Depreciation			87,327.40	165,922.06	149,329.85	134,396.87	120,957.18	108,861.46	97,975.32	88,177.79	79,360.01	35,712.00
Investment Activities												
Equipment and Infrastructure												
Salvage Value	3.74%	-2,105,264.62										
Gains taxes (33%)												
Working capital	3.74%	-45,000.00	-1,683.00	-1,745.94	-1,811.24	-1,878.98	-1,949.26	-2,022.16	-2,097.79	-2,176.25	-2,257.64	
Financing Activities												
Borrowed Funds		660,688.00										560,000.00
Principle Repayment			-60,165.00	-63,113.00	-66,206.00	-73,320.00	-93,657.00	-98,247.00	-98,061.00	-108,110.00	-108,492.00	0.00
Net Cash Flow		-1,489,576.62	41,616.64	49,814.37	50,110.47	46,598.29	30,737.64	23,099.57	22,578.73	11,207.73	11,462.15	797,151.14
		IRR	-4%		PW	-937,322.11						

## 5.3 Best Condition

### 5.3.1 Income Statement

Table 8: Best Condition Income Statement

End of Year	Inflation rate	Income Statement									
		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Revenue	3.74%	244,493.34	250,567.28	257,360.74	264,964.55	274,132.73	283,696.76	294,395.93	306,365.89	319,830.38	335,162.18
Passenger flow(10000 person times)		17,447.00	18,842.76	20,350.18	21,978.20	23,736.45	25,635.37	27,686.20	29,901.09	32,293.18	34,876.63
Actual average fare(after adjustment)	3.74%	2.786	2.890	2.998	3.110	3.227	3.347	3.473	3.603	3.737	3.877
Operating income(passenger actual average fare)	3.74%	48,607.342	54,459.277	61,015.738	68,361.545	76,591.728	85,812.760	96,143.929	107,718.889	120,687.382	135,217.177
VAT	3.74%	465	565	673	792	1312	1478	1658	1853	2127	3129
Subsidy income	3.74%	195365	195475	195592	195716	196072	196229	196395	196572	196761	196440
Attach	3.74%	56	68	80	95	157	177	199	222	255	376
Expenses: (total)											
Power	3.74%	7487.96	7,768.01	8,058.53	8,359.92	8,672.58	8,996.94	9,333.42	9,682.49	10,044.62	10,420.29
Repair	3.74%	5,710.90	5,926.18	6,150.43	6,380.66	6,622.85	6,871.02	7,131.15	7,400.25	7,531.81	7,666.36
Operation	3.74%	2,444.80	2,536.96	2,632.96	2,731.52	2,835.20	2,941.44	3,052.80	3,168.00	3,224.32	3,281.92
Wages		15148.21	15148.21	15148.21	15148.21	15148.21	15148.21	15148.21	15148.21	15148.21	15148.21
Management	3.74%	2,703.00	2,804.09	2,908.97	3,017.76	3,130.62	3,247.71	3,369.17	3,495.18	3,625.90	3,761.51
Financial expenses	3.74%	55,249.00	53,422.00	51,505.00	49,494.00	47,385.00	45,173.00	42,852.00	42,137.00	39,426.00	36,583.00
Debt interest		35,185.00	35,186.00	35,187.00	35,188.00	35,189.00	35,190.00	35,191.00	35,192.00	35,193.00	0.00
Depreciation		87,327.40	165,922.06	149,329.85	134,396.87	120,957.18	108,861.46	97,975.32	88,177.79	79,360.01	35,712.00
Taxable income		33,237.07	-38,146.23	-13,560.21	10,247.60	34,192.08	57,266.98	80,342.85	101,964.97	126,276.51	222,588.89
Income tax rate (33%)		10,968.23	0.00	0.00	0.00	0.00	18,898.10	26,513.14	33,648.44	41,671.25	73,454.33
Net Income		22,268.84	-38,146.23	-13,560.21	10,247.60	34,192.08	38,368.88	53,829.71	68,316.53	84,605.26	149,134.55

## 5.3.2 Cash Flow Statement

Table 9: Best Condition Cash Flow Statement

Cash Flow Statement												
End of year	Inflation rate	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Operating Activities:												
Net income			22,268.84	-38,146.23	-13,560.21	10,247.60	34,192.08	38,368.88	53,829.71	68,316.53	84,605.26	149,134.55
Depreciation			87,327.40	165,922.06	149,329.85	134,396.87	120,957.18	108,861.46	97,975.32	88,177.79	79,360.01	35,712.00
Investment Activities												
Equipment and Infrastructure		-2,105,264.62										
Salvage Value	3.74%											840,000.00
Gains taxes (33%)												-53,285.74
Working capital	3.74%	-45,000.00	-1,683.00	-1,745.94	-1,811.24	-1,878.98	-1,949.26	-2,022.16	-2,097.79	-2,176.25	-2,257.64	62,622.26
Financing Activities												
Borrowed Funds		660,688.00										
Principle Repayment			-60,165.00	-63,113.00	-66,206.00	-73,320.00	-93,657.00	-98,247.00	-98,061.00	-108,110.00	-108,492.00	0.00
Net Cash Flow		-1,489,576.62	47,748.24	62,916.88	67,752.40	69,445.49	59,543.00	46,961.18	51,646.24	46,208.07	53,215.64	1,034,183.07
		IRR	0%		PW	-702,250.29						

## 6 Summary

Our project analyzes the Metro Line 5, which is about to start in Dalian, and analyzes the demand and economic feasibility of this example. Taking this specific project as an example, we constructed a series of economic index calculation systems for the No. 5 subway in Dalian.

Based on the actual situation and real data, and consider the inflation rate, we analyzed the cost of the project, the estimated income, investment and depreciation of various types of equipment in a ten-year cycle. The corresponding chart was established. We also used the data to design the financial statements of the project, which includes the income statement and the cash flow statement. The Income statement includes revenue and expenses of each year. We use the them to calculate the taxable income and the income taxes. The Cash flow statement includes the Operating activities, the investment activities and the financing activities.

The net cash flow of each year is calculated by the data in the cash flow statement. We also use the annual cash flow to calculate the Internal Rate of Return. The *IRR* is  $-1\%$ , which is lower than the market interest rate (8.8%). Although the project is lose now, it is a publican project and it is vital to citizen the invisible is more than attracting. In summary, this project can effectively alleviate financial pressure and improve the efficiency of resource utilization without incurring additional burden on the municipal finance. Through the introduction of social capital, the design, construction, operation, maintenance, renewal and transformation of the project will alleviate the government's financial pressure and facilitate the rational arrangement of other expenditures. The government can guarantee the construction of infrastructure, improve the quality of public services, and increase the public benefits of Dalian. In addition, the project can greatly meet the travel needs of the citizens and bring a lot of convenience to the residents of Dalian. Therefore, Dalian Metro Line 5 is worth implementing.

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