

MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
Kyiv national university of construction and architecture

METHODS OF VALUE ENGINEERING IN CONSTRUCTION

Methodological instructions and tasks
for performing individual work of “Value Engineering” of qualification
work for applicants of the second master`s degree of higher education of the
specialty 051 “Economics”
branch of knowledge 05 “Social and behavioral sciences”

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Contains output data for individual tasks for using the methods of
value engineering in construction.

Intending for students of the educational and qualification degree “master”
of specialty 051 “Economics” branch of knowledge 05 “Social and
behavioral sciences”.

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Містить вихідні дані для індивідуальних завдань використання
методів вартісного інжинірингу в будівництві.

Призначено для здобувачів освітньо-кваліфікаційного ступеня
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GENERAL PROVISION

Methodological instructions have been prepared for doing individual work of “Value Engineering” of qualification work for applicants of the second master`s degree of higher education of the specialty 051 “Economics” branch of knowledge 05 “Social and behavioral sciences”

The content of individual work consists in project cost forecast, construction cost of the project, metrics of economic performance.

Individual work has a purpose to acquire skills of students of value engineering methods which includes cost forecast methods accordance with forecasting methods for cost [5], estimating construction cost [6] and metrics of economic performance [1,2,3,4].

Table 1 shows individual tasks for project cost forecast. Table 2 shows individual tasks for construction of the cottage and table 3 contains data for material (M), labor (L) and equipment (Eq) costs. Table 4 shows individual tasks for additional works and annual discount rate.

Example of individual work for variant №0 shows tables 5-8.

CALCULATION OF INITIAL INDICATORS

1. Project cost forecast

The cost of a project activity, based on past data, and wish to estimate the probable cost for a project that starts next month. We could simply plug in old numbers, but they may be out of date, which would lead to serious over- or underestimation of costs. However, we do have some historical information on how much this activity has cost in past jobs. The historical data on the cost (in thousands of \$) for the project activity is given in table 1. With this in hand, we can develop a trend equation using linear regression analysis and forecast the cost of this activity for periods 13 and 15 of the project.

To evaluate the trend component of a time series, we use linear regression analysis to develop a linear trend equation. This is the equation of a straight line as given by

$$y_t = a + bt + e, \quad (1)$$

where b is the slope (gradient) of the line and a is the intercept with the y axis at $t = 0$, y_t is the value of the project variable (for which we desire a forecast) at time period t , and e is the forecast error.

The technique of least squares regression minimizes this sum of the squared differences or errors. By using this technique, we can get formulas for a (the intercept) and b (the slope of the regression line). These formulas are given below for a time series of n points of data, where t = time, i.e., the number of time periods from the starting point, and y = the observed value in a given time period. The slope b of the line is given by

$$b = \frac{n\sum ty - \sum t\sum y}{n\sum t^2 - (\sum t)^2}, \quad (2)$$

The intercept a is given by

$$a = \frac{\sum y - b\sum t}{n}, \quad (3)$$

Interpretation of coefficients

- Slope b : the estimated y changes by b for each one unit increase in t .
- y intercept (a): the average value of y when $t = 0$.

Let's look at a simple example for developing a linear trend equation using linear regression analysis for forecasting the trend component of a time series.

2. Construction cost of the project can calculate accordance with the next equation:

Construction cost = Direct cost + Indirect cost

Direct cost = Labor + Material + Equipment

Indirect cost = Jobsite general conditions + Home office general conditions

3. Metrics for economic performance:

Metric 1 – net present value (NPV)

A stream of future costs and benefits should be converted to a net present value using the following equation:

$$NPV = \sum_{n=1}^p (C_n \times q) = \sum_{n=1}^p \frac{C_n}{(1+d)^n}, \quad (4)$$

where,

C is the cost in year n

q is the discount rate

d is the expected real discount rate per annum

n is the number of years between the base date and the occurrence of the cost

p is the period of analysis

\sum is the sum of all the costs that follow.

Metric 2 – annual equivalent value (AEV)

To calculate the AEV:

$$AEV = \frac{Cd}{(1+g)^n - 1}, \quad (5)$$

where

AEV annual equivalent value

C is the cost in year n

d is the expected real discount rate per annum

n is the number of years between the base date and the occurrence of the cost

Table 1

INDIVIDUAL TASKS FOR PROJECT COST FORECAST, \$

Variants	Cost by years											
	1	2	3	4	5	6	7	8	9	10	11	12
0	680400	690000	695000	700000	710000	730000	765000	725000	760000	790000	800000	850000
1	690500	690500	698000	701500	720000	7250000	745000	755000	765500	785000	810000	840000
2	680500	695000	695500	708000	715500	715000	735000	730000	755000	780000	790000	810000
3	670400	680000	685000	700500	710500	720000	745000	735000	740000	770000	785000	820000
4	660400	670000	675000	705000	715000	720500	770000	765000	768000	780000	810000	830000
5	680400	690000	695000	700000	710000	730000	765000	725000	760000	790000	800000	840000
6	680400	690000	695000	700000	712000	730000	765000	725000	760000	780000	804000	870000
7	680400	690000	695000	700000	710000	730000	767000	725000	760000	797000	802000	880000
8	680400	690000	695000	700000	720000	710000	768000	715000	760000	790000	800000	850000
9	690500	680500	698000	702500	730000	728000	735000	755000	765500	785000	810000	840000
10	670500	685000	665500	706000	715500	725000	731000	730000	755000	780000	790000	810000
11	680400	670000	675000	703500	720500	730000	744000	735000	740000	770000	785000	820000
12	690400	660000	685000	704000	715000	725500	770000	765000	768000	780000	810000	830000
13	670400	670000	685000	703000	718000	730000	745000	725000	768000	795000	800000	840000
14	660400	680000	675000	705000	719000	730000	755000	725000	765000	794000	802000	870000
15	670400	680000	675000	703000	720000	735000	765000	725000	764000	790000	800000	880000
16	680400	690000	695000	706500	715500	729000	745000	735000	740000	770000	785000	820000
17	660500	660000	655000	704000	720000	721500	770000	765000	768000	780000	810000	830000
18	680500	650000	685000	703000	716000	735000	765000	725000	760000	790000	805000	840000

Continue of the Table 1

1	2	3	4	5	6	7	8	9	10	11	12	13
19	680600	670000	675000	702000	715000	739000	768000	725000	765000	792000	800000	870000
20	670600	680000	665000	707000	718000	737000	769000	725000	764000	795000	804000	880000
21	670500	685000	665500	706000	715500	725000	731000	730000	755000	780000	790000	810000
22	680400	670000	675000	703500	720500	730000	744000	735000	740000	770000	785000	820000
23	690400	660000	685000	704000	715000	725500	770000	765000	768000	780000	810000	830000
24	670400	670000	685000	703000	718000	730000	745000	725000	768000	795000	800000	840000
25	660400	680000	675000	705000	719000	730000	755000	725000	765000	794000	802000	870000
26	670400	680000	675000	703000	720000	735000	765000	725000	764000	790000	800000	880000
27	680400	690000	695000	706500	715500	729000	745000	735000	740000	770000	785000	820000
28	660500	660000	655000	704000	720000	721500	770000	765000	768000	780000	810000	830000
29	680500	650000	685000	703000	716000	735000	765000	725000	760000	790000	805000	840000
30	680600	670000	675000	702000	715000	739000	768000	725000	765000	792000	800000	870000
31	660400	680000	675000	705000	719000	730000	765000	725000	764000	790000	800000	880000
32	670400	670000	685000	703000	718000	730000	745000	725000	768000	795000	800000	840000
33	680400	670000	675000	703500	720500	730000	744000	735000	740000	770000	785000	820000

Table 2

INDIVIDUAL TASKS FOR CONSTRUCTION OF A TWO-STORY BUILDING

Type of works	Units of measurements	Variants										
		0	1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10	11	12	13
1.Foundation installation												
1.1 Pile sinking	pieces	42	42	42	42	46	42	46	48	46	54	40
1.2 Felling piles	pieces	42	42	42	42	46	42	46	48	46	54	40
1.3 Grillage reinforcement	pieces	42	42	42	42	46	42	46	48	46	54	40
2. Frame installation												
2.1 Brickwork under the floor slabs of the 1 st floor (red brick)	m ³	2450	3050	2480	2450	2850	2450	2850	2850	2850	3400	2250
2.2 Installation of floor slabs on the 1 st floor (reinforced concrete slabs 6380x990x220 mm)	pieces	14	21	16	14	18	14	18	18	18	22	12
2.3 Masonry of walls and partitions of the 1 st floor (red brick)	m ³	530	440	530	530	560	530	560	580	560	530	530
2.4 Brickwork under the floor slabs of the 2 st floor (red brick)	m ³	1430	1750	1630	1430	1430	1430	1830	1830	1830	1830	1430
2.5 Installation of floor slabs on the 2 st floor (reinforced concrete slabs 6380x990x220 mm)	pieces	10	16	12	10	12	10	12	14	12	16	10
2.6 Masonry of walls and partitions of the 2 st floor (red brick)	m ³	360	380	380	360	380	360	380	380	380	400	340

Continue of the Table 2

1	2	3	4	5	6	7	8	9	10	11	12	13
2.7 Installation of floor slabs between the 2 st floor and the attic (reinforced concrete slabs 6380x990x220 mm)	pieces	10	16	12	10	12	10	12	14	12	16	10
2.8 Masonry parapet and ventilation shafts (red brick)	m ³	210	240	212	210	220	210	220	210	220	260	210
3. Roof installation												
3.1 Installation of the rafter system	m ²	160	180	180	160	200	160	200	240	200	260	140
3.2 Installing a vapor barrier layer	m ²	160	180	180	160	200	160	200	240	200	260	140
3.3 Laying insulating materials	m ²	160	180	180	160	200	160	200	240	200	260	140
3.4 Laying a layer of waterproofing	m ²	160	180	180	160	200	160	200	240	200	260	140
3.5 Insulation of the roof with a screed	m ²	160	180	180	160	200	160	200	240	200	260	140
3.6 Metal tiles of the main roof	m ²	160	180	180	160	200	160	200	240	200	260	140
3.7 Sheeting of ventilation shafts and installation of a visor	m ²	40	60	60	40	80	40	60	80	60	100	40
4. Arrangement of the façade												
4.1 Warming and priming	m ²	240	280	260	240	280	240	240	280	240	340	220
4.2 Decorative façade plaster	m ²	240	280	260	240	280	240	240	280	240	340	220
4.3 Arrangement of stucco	m ²	100	150	120	100	140	100	100	140	100	180	100
4.4 Façade painting and landscaping	m ²	240	260	260	240	280	240	240	280	240	340	220
5. Improvement of the territory												
5.1 Territory planning	m ²	360	380	380	360	360	360	360	360	360	560	340

Continue of the Table 2

1	2	3	4	5	6	7	8	9	10	11	12	13
5.2 Construction of sidewalks and driveways	m ²	80	100	100	80	80	80	80	80	80	180	60
5.3 Landscaping	m ²	200	200	220	200	200	200	200	200	200	300	180
5.4 Fencing of the territory	m	76	86	96	76	76	76	76	100	76	150	70
Type of works	Units of measurements	Variants										
		11	12	13	14	15	16	17	18	19	20	21
1.Foundation installation												
1.1 Pile sinking	pieces	40	46	42	52	60	52	64	58	40	52	40
1.2 Felling piles	pieces	40	46	42	52	60	52	64	58	40	52	40
1.3 Grillage reinforcement	pieces	40	46	42	52	60	52	64	58	40	52	40
2. Frame installation												
2.1 Brickwork under the floor slabs of the 1 st floor (red brick)	m ³	2250	2850	2450	3450	4450	3450	4450	3000	2250	3450	2250
2.2 Installation of floor slabs on the 1 st floor (reinforced concrete slabs 6380x990x220 mm)	pieces	12	18	14	24	28	24	32	28	12	24	12
2.3 Masonery of walls and partitions of the 1 st floor (red brick)	m ³	530	560	530	830	830	830	930	830	530	830	530
2.4 Brickwork under the floor slabs of the 2 st floor (red brick)	m ³	1430	1830	1430	1830	2830	1830	3430	1830	1430	1830	1430
2.5 Installation of floor slabs on the 2 st floor (reinforced concrete slabs 6380x990x220 mm)	pieces	10	12	10	18	20	18	28	20	10	18	10

Continue of the Table 2

1	2	3	4	5	6	7	8	9	10	11	12	13
2.6 Masonry of walls and partitions of the 2 st floor (red brick)	m ³	340	380	360	360	360	360	360	560	340	360	340
2.7 Installation of floor slabs between the 2 st floor and the attic (reinforced concrete slabs 6380x990x220 mm)	pieces	10	12	10	18	20	18	28	20	10	18	10
2.8 Masonry parapet and ventilation shafts (red brick)	m ³	210	210	210	210	260	210	410	280	210	210	210
3. Roof installation												
3.1 Installation of the rafter system	m ²	140	180	160	280	360	280	360	260	140	280	140
3.2 Installing a vapor barrier layer	m ²	140	180	160	280	360	280	360	260	140	280	140
3.3 Laying insulating materials	m ²	140	180	160	280	360	280	360	260	140	280	140
3.4 Laying a layer of waterproofing	m ²	140	180	160	280	360	280	360	260	140	280	140
3.5 Insulation of the roof with a screed	m ²	140	180	160	280	360	280	360	260	140	280	140
3.6 Metal tiles of the main roof	m ²	140	180	160	280	360	280	360	260	140	280	140
3.7 Sheathing of ventilation shafts and installation of a visor	m ²	40	40	40	80	80	80	140	80	40	80	40
4. Arrangement of the façade												
4.1 Warming and priming	m ²	220	260	240	440	320	440	440	340	220	440	220
4.2 Decorative façade plaster	m ²	220	260	240	440	320	440	440	340	220	440	260
4.3 Arrangement of stucco	m ²	100	120	100	280	160	280	200	160	100	280	120
4.4 Façade painting and landscaping	m ²	220	260	240	440	320	440	440	340	220	440	260

Continue of the Table 2

1	2	3	4	5	6	7	8	9	10	11	12	13
5. Improvement of the territory												
5.1 Territory planning	m ²	340	380	360	460	460	460	560	460	340	460	380
5.2 Construction of sidewalks and driveways	m ²	60	90	80	180	180	180	180	120	60	180	90
5.3 Landscaping	m ²	180	220	200	400	400	400	400	280	180	400	220
5.4 Fencing of the territory	m	70	86	76	160	180	160	220	100	70	160	86
Type of works	Units of measurements	Variants										
		22	23	24	25	26	27	28	29	30	32	33
1.Foundation installation												
1.1 Pile sinking	pieces	40	46	42	52	60	52	64	58	40	52	40
1.2 Felling piles	pieces	40	46	42	52	60	52	64	58	40	52	40
1.3 Grillage reinforcement	pieces	40	46	42	52	60	52	64	58	40	52	40
2. Frame installation												
2.1 Brickwork under the floor slabs of the 1 st floor (red brick)	m ³	2250	2850	2450	3450	4450	3450	4450	3000	2250	3450	2250
2.2 Installation of floor slabs on the 1 st floor (reinforced concrete slabs 6380x990x220 mm)	pieces	14	21	16	14	18	14	18	18	18	22	14
2.3 Masonry of walls and partitions of the 1 st floor (red brick)	m ³	530	440	530	530	560	530	560	580	560	530	530
2.4 Brickwork under the floor slabs of the 2 st floor (red brick)	m ³	1430	1750	1630	1430	1430	1430	1830	1830	1830	1830	1430

Continue of the Table 2

1	2	3	4	5	6	7	8	9	10	11	12	13
2.5 Installation of floor slabs on the 2 st floor (reinforced concrete slabs 6380x990x220 mm)	pieces	10	16	12	10	12	10	12	14	12	16	10
2.6 Masonry of walls and partitions of the 2 st floor (red brick)	m ³	360	380	380	360	380	360	380	380	380	400	360
2.7 Installation of floor slabs between the 2 st floor and the attic (reinforced concrete slabs 6380x990x220 mm)	pieces	10	16	12	10	12	10	12	14	12	16	10
2.8 Masonry parapet and ventilation shafts (red brick)	m ³	210	240	212	210	220	210	220	210	220	260	210
3. Roof installation												
3.1 Installation of the rafter system	m ²	160	180	180	160	200	160	200	240	200	260	160
3.2 Installing a vapor barrier layer	m ²	160	180	180	160	200	160	200	240	200	260	160
3.3 Laying insulating materials	m ²	140	180	160	280	360	280	360	260	140	280	140
3.4 Laying a layer of waterproofing	m ²	140	180	160	280	360	280	360	260	140	280	140
3.5 Insulation of the roof with a screed	m ²	140	180	160	280	360	280	360	260	140	280	140
3.6 Metal tiles of the main roof	m ²	140	180	160	280	360	280	360	260	140	280	140
3.7 Sheeting of ventilation shafts and installation of a visor	m ²	40	40	40	80	80	80	140	80	40	80	40
4. Arrangement of the façade												
4.1 Warming and priming	m ²	220	260	240	440	320	440	440	340	220	440	220
4.2 Decorative façade plaster	m ²	220	260	240	440	320	440	440	340	220	440	220

Continue of the Table 2

1	2	3	4	5	6	7	8	9	10	11	12	13
4.3 Arrangement of stucco	m ²	100	120	100	280	160	280	200	160	100	280	100
4.4 Façade painting and landscaping	m ²	220	260	240	440	320	440	440	340	220	440	220
5. Improvement of the territory												
5.1 Territory planning	m ²	340	380	360	460	460	460	560	460	340	460	340
5.2 Construction of sidewalks and driveways	m ²	60	90	80	180	180	180	180	120	60	180	60
5.3 Landscaping	m ²	180	220	200	400	400	400	400	280	180	400	180
5.4 Fencing of the territory	m	70	86	76	160	180	160	220	100	70	160	70

Table 3

INDIVIDUAL TASKS OF THE COST OF MATERIAL (M), LABOR (L) AND EQUIPMENT (EQ), PER UNIT \$

Type of works	Variants											
	0			1			2			3		
	M	L	Eq	M	L	Eq	M	L	Eq	M	L	Eq
1	2	3	4	5	6	7	8	9	10	11	12	13
1.Foundation installation												
1.1 Pile sinking	220	50	25	250	40	25	220	50	25	200	40	25
1.2 Felling piles	30	25	-	40	30	-	30	25		30	25	-
1.3 Grillage reinforcement	80	22	-	70	25	-	80	22		60	22	-
2. Frame installation												
2.1 Brickwork under the floor slabs of the 1 st floor (red brick)	72	50	-	78	50	-	72	50	-	70	40	-
2.2 Installation of floor slabs on the 1 st floor (reinforced concrete slabs 6380x990x220 mm)	375	30	25	395	30	25	375	30	25	360	30	25
2.3 Masonry of walls and partitions of the 1 st floor (red brick)	72	50	-	78	50		72	50		70	40	-
2.4 Brickwork under the floor slabs of the 2 st floor (red brick)	72	50	-	78	50		72	50		70	40	-
2.5 Installation of floor slabs on the 2 st floor (reinforced concrete slabs 6380x990x220 mm)	375	30	25	395	30	25	375	30	25	360	30	25
2.6 Masonry of walls and partitions of the 2 st floor (red brick)	72	50	-	78	50		72	50		70	40	-
2.7 Installation of floor slabs between the 2 st floor and the attic (reinforced concrete slabs 6380x990x220 mm)	375	30	25	395	30	25	375	30	25	360	30	25

Continue of the Table 3

1	2	3	4	5	6	7	8	9	10	11	12	13
2.8 Masonry parapet and ventilation shafts (red brick)	72	50	-	10	50	-	72	50	-	70	40	-
3. Roof installation												
3.1 Installation of the rafter system	50	20	15	40	22	15	40	20	15	50	20	15
3.2 Installing a vapor barrier layer	30	15	-	25	17	-	30	15	-	30	15	-
3.3 Laying insulating materials	20	10	-	25	12	-	25	10	-	22	10	-
3.4 Laying a layer of waterproofing	15	10	-	15	12	-	18	10	-	15	10	-
3.5 Insulation of the roof with a screed	30	25	-	25	20	-	25	24	-	25	20	-
3.6 Metal tiles of the main roof	40	30	-	35	25	-	35	22		35	25	-
3.7 Sheathing of ventilation shafts and installation of a visor	25	20	-	30	20	-	28	25	-	25	20	-
4. Arrangement of the façade												-
4.1 Warming and priming	30	20	-	30	25	-	30	20	-	20	20	
4.2 Decorative façade plaster	10	20	-	10	22	-	10	20	-	10	20	-
4.3 Arrangement of stucco	15	25	-	15	27	-	15	25	-	15	20	-
4.4 Façade painting and landscaping	25	25	-	25	28	-	25	25	-	25	20	-
5. Improvement of the territory												
5.1 Territory planning	400	35	-	38	30	-	30	35	-	35	35	-
5.2 Construction of sidewalks and driveways	40	20	-	38	22	-	30	20	-	35	20	-
5.3 Landscaping	25	30	-	25	25	-	25	20	-	25	30	-
5.4 Fencing of the territory	36	10	-	34	10	-	36	15	-	30	10	-

Continue of the Table 3

1	2	3	4	5	6	7	8	9	10	11	12	13
Type of works	Variants											
	4			5			6			7		
	M	L	Eq	M	L	Eq	M	L	Eq	M	L	Eq
1	2	3	4	5	6	7	8	9	10	11	12	13
1.Foundation installation												
1.1 Pile sinking	240	40	25	240	50	25	220	50	25	220	50	25
1.2 Felling piles	40	20	-	30	25	-	30	25	-	30	25	-
1.3 Grillage reinforcement	90	20	-	90	22	-	80	22	-	80	22	-
2. Frame installation												
2.1 Brickwork under the floor slabs of the 1 st floor (red brick)	72	40	-	80	50	-	72	50	-	72	50	-
2.2 Installation of floor slabs on the 1 st floor (reinforced concrete slabs 6380x990x220 mm)	375	30	25	390	30	25	375	30	25	375	30	25
2.3 Masonry of walls and partitions of the 1 st floor (red brick)	72	40	-	80	50	-	72	50	-	72	50	-
2.4 Brickwork under the floor slabs of the 2 st floor (red brick)	72	40	-	80	50	-	72	50	-	72	50	-
2.5 Installation of floor slabs on the 2 st floor (reinforced concrete slabs 6380x990x220 mm)	375	30	25	390	30	25	375	30	25	375	30	25
2.6 Masonry of walls and partitions of the 2 st floor (red brick)	72	40	-	80	50	-	72	50	-	72	50	-
2.7 Installation of floor slabs between the 2 st floor and the attic (reinforced concrete slabs 6380x990x220 mm)	375	30	25	390	30	25	375	30	25	375	30	25

Continue of the Table 3

1	2	3	4	5	6	7	8	9	10	11	12	13
2.8 Masonry parapet and ventilation shafts (red brick)	72	50	-	80	50	-	72	50	-	72	50	-
3. Roof installation												
3.1 Installation of the rafter system	45	20	15	40	20	15	40	20	15	50	20	15
3.2 Installing a vapor barrier layer	20	15	-	20	15	-	20	15	-	30	15	-
3.3 Laying insulating materials	20	10	-	25	10	-	25	10	-	20	10	-
3.4 Laying a layer of waterproofing	15	15	-	15	15	-	15	10	-	15	10	-
3.5 Insulation of the roof with a screed	30	25	-	35	25	-	30	25	-	30	25	-
3.6 Metal tiles of the main roof	40	30	-	45	35	-	30	35	-	40	30	-
3.7 Sheathing of ventilation shafts and installation of a visor	25	20	-	25	20	-	25	25	-	25	20	-
4. Arrangement of the façade												
4.1 Warming and priming	30	15	-	30	20	-	30	20	-	30	20	-
4.2 Decorative façade plaster	10	20	-	10	20	-	10	20	-	10	20	-
4.3 Arrangement of stucco	15	25	-	15	25	-	15	25	-	15	25	-
4.4 Façade painting and landscaping	25	25	-	25	25	-	25	25	-	25	25	-
5. Improvement of the territory												
5.1 Territory planning	40	35	-	40	35	-	40	35	-	40	35	-
5.2 Construction of sidewalks and driveways	40	20	-	40	20	-	40	20	-	40	20	-
5.3 Landscaping	25	30	-	25	30	-	25	30	-	25	30	-
5.4 Fencing of the territory	36	10	-	36	10	-	36	10	-	36	10	-

Continue of the Table 3

1	2	3	4	5	6	7	8	9	10	11	12	13
Type of works	Variants											
	8			9			10			11		
	M	L	Eq	M	L	Eq	M	L	Eq	M	L	Eq
1	2	3	4	5	6	7	8	9	10	11	12	13
1.Foundation installation												
1.1 Pile sinking	220	50	25	220	50	25	220	50	25	250	50	25
1.2 Felling piles	30	25	-	30	25	-	30	25		40	25	-
1.3 Grillage reinforcement	80	22	-	80	22	-	80	22		90	22	-
2. Frame installation												
2.1 Brickwork under the floor slabs of the 1 st floor (red brick)	72	50	-	72	50	-	70	50	-	75	50	-
2.2 Installation of floor slabs on the 1 st floor (reinforced concrete slabs 6380x990x220 mm)	375	30	25	375	30	25	370	30	25	380	50	25
2.3 Masonry of walls and partitions of the 1 st floor (red brick)	72	50	-	72	50	-	70	50	-	75	30	-
2.4 Brickwork under the floor slabs of the 2 st floor (red brick)	72	50	-	72	50	-	70	50	-	75	50	-
2.5 Installation of floor slabs on the 2 st floor (reinforced concrete slabs 6380x990x220 mm)	375	30	25	375	30	25	370	30	25	380	30	25
2.6 Masonry of walls and partitions of the 2 st floor (red brick)	72	50	-	72	50	-	70	50	-	75	50	-
2.7 Installation of floor slabs between the 2 st floor and the attic (reinforced concrete slabs 6380x990x220 mm)	375	30	25	375	30	25	370	30	25	380	30	25

Continue of the Table 3

1	2	3	4	5	6	7	8	9	10	11	12	13
2.8 Masonry parapet and ventilation shafts (red brick)	72	50	-	72	50	-	70	50	-	75	50	-
3. Roof installation												
3.1 Installation of the rafter system	50	20	15	50	20	15	40	20	15	40	20	15
3.2 Installing a vapor barrier layer	30	15	-	30	15	-	20	15	-	20	15	-
3.3 Laying insulating materials	20	10	-	20	10	-	30	10	-	20	10	-
3.4 Laying a layer of waterproofing	15	10	-	15	10	-	15	10	-	15	10	-
3.5 Insulation of the roof with a screed	30	25	-	30	25	-	30	25	-	30	25	-
3.6 Metal tiles of the main roof	40	30	-	40	30	-	40	30	-	40	30	-
3.7 Sheathing of ventilation shafts and installation of a visor	25	20	-	25	20	-	25	20	-	25	20	-
4. Arrangement of the façade												
4.1 Warming and priming	30	20	-	30	20	-	30	20	-	30	20	-
4.2 Decorative façade plaster	10	20	-	10	20	-	10	20	-	10	20	-
4.3 Arrangement of stucco	15	25	-	15	25	-	15	25	-	15	25	-
4.4 Façade painting and landscaping	25	25	-	25	25	-	25	25	-	25	25	-
5. Improvement of the territory												
5.1 Territory planning	40	35	-	40	35	-	30	35	-	40	35	-
5.2 Construction of sidewalks and driveways	40	20	-	40	20	-	30	20	-	40	20	-
5.3 Landscaping	25	30	-	25	30	-	25	30	-	25	30	-
5.4 Fencing of the territory	36	10	-	36	10	-	36	10	-	36	10	-

Continue of the Table 3

1	2	3	4	5	6	7	8	9	10	11	12	13
Type of works	Variants											
	12			13			14			15		
	M	L	Eq	M	L	Eq	M	L	Eq	M	L	Eq
1	2	3	4	5	6	7	8	9	10	11	12	13
1.Foundation installation												
1.1 Pile sinking	220	50	25	230	40	25	220	50	25	220	50	25
1.2 Felling piles	30	25	-	20	25	-	30	25	-	30	25	-
1.3 Grillage reinforcement	80	22	-	70	22	-	80	22	-	80	22	-
2. Frame installation												
2.1 Brickwork under the floor slabs of the 1 st floor (red brick)	72	50	-	80	50	-	72	50	-	72	50	-
2.2 Installation of floor slabs on the 1 st floor (reinforced concrete slabs 6380x990x220 mm)	375	30	25	380	30	25	375	30	25	375	30	25
2.3 Masonry of walls and partitions of the 1 st floor (red brick)	72	50	-	80	50	-	72	50	-	72	50	-
2.4 Brickwork under the floor slabs of the 2 st floor (red brick)	72	50	-	80	50	-	72	50	-	72	50	-
2.5 Installation of floor slabs on the 2 st floor (reinforced concrete slabs 6380x990x220 mm)	375	30	25	380	30	25	375	30	25	375	30	25
2.6 Masonry of walls and partitions of the 2 st floor (red brick)	72	50	-	80	50	-	72	50	-	72	50	-
2.7 Installation of floor slabs between the 2 st floor and the attic (reinforced concrete slabs 6380x990x220 mm)	375	30	25	380	30	25	375	30	25	375	30	25

Continue of the Table 3

1	2	3	4	5	6	7	8	9	10	11	12	13
2.8 Masonry parapet and ventilation shafts (red brick)	72	50	-	80	50	-	72	50	-	72	50	-
3. Roof installation												
3.1 Installation of the rafter system	40	20	15	40	20	15	50	20	15	50	20	15
3.2 Installing a vapor barrier layer	30	15	-	20	15	-	30	15	-	30	15	-
3.3 Laying insulating materials	20	10	-	20	10	-	20	10	-	20	10	-
3.4 Laying a layer of waterproofing	15	10	-	25	10	-	15	10	-	15	10	-
3.5 Insulation of the roof with a screed	30	25	-	30	25	-	20	25	-	30	25	-
3.6 Metal tiles of the main roof	30	30	-	30	30	-	30	30	-	40	30	-
3.7 Sheathing of ventilation shafts and installation of a visor	25	20	-	25	20	-	25	20	-	25	20	-
4. Arrangement of the façade												
4.1 Warming and priming	30	20	-	30	20	-	30	20	-	30	20	-
4.2 Decorative façade plaster	10	20	-	10	20	-	10	20	-	10	20	-
4.3 Arrangement of stucco	15	25	-	15	25	-	15	25	-	15	25	-
4.4 Façade painting and landscaping	25	25	-	25	25	-	25	25	-	25	25	-
5. Improvement of the territory												
5.1 Territory planning	30	35	-	40	35	-	30	30	-	40	35	-
5.2 Construction of sidewalks and driveways	30	20	-	40	20	-	30	20	-	40	20	-
5.3 Landscaping	25	30	-	25	30	-	25	30	-	25	30	-
5.4 Fencing of the territory	36	10	-	36	10	-	36	20	-	36	10	-

Continue of the Table 3

1	2	3	4	5	6	7	8	9	10	11	12	13
Type of works	Variants											
	16			17			18			19		
	M	L	Eq	M	L	Eq	M	L	Eq	M	L	Eq
1	2	3	4	5	6	7	8	9	10	11	12	13
1.Foundation installation												
1.1 Pile sinking	240	50	25	220	50	25	220	50	25	230	50	25
1.2 Felling piles	40	25	-	30	25	-	30	25	-	30	25	-
1.3 Grillage reinforcement	60	22	-	80	22	-	80	22	-	80	22	-
2. Frame installation												
2.1 Brickwork under the floor slabs of the 1 st floor (red brick)	90	50	-	72	50	-	72	50	-	70	50	-
2.2 Installation of floor slabs on the 1 st floor (reinforced concrete slabs 6380x990x220 mm)	420	30	25	375	30	25	375	30	25	370	30	25
2.3 Masonry of walls and partitions of the 1 st floor (red brick)	90	50	-	72	50	-	72	50	-	72	50	-
2.4 Brickwork under the floor slabs of the 2 st floor (red brick)	90	50	-	72	50	-	72	50	-	72	40	-
2.5 Installation of floor slabs on the 2 st floor (reinforced concrete slabs 6380x990x220 mm)	420	30	25	375	30	25	375	30	25	375	30	25
2.6 Masonry of walls and partitions of the 2 st floor (red brick)	90	50	-	72	50	-	72	50	-	72	40	-
2.7 Installation of floor slabs between the 2 st floor and the attic (reinforced concrete slabs 6380x990x220 mm)	420	30	25	375	30	25	375	30	25	375	30	25

Continue of the Table 3

1	2	3	4	5	6	7	8	9	10	11	12	13
2.8 Masonry parapet and ventilation shafts (red brick)	90	50	-	72	50	-	72	50	-	72	50	-
3. Roof installation												
3.1 Installation of the rafter system	40	20	15	50	20	15	15	20	15	50	20	15
3.2 Installing a vapor barrier layer	20	15	-	30	15	-	30	15	-	30	15	-
3.3 Laying insulating materials	20	20	-	20	10	-	20	10	-	20	10	-
3.4 Laying a layer of waterproofing	25	10	-	15	10	-	15	10	-	15	10	-
3.5 Insulation of the roof with a screed	30	15	-	30	25	-	30	25	-	30	25	-
3.6 Metal tiles of the main roof	40	20	-	40	30	-	20	20	-	40	30	-
3.7 Sheathing of ventilation shafts and installation of a visor	25	20	-	25	20	-	35	20	-	25	20	-
4. Arrangement of the façade												
4.1 Warming and priming	20	20	-	30	20	-	30	20	-	30	20	-
4.2 Decorative façade plaster	10	20	-	10	20	-	10	20	-	10	20	-
4.3 Arrangement of stucco	25	25	-	15	25	-	15	25	-	15	25	-
4.4 Façade painting and landscaping	25	25	-	25	25	-	25	25	-	25	25	-
5. Improvement of the territory												
5.1 Territory planning	30	35	-	40	35	-	40	35	-	40	35	-
5.2 Construction of sidewalks and driveways	30	20	-	40	20	-	40	20	-	40	20	-
5.3 Landscaping	25	30	-	25	30	-	25	30	-	25	30	-
5.4 Fencing of the territory	36	10	-	36	10	-	36	10	-	36	10	-

Continue of the Table 3

1	2	3	4	5	6	7	8	9	10	11	12	13
Type of works	Variants											
	20			21			22			23		
	M	L	Eq	M	L	Eq	M	L	Eq	M	L	Eq
1	2	3	4	5	6	7	8	9	10	11	12	13
1.Foundation installation												
1.1 Pile sinking	240	50	25	220	50	25	230	40	25	220	50	25
1.2 Felling piles	20	25	-	30	25	-	20	25	-	30	25	-
1.3 Grillage reinforcement	70	22	-	80	22	-	70	22	-	80	22	-
2. Frame installation												
2.1 Brickwork under the floor slabs of the 1 st floor (red brick)	78	50	-	72	50	-	80	50	-	72	50	-
2.2 Installation of floor slabs on the 1 st floor (reinforced concrete slabs 6380x990x220 mm)	378	30	25	375	30	25	380	30	25	375	30	25
2.3 Masonry of walls and partitions of the 1 st floor (red brick)	78	50	-	72	50	-	80	50	-	72	50	-
2.4 Brickwork under the floor slabs of the 2 st floor (red brick)	78	50	-	72	50	-	80	50	-	72	50	-
2.5 Installation of floor slabs on the 2 st floor (reinforced concrete slabs 6380x990x220 mm)	378	30	25	375	30	25	380	30	25	375	30	25
2.6 Masonry of walls and partitions of the 2 st floor (red brick)	78	50	-	72	50	-	80	50	-	72	50	-
2.7 Installation of floor slabs between the 2 st floor and the attic (reinforced concrete slabs 6380x990x220 mm)	378	30	25	375	30	25	380	30	25	375	30	25

Continue of the Table 3

1	2	3	4	5	6	7	8	9	10	11	12	13
2.8 Masonry parapet and ventilation shafts (red brick)	78	50	-	72	50	-	80	50	-	72	50	-
3. Roof installation												
3.1 Installation of the rafter system	40	20	15	50	20	15	40	20	15	50	20	15
3.2 Installing a vapor barrier layer	20	15	-	30	15	-	20	15	-	30	15	-
3.3 Laying insulating materials	20	10	-	20	10	-	20	10	-	20	10	-
3.4 Laying a layer of waterproofing	25	10	-	15	10	-	25	10	-	15	10	-
3.5 Insulation of the roof with a screed	30	25	-	30	25	-	30	25	-	30	25	-
3.6 Metal tiles of the main roof	30	30	-	40	30	-	30	30	-	40	30	-
3.7 Sheathing of ventilation shafts and installation of a visor	25	20	-	25	20	-	25	20	-	25	20	-
4. Arrangement of the façade												
4.1 Warming and priming	30	20	-	30	20	-	30	20	-	30	20	-
4.2 Decorative façade plaster	10	20	-	10	20	-	10	20	-	10	20	-
4.3 Arrangement of stucco	15	25	-	15	25	-	15	25	-	15	25	-
4.4 Façade painting and landscaping	25	25	-	25	25	-	25	25	-	25	25	-
5. Improvement of the territory												
5.1 Territory planning	40	35	-	40	35	-	40	35	-	40	35	-
5.2 Construction of sidewalks and driveways	40	20	-	40	20	-	40	20	-	40	20	-
5.3 Landscaping	25	30	-	25	30	-	25	30	-	25	30	-
5.4 Fencing of the territory	36	10	-	36	10	-	36	10	-	36	10	-

Continue of the Table 3

1	2	3	4	5	6	7	8	9	10	11	12	13
Type of works	Variants											
	24			25			26			27		
	M	L	Eq	M	L	Eq	M	L	Eq	M	L	Eq
1	2	3	4	5	6	7	8	9	10	11	12	13
1.Foundation installation												
1.1 Pile sinking	220	50	25	240	50	25	220	50	25	250	50	25
1.2 Felling piles	30	25	-	40	25	-	30	25	-	40	25	-
1.3 Grillage reinforcement	80	22	-	60	22	-	80	22	-	90	22	-
2. Frame installation												
2.1 Brickwork under the floor slabs of the 1 st floor (red brick)	72	50	-	90	50	-	72	50	-	75	50	-
2.2 Installation of floor slabs on the 1 st floor (reinforced concrete slabs 6380x990x220 mm)	375	30	25	420	30	25	375	30	25	380	50	25
2.3 Masonry of walls and partitions of the 1 st floor (red brick)	72	50	-	90	50	-	72	50	-	75	30	-
2.4 Brickwork under the floor slabs of the 2 st floor (red brick)	72	50	-	90	50	-	72	50	-	75	50	-
2.5 Installation of floor slabs on the 2 st floor (reinforced concrete slabs 6380x990x220 mm)	375	30	25	420	30	25	375	30	25	380	30	25
2.6 Masonry of walls and partitions of the 2 st floor (red brick)	72	50	-	90	50	-	72	50	-	75	50	-
2.7 Installation of floor slabs between the 2 st floor and the attic (reinforced concrete slabs 6380x990x220 mm)	375	30	25	420	30	25	375	30	25	380	30	25

Continue of the Table 3

1	2	3	4	5	6	7	8	9	10	11	12	13
2.8 Masonry parapet and ventilation shafts (red brick)	72	50	-	90	50	-	72	50	-	75	50	-
3. Roof installation												
3.1 Installation of the rafter system	50	20	15	40	20	15	50	20	15	40	20	15
3.2 Installing a vapor barrier layer	30	15	-	20	15	-	30	15	-	20	15	-
3.3 Laying insulating materials	20	10	-	20	20	-	20	10	-	20	10	-
3.4 Laying a layer of waterproofing	15	10	-	25	10	-	15	10	-	15	10	-
3.5 Insulation of the roof with a screed	30	25	-	30	15	-	30	25	-	30	25	-
3.6 Metal tiles of the main roof	40	30	-	40	20	-	40	30	-	40	30	-
3.7 Sheathing of ventilation shafts and installation of a visor	25	20	-	25	20	-	25	20	-	25	20	-
4. Arrangement of the façade												
4.1 Warming and priming	30	20	-	20	20	-	30	20	-	30	20	-
4.2 Decorative façade plaster	10	20	-	10	20	-	10	20	-	10	20	-
4.3 Arrangement of stucco	15	25	-	25	25	-	15	25	-	15	25	-
4.4 Façade painting and landscaping	25	25	-	25	25	-	25	25	-	25	25	-
5. Improvement of the territory												
5.1 Territory planning	40	35	-	30	35	-	40	35	-	40	35	-
5.2 Construction of sidewalks and driveways	40	20	-	30	20	-	40	20	-	40	20	-
5.3 Landscaping	25	30	-	25	30	-	25	30	-	25	30	-
5.4 Fencing of the territory	36	10	-	36	10	-	36	10	-	36	10	-

Continue of the Table 3

1	2	3	4	5	6	7	8	9	10	11	12	13
Type of works	Variants											
	28			29			30			31		
	M	L	Eq	M	L	Eq	M	L	Eq	M	L	Eq
1	2	3	4	5	6	7	8	9	10	11	12	13
1.Foundation installation												
1.1 Pile sinking	240	40	25	220	50	25	220	50	25	220	50	25
1.2 Felling piles	40	20	-	30	25	-	30	25	-	30	25	-
1.3 Grillage reinforcement	90	20	-	80	22	-	80	22	-	80	22	-
2. Frame installation												
2.1 Brickwork under the floor slabs of the 1 st floor (red brick)	72	40	-	72	50	-	72	50	-	72	50	-
2.2 Installation of floor slabs on the 1 st floor (reinforced concrete slabs 6380x990x220 mm)	375	30	25	375	30	25	375	30	25	375	30	25
2.3 Masonry of walls and partitions of the 1 st floor (red brick)	72	40	-	72	50	-	72	50	-	72	50	-
2.4 Brickwork under the floor slabs of the 2 st floor (red brick)	72	40	-	72	50	-	72	50	-	72	50	-
2.5 Installation of floor slabs on the 2 st floor (reinforced concrete slabs 6380x990x220 mm)	375	30	25	375	30	25	375	30	25	375	30	25
2.6 Masonry of walls and partitions of the 2 st floor (red brick)	72	40	-	72	50	-	72	50	-	72	50	-
2.7 Installation of floor slabs between the 2 st floor and the attic (reinforced concrete slabs 6380x990x220 mm)	375	30	25	375	30	25	375	30	25	375	30	25

Continue of the Table 3

1	2	3	4	5	6	7	8	9	10	11	12	13
2.8 Masonry parapet and ventilation shafts (red brick)	72	50	-	72	50	-	72	50	-	72	50	-
3. Roof installation												
3.1 Installation of the rafter system	45	20	15	50	20	15	15	20	15	40	20	15
3.2 Installing a vapor barrier layer	20	15	-	30	15	-	30	15	-	30	15	-
3.3 Laying insulating materials	20	10	-	20	10	-	20	10	-	20	10	-
3.4 Laying a layer of waterproofing	15	15	-	15	10	-	15	10	-	15	10	-
3.5 Insulation of the roof with a screed	30	25	-	30	25	-	30	25	-	30	25	-
3.6 Metal tiles of the main roof	40	30	-	40	30	-	20	20	-	30	30	-
3.7 Sheathing of ventilation shafts and installation of a visor	25	20	-	25	20	-	35	20	-	25	20	-
4. Arrangement of the façade												
4.1 Warming and priming	30	15	-	30	20	-	30	20	-	30	20	-
4.2 Decorative façade plaster	10	20	-	10	20	-	10	20	-	10	20	-
4.3 Arrangement of stucco	15	25	-	15	25	-	15	25	-	15	25	-
4.4 Façade painting and landscaping	25	25	-	25	25	-	25	25	-	25	25	-
5. Improvement of the territory												
5.1 Territory planning	40	35	-	40	35	-	40	35	-	30	35	-
5.2 Construction of sidewalks and driveways	40	20	-	40	20	-	40	20	-	30	20	-
5.3 Landscaping	25	30	-	25	30	-	25	30	-	25	30	-
5.4 Fencing of the territory	36	10	-	36	10	-	36	10	-	36	10	-

Continue of the Table 3

1	2	3	4	5	6	7
Type of works	Variants					
	32			33		
	M	L	Eq	M	L	Eq
1	2	3	4	5	6	7
1.Foundation installation						
1.1 Pile sinking	240	40	25	220	50	25
1.2 Felling piles	40	20	-	30	25	-
1.3 Grillage reinforcement	90	20	-	80	22	-
2. Frame installation						
2.1 Brickwork under the floor slabs of the 1 st floor (red brick)	72	40	-	72	50	-
2.2 Installation of floor slabs on the 1 st floor (reinforced concrete slabs 6380x990x220 mm)	375	30	25	375	30	25
2.3 Masonry of walls and partitions of the 1 st floor (red brick)	72	40	-	72	50	-
2.4 Brickwork under the floor slabs of the 2 st floor (red brick)	72	40	-	72	50	-
2.5 Installation of floor slabs on the 2 st floor (reinforced concrete slabs 6380x990x220 mm)	375	30	25	375	30	25
2.6 Masonry of walls and partitions of the 2 st floor (red brick)	72	40	-	72	50	-
2.7 Installation of floor slabs between the 2 st floor and the attic (reinforced concrete slabs 6380x990x220 mm)	375	30	25	375	30	25

Continue of the Table 3

1	2	3	4	5	6	7
2.8 Masonry parapet and ventilation shafts (red brick)	72	50		72	50	
3. Roof installation						
3.1 Installation of the rafter system	45	20	15	50	20	15
3.2 Installing a vapor barrier layer	20	15	-	30	15	-
3.3 Laying insulating materials	20	10	-	20	10	-
3.4 Laying a layer of waterproofing	15	15	-	15	10	-
3.5 Insulation of the roof with a screed	30	25	-	30	25	-
3.6 Metal tiles of the main roof	40	30	-	40	30	-
3.7 Sheathing of ventilation shafts and installation of a visor	25	20	-	25	20	-
4. Arrangement of the façade						
4.1 Warming and priming	30	15	-	30	20	-
4.2 Decorative façade plaster	10	20	-	10	20	-
4.3 Arrangement of stucco	15	25	-	15	25	-
4.4 Façade painting and landscaping	25	25	-	25	25	-
5. Improvement of the territory						
5.1 Territory planning	40	35	-	40	35	-
5.2 Construction of sidewalks and driveways	40	20	-	40	20	-
5.3 Landscaping	25	30	-	25	30	-
5.4 Fencing of the territory	36	10	-	36	10	-

Table 4

INDIVIDUAL TASKS FOR ADDITIONAL WORKS AND ANNUAL DISCOUNT RATE

Variant №	Cost (C), \$			Annual discount rate (d), %
	Cost type			
	Recurring (e.g. cleaning)	Intermittent (e.g. decoration)	Intermittent (e.g. replacement)	
1	2	3	4	5
0	5000	10000	12000	3
1	5000	11000	13000	4
2	5000	12000	14000	2
3	6000	13000	12000	5
4	4000	11000	11000	4
5	7000	10000	13000	6
6	8000	14000	12000	3
7	5000	12000	11000	5
8	6000	10000	13000	4
9	8000	10000	12000	3
10	5000	12000	11000	4
11	6000	13000	13000	2
12	4000	11000	11000	5
13	5000	10000	14000	4
14	4000	14000	15000	6
15	7000	12000	12000	3
16	8000	10000	13000	5
17	5000	10000	14000	4
18	6000	11000	12000	3

Continue of the Table 4

1	2	3	4	5
19	4000	12000	11000	5
20	5000	13000	13000	4
21	4000	11000	11000	4
22	7000	10000	13000	6
23	8000	14000	12000	3
24	5000	12000	11000	5
25	6000	10000	13000	4
26	8000	10000	12000	3
27	5000	12000	11000	4
28	6000	13000	13000	2
29	4000	11000	11000	5
30	5000	10000	14000	4
31	4000	14000	15000	6
32	7000	10000	13000	6
33	4000	11000	11000	4

EXAMPLE OF INDIVIDUAL WORK (VARIANT №0)

1. Liner Regression Analysis

Table 5

Activity cost by years

t=year	y=activity cost, \$
1	2
1	680400
2	690000
3	695000
4	700000
5	710000
6	730000
7	765000
8	725000
9	760000
10	790000
11	800000
12	850000

Table 6

Calculations for determining the slope and intercept of the regression line

t=year	y=activity cost, (in \$ thousand)	t x y, (in \$ thousand)	t ²	y ² , (in \$ thousand)
1	2	3	4	5
1	680,4	680,4	1	462944,16
2	690,0	1380,0	4	476100,00

Continue of the Table 6

1	2	3	4	5
3	695,0	2085,0	9	483025,00
4	700,0	2800,0	16	490000,00
5	710,0	3550,0	25	504100,00
6	730,0	4380,0	36	532900,00
7	765,0	5355,0	49	585225,00
8	725,0	5800,0	64	525625,00
9	760,0	6840,0	81	577600,00
10	790,0	7900,0	100	624100,00
11	800,0	8800,0	121	640000,00
12	850,0	10200,0	144	722500,00
$\Sigma t = 78$	$\Sigma y = 8\,895,4$	$\Sigma t \times y = 59\,770,4$	$\Sigma t^2 = 650$	$\Sigma y^2 = 66\,241\,19,16$

The slope b of the line is given by

$$b = \frac{n\Sigma ty - \Sigma t\Sigma y}{n\Sigma t^2 - (\Sigma t)^2} = \frac{12 \times 59\,770,4 - 78 \times 8\,895,4}{12 \times 650 - (78)^2} = 13,639. \quad (6)$$

The intercept a is given by

$$a = \frac{\Sigma y - b\Sigma t}{n} = \frac{8\,895,4 - 13,639 \times 78}{12} = 652,633. \quad (7)$$

The intercept a of the line is given by

$$y_t = a + bt = 652,633 + 13,633t. \quad (8)$$

The forecast for periods 13, 14, 15 are given by

$$y_{13} = 652,633 + 13,633 \times 13 = 829,862 \text{ (in \$ thousand)}, \quad (9)$$

$$y_{14} = 652,633 + 13,633 \times 14 = 843,495 \text{ (in \$ thousand)}, \quad (10)$$

$$y_{15} = 652,633 + 13,633 \times 15 = 857,128 \text{ (in \$ thousand)}. \quad (11)$$

2. Cost estimating of the project

Table 7

Construction cost estimating

№	Title of work	Units of measurements	Volume of work	Material cost		Wages of workers		Equipment	
				Cost per unit, \$	Cost for the entire volume, \$	Cost per unit, \$	Cost for the entire volume, \$	Cost per unit, \$	Cost for the entire volume, \$
1	2	3	4	5	6	7	8	9	10
1	Direct costs	-	-	-	-	-	-	-	-
	Foundation installation	-	-	-	-	-	-	-	-
1.1	Pile sinking	pieces	42	220	9240	50	2100	25	1050
1.2	Felling piles	pieces	42	30	1260	25	1050	-	-
1.3	Grillage reinforcement	pieces	42	80	3360	22	924	-	-
1.4	Concreting grillage	-	-	-	-	-	-	-	-
	Total foundation installation by cost elements, \$	-	-	-	13 860	-	4074	-	-
	Total cost of the foundation installation – 17 934 \$								
2	Frame installation	-	-	-	-	-	-	-	-
2.1	Brickwork under the floor slabs of the 1 st floor (red brick)	m ³	2450	72	176400	50	122500	-	-

Continue of the Table 7

1	2	3	4	5	6	7	8	9	10
2.2	Installation of floor slabs on the 1 st floor (reinforced concrete slabs 6380x990x220 mm)	pieces	14	375	5250	30	420	25	350
2.3	Masonry of walls and partitions of the 1 st floor (red brick)	m ³	530	72	38160	50	26500	-	-
2.4	Brickwork under the floor slabs of the 2 st floor (red brick)	m ³	1430	72	102960	50	71500	-	-
2.5	Installation of floor slabs on the 2 st floor (reinforced concrete slabs 6380x990x220 mm)	pieces	10	375	3750	30	300	25	250
2.6	Masonry of walls and partitions of the 2 st floor (red brick)	m ³	360	72	25920	50	18000	-	-
2.7	Installation of floor slabs between the 2 st floor and the attic (reinforced concrete slabs 6380x990x220 mm)	pieces	10	375	3750	30	300	25	250
2.8	Masonry parapet and ventilation shafts (red brick)	m ³	210	72	15120	50	10500	-	-
	Total frame installation by cost elements	-	-	-	371310	-	250020	-	1190
	Total cost of the frame installation – 622 520 \$								

Continue of the Table 7

1	2	3	4	5	6	7	8	9	10
3	Roof installation	-	-	-	-	-	-	-	-
3.1	Installation of the rafter system	m ²	160	50	8000	20	3200	15	2400
3.2	Installing a vapor barrier layer	m ²	160	30	4800	15	2400	-	-
3.3	Laying insulating materials		160	20	3200	10	1600	-	-
3.4	Laying a layer of waterproofing	m ²	160	15	2400	10	1600	-	-
3.5	Insulation of the roof with a screed	m ²	160	30	4800	25	4000	-	-
3.6	Metal tiles of the main roof	m ²	160	40	6400	30	4800	-	-
3.7	Sheating of ventilation shafts and installation of a visor	m ²	40	25	4000	20	3200	-	-
	Total roof installation by element	-	-	-	33600	-	20800	-	2400
	Total cost of the roof installation – 56 800 \$								
4	Arrangement of the facade	-	-	-	-	-	-	-	-
4.1	Warming and priming	m ²	240	30	7200	20	4800	-	-
4.2	Decorative façade plaster	m ²	240	10	2400	20	4800	-	-
4.3	Arrangement of stucco	m ²	100	15	1500	25	2500	-	-
4.4	Façade painting and landscaping	m ²	240	25	6000	25	6000	-	-

Continue of the Table 7

1	2	3	4	5	6	7	8	9	10
	Total arrangement of the facade by element	-	-	-	17100	-	18100	-	-
Total cost of arrangement of the façade – 35200 \$									
5	Improvement of the territory	-	-	-	-	-	-	-	-
5.1	Territory planning	m ²	360	40	14400	35	12600	-	-
5.2	Construction of sidewalks and driveways	m ²	80	40	3200	20	1600	-	-
5.3	Landscaping	m ²	200	25	5000	30	6000	-	-
5.4	Fencing of the territory	m	76	36	2736	10	760	-	-
	Total improvement of the territory by element	-	-	-	25336	-	20960	-	-
Total cost of improvement of the territory – \$ 46296									
TOTAL DIRECT COST– \$ 778 750									
Indirect cost									
Home office general conditions, 5% from total direct cost – \$ 42831									
Jobsite general conditions, 10% from total direct cost – \$ 77875									
TOTAL INDIRECT COST – \$120706									
TOTAL COST OF THE PROJECT – \$899456									

3. Metrics for economic performance

Table 8

Calculation of net present value (NPV)

Annual discount rate (d) – 3%													
Period of analysis (p)													
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Cost type	Year	Cost (C)	0	1	2	3	4	5	6	7	8	9	10
-	incurred (n)	-	-	-	-	-	-	-	-	-	-	-	-
-	Discount rate (q)	1	1,0000	0,9709	0,9426	0,9151	0,8885	0,8626	0,8375	0,8131	0,7894	0,7664	0,7441
Capital (e.g. construction)	0	\$899456	\$899456	\$0,0	\$0,0	\$0,0	\$0,0	\$0,0	\$0,0	\$0,0	\$0,0	\$0,0	\$0,0
Recurring (e.g. cleaning)	1	\$5000	\$0,0	\$4854,5	\$4713	\$4575,5	\$4442,5	\$4313	\$4187,5	\$4065,5	\$3947	\$3832	\$3723,5
Intermittent (e.g. decoration)	5	\$10000	\$0,0	\$0,0	\$0,0	\$0,0	\$0,0	\$8626	\$0,0	\$0,0	\$0,0	\$0,0	\$7441
Intermittent (e.g. replacement)	10	\$12000	\$0,0	\$0,0	\$0,0	\$0,0	\$0,0	\$0,0	\$0,0	\$0,0	\$0,0	\$0,0	\$8929,2

Continue of the Table 7

1	2	3	4	5	6	7	8	9	10	11	12	13	14
-	Total NPV p.a (Cnxq) =	-	\$899456	\$4854,5	\$4713	\$4575,5	\$4442,5	\$12939	\$4187,5	\$4065,5	\$3947	\$3832	\$20093,7
-	Comulative total NPV (sum Cnxq) =	-	\$899456	\$904310	\$904169	\$904031	\$903898	\$912395	\$903643	\$903521	\$903403	\$903288	\$919549
-	Total NPV = Cn x q for p =	-	-	-	-	-	-	-	-	-	-	-	\$919549

Calculation of annual equivalent value (AEV):

$$AEV = \frac{919549 \times 0.03}{(1 + 0,03)^{10} - 1} = 80213 \text{ \$}. \quad (12)$$

Therefore, a cost of 919549 \$ units in 10 years' time at an interest rate of 3% will be equivalent to an annual investment of 80213 \$ units.

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Present Value of \$1 Table

n	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
1	0.9901	0.9804	0.9709	0.9615	0.9524	0.9434	0.9346	0.9259	0.9174	0.9091
2	0.9803	0.9612	0.9426	0.9246	0.9070	0.8900	0.8734	0.8573	0.8417	0.8264
3	0.9706	0.9423	0.9151	0.8890	0.8638	0.8396	0.8163	0.7938	0.7722	0.7513
4	0.9610	0.9238	0.8885	0.8548	0.8227	0.7921	0.7629	0.7350	0.7084	0.6830
5	0.9515	0.9057	0.8626	0.8219	0.7835	0.7473	0.7130	0.6806	0.6499	0.6209
6	0.9420	0.8880	0.8375	0.7903	0.7462	0.7050	0.6663	0.6302	0.5963	0.5645
7	0.9327	0.8706	0.8131	0.7599	0.7107	0.6651	0.6227	0.5835	0.5470	0.5132
8	0.9235	0.8535	0.7894	0.7307	0.6768	0.6274	0.5820	0.5403	0.5019	0.4665
9	0.9143	0.8368	0.7664	0.7026	0.6446	0.5919	0.5439	0.5002	0.4604	0.4241
10	0.9053	0.8203	0.7441	0.6756	0.6139	0.5584	0.5083	0.4632	0.4224	0.3855
11	0.8963	0.8043	0.7224	0.6496	0.5847	0.5268	0.4751	0.4289	0.3875	0.3505
12	0.8874	0.7885	0.7014	0.6246	0.5568	0.4970	0.4440	0.3971	0.3555	0.3186
13	0.8787	0.7730	0.6810	0.6006	0.5303	0.4688	0.4150	0.3677	0.3262	0.2897
14	0.8700	0.7579	0.6611	0.5775	0.5051	0.4423	0.3878	0.3405	0.2992	0.2633
15	0.8613	0.7430	0.6419	0.5553	0.4810	0.4173	0.3624	0.3152	0.2745	0.2394
16	0.8528	0.7284	0.6232	0.5339	0.4581	0.3936	0.3387	0.2919	0.2519	0.2176
17	0.8444	0.7142	0.6050	0.5134	0.4363	0.3714	0.3166	0.2703	0.2311	0.1978
18	0.8360	0.7002	0.5874	0.4936	0.4155	0.3503	0.2959	0.2502	0.2120	0.1799
19	0.8277	0.6864	0.5703	0.4746	0.3957	0.3305	0.2765	0.2317	0.1945	0.1635
20	0.8195	0.6730	0.5537	0.4564	0.3769	0.3118	0.2584	0.2145	0.1784	0.1486

A present value of \$1 table uses for listing the discount rates that are used for a variety of interest rate (i) and time period (n) combinations. This is also known as a present value interest factor (PVIF).

The discount rate in the PVIF table can then be multiplied by the cash amount to be received at a future date, and the result will be the present value of that sum.

NOTES

Навчально-методичне видання

МЕТОДИ ВАРТІСНОГО ІНЖИНІРИНГУ В БУДІВНИЦТВІ

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