USE OF HOURLY RATE IN DETERMINING THE COST OF ENGINEERING SERVICES

Inna Vakhovych[1], Larisa Tereshchenko[2], Oleksander Demianenko[3]

[1]PhD (Economics), Associate Professor, Director of LLC "AMV Engineering", Kyiv, Ukraine, E-mail: inna.vahovich@gmail.com, ORCID: 0000-0001-8486-759X

[2]Director of the «Ecobud» Center, Kiev, Ukraine, E-mail: lvdnot@ukr.net, ORCID: 0000-0001-9860-2226

[3]Graduate student of the Department of Construction Economics, Kyiv National University of Construction and Architecture, Kyiv, Ukraine, E-mail: sasha_demyan@ukr.net, ORCID: 0000-0002-7345-3559

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Abstract. *In 2017, a new profession with the code KP-2142.2 – Consulting Engineer (Construction) was officially approved in Ukraine. Construction customers additionally include in the construction cost up to 3% the cost of the services of a consulting engineer. The Ministry of Regional Development of Ukraine has approved an approximate form of contract for the provision of consulting engineer services. In world practice, there are three main methods of calculating the cost of engineering services in construction: hourly rate, interest fee, one-time fee. Each organization must choose for itself a convenient principle of calculating the cost of services of a consulting engineer as a business entity for different types of services. One of the types of engineering services in construction is a survey of the technical condition and operational suitability of buildings and structures. Existing regulations do not fully take into account the needs of the industry, in particular do not contain rules for the inspection of technical condition of structures: tunnels, subways, collectors, railways, ports, dams, canals, etc.*

In market conditions, serious difficulties that prevent the effective use of scientific developments, in terms of improving the operational reliability of buildings and structures, is the lack of regulatory framework for determining the cost of such works.

Keywords: *Consulting engineer, time rate, cost of services, time rate, inspection of technical condition.*

JEL Classification: L74, L89, M52

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Introduction. In 2017, a new profession with the code KP-2142.2 - Consulting Engineer (Construction) was officially approved in Ukraine. In this regard, according to the order of the Ministry of Economic Development of Ukraine dated 26.10.2017 № 1542, appropriate changes were made to the National Classification of Ukraine DK 003:2010 (2010). And also developed and approved according to the order of the Ministry of Regional Development, Construction and Housing of Ukraine from 08.08.2017 №192 qualification description of the consulting engineer (Handbook of qualification characteristics of occupations. Issue 64. Construction, installation and repair work. Section 1 Leaders Professionals, Specialists, 1999).

Amendment №2 to DSTU B. D.1.1-2013 “Rules for determining the cost of construction” from June 1, 2018 to Chapter 10 “Maintenance of customer service” (columns 6 and 7) of the consolidated estimate added the ability to take into account funds not only for maintenance customer, but also include funds for technical supervision, up to 2,5% of column 7, and funds up to 3% of column 8 for the provision of information and consulting services in construction by consulting engineers (individuals or legal entities).

If the cost of services of consulting engineers for project implementation is taken into account, the cost of these services should not exceed 5,5% of Chapters 1-9 of the consolidated estimate (Tereshchenko, Vakhovych & Demianenko, 2018).

The Ministry of Regional Development of Ukraine has approved an approximate form of contract for the provision of engineering consulting services used by the customer and engineering consultants in construction as a recommendation when concluding contracts for the provision of these services (Order of the Ministry of Regional Development №89 from 13.04.2020).

From now on, managers of budget funds, funds of state enterprises, institutions and organizations, as well as credit funds provided under state guarantees, customers and investors have additionally received a mechanism to involve consulting engineers in the implementation of construction projects at the pre-project stage. According to the resolution of the Cabinet of Ministers of Ukraine of August 12, 2020 № 704.

In particular, the Title for the performance of design and survey works for construction is supplemented by column 14, which justifies the possibility of involving a consulting engineer at the beginning of the design and survey work (Interstate Guild of Consulting Engineers, 2021).

The amount of funds for the services of a consulting engineer in case of his involvement at the design stage, as a rule, may not exceed 15 percent of the total limit of funds planned for the respective purposes in the consolidated estimate of the investment estimate of the construction object (FBM Ukraine, 2021).

Literature review. The vast majority of research, publications and documents on the cost of engineering services are carried out and developed in developed countries by national associations of engineering consultants, such as: Canada (Association of Consulting Engineering Companies British Columbia (ACEC-BC), & Association of Professional Engineers and Geoscientists of British Columbia (Engineers and Geoscientists BC), 2009, Association of Consulting Engineering Companies - Canada (ACEC), 2010, Ontario Society of Professional Engineers (OSPE), 2015, Consulting Engineers of Nova Scotia (CENS), 2017), United States of America (National Society of Professional Engineers (NSPE), American Council of Engineering Companies (ACEC), & Associated General Contractors of America (AGC), 2009).In Ukraine, there are currently no regulations and / or publications that systematically define approaches to determining the cost of services of a consulting engineer as a business entity, in particular when performing work using budget funds.

Aims. The purpose of the study is substantiation of the need to develop an effective mechanism for regulating the hourly rate indicator when determining the cost of engineering services.

Methods. The study used general and specific research methods, including the method of comparison, tabular method, coefficient method, graphical method, and other methods.

Results. In world practice, there are three main methods of calculating the cost of engineering services in construction: hourly rate, interest fee, one-time fee. When concluding a contract with a consulting engineer, the calculation of the cost of services can be performed by applying all these methods - for each of the services,

the pricing method is chosen that is most acceptable to the parties at the stage of its conclusion.

The first method is the interest fee - used in projects with a well-defined scope of services of a consulting engineer. The cost of consulting and consulting services of a consulting engineer is calculated on the basis of a percentage of the cost of work performed, for which the consulting engineer is directly responsible (Vakhovych, Demianenko, 2019).

The content of the interest method is that the cost of services is expressed as a percentage (%) of the cost of construction works. However, from our practical experience in determining the cost of services of a consulting engineer at the initial stage of the investment and construction project when the estimate documentation is missing or not developed in full, there is a problem in determining the reliable cost of construction work at this stage.

To this end, in order to determine the cost of consulting services, the Aggregate Indicators of Construction Costs of Different Levels of Detail and Percentages for Determining the Costs of Different Types of Services of Consulting Engineers are developed in detail.

The second method of determining the cost of services of Consulting Engineers is the "hourly rate", which involves expressing the cost of services based on the complexity of services in man-hours and the cost of one hour of services. The hourly rate can be calculated according to the following basic approaches:

Price for one hour of work of one specialist:

- the price for the key specialist, which includes the cost of the specialist team. That is, the salary of a specialist is equal to the salary of the team (the composition of the team is not disclosed);
- price for each specific specialist.

Price for one person-hour of service:

- based on the salary of each member of the service team;
- based on the average salary in the organization of a consulting engineer.

The method of calculating the cost of one person-hour based on the average salary in the organization does not allow:

- take into account the situation, the involvement of highly qualified highly paid professionals;
- take into account part of the labor participation of a particular specialist;
- take into account the harmful conditions of some works;
- determine different costs for different types of services in the same organization.

At the same time, currently in table G3 DSTU B D.1.1-7 (2013) different cost of one person-day is defined only for different types of design and survey works.

To calculate the cost for one hour of work of one specialist are allocated operations that are assigned to a specific group of performers. A time norm is developed for each operation, according to which it is clear what percentage of time or hours each executor is employed, which will allow taking into account different wages. The advantage of this method is to take into account different labor costs and the ability to calculate the average duration of all work.

The cost of one man-hour is determined based on the calculation of labor costs and economically justified elements of costs for the following items:

- salaries of performers;
- deductions for social events;
- total expenditures;
- administrative expenses;
- profit;
- taxes, fees and other mandatory payments.

The cost of one man-hour does not take into account:

- material costs (cost of purchased basic materials and raw materials, devices, equipment, reagents, etc.), which are necessary components in the performance of work (provision of services) and can be directly attributed to the object of costs (these works, services), etc.);
- business trip costs engineer-consultants;
- the cost of third-party services
- other costs are not included in the cost of one man-hour.

When calculating the cost of one man-hour based on the average wage, the average man-hour for the previous period of similar services is taken, not the potential salary. This method is more differentiated in terms of specific conditions for specific works and allows you to take into account the specifics of this service in terms of cost structure.

In our opinion, each organization should choose for itself a convenient principle of calculating the cost of services of a consulting engineer as a business entity for different types of services. In our opinion, the most practical approach is one that takes into account the labor contribution of various specialists who perform work as part of a team.

To calculate the cost of services required justification complexity of work and algorithm for its determination.

Own experience in assessing the technical condition and operational reliability of buildings and structures, allowed to identify guidelines for the same types of work. One of the types of engineering services in construction is a survey of the technical condition and operational suitability of buildings and structures.

As of 2020 in Ukraine, the list of current regulations governing the determination of the cost of work to assess the technical condition is:

1. Methodical recommendations for determining the cost of works on inspection, assessment of technical condition and certification of buildings and structures - 1999
2. SOU D.1.2-02495431-001:2008 "Standards of labor costs to determine the cost of work to assess the technical condition and serviceability of structures of buildings and structures."
3. DSTU B D.1.2-3:2016 “Procedure for determining the cost of works on inspection of metal structures of buildings and structures”.
4. SOU D.1.3-31223828-001:2016 "Labor costs for determining the cost of work to assess the technical condition of technological and storage bins";

5. SOU 42.1-37641918-097:2017 "Motor roads. Time norms for maintenance work".

6. SOU 42.1-37641918-071:2018 "Roads. Resource element estimates for maintenance work (Group 6-59 Inspection of the underwater part of bridge piers after floods and ice drifts)".

The above regulations incomplete volumes take into account the needs of the industry, in particular do not contain rules for the inspection of the technical condition of structures: tunnels, subways, collectors, railways, ports, dams, canals, etc. Based on this, there is a need to develop appropriate time standards.

Research method to substantiate the norms of time, an analytical-research method was chosen, which is based on normative observation (DSTU-N B D.1.1-6, 2013) and provides for the study of production processes by studying the duration and nature of working time to perform these works (Figure 1).

Discussion. Timing (Table 1) for the development of time norms was performed during the inspection of the technical condition of the structures of the South-Western sewer collector in Kyiv (Figure 2). Process meter of 100 m of reinforced concrete sewer collector with a diameter of 1860 mm, accuracy of measurements up to one minute.

The timing table consists of: individual labor operations, the duration of these operations (minutes), the number of employees for each operation and a certain complexity of man-minutes.

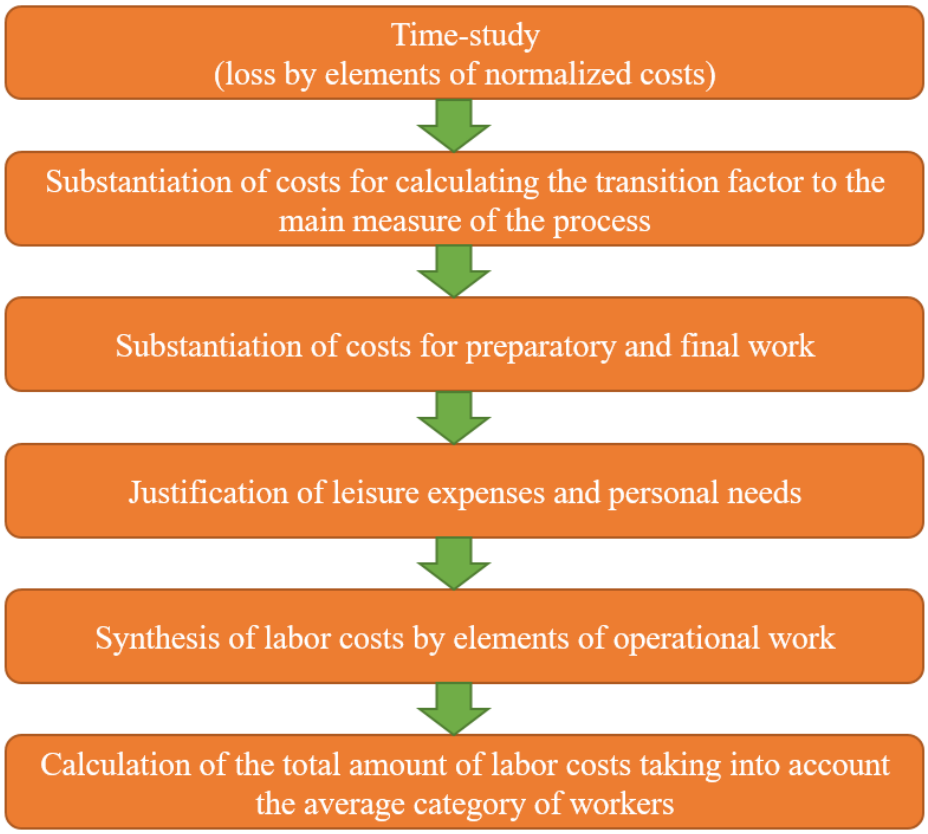

Figure 1. The main stages of development of time norms, analytical research method based on normative observation

Source: developed by the authors on the basis of (DSTU-N B D.1.1-6, 2013)

Table 1. Timing for the performance of normalized work

№	The name of the elements of the normalized process		Element meter	Duration, minutes	Labor costs, man-minutes	Quantity of finished products	Number of performers
1	Collection and analysis of technical documentation		1 sheet A4	4	24	3	2
2	Development of the program of inspections, the technical task for performance of works with definition of types of instrumental inspections and necessary measuring works		1 sheet A4	145	435	3	1
3	Detailed visual inspection with assessment of technical condition		100 r. m.	105	315	1	3
4	Defects and damage	Detection	1 defect	10	300	10	3
		Measurement	1 defect	5	100	10	2
		Sketching	1 sheet	7	70	10	1
		Photography	1 photo	1	10	10	1
5	Clarification of the calculation scheme and load collection schemes		1 sheet A4	62	124	1	2
6	Establishment of places for instrumental inspection		1 sheet A4	45	180	2	2
7	Analysis and processing of survey results		1 sheet A4 / photo	15	450	15	2
8	Determining the conformity of the arranged structures to the working documentation (if it is available)		1 sheet A4	10	60	3	2

Source: developed by the authors

Figure 2. Defects noted during the inspection of the sewer in Kyiv*

Source: photographed by the authors

After that, with the help of synthesis of labor costs and special calculations, additional consideration of rest time and personal needs in the amount of 10% of the time of operational work, the total labor costs of the whole process for measuring 100 meters of the collector are determined (Table 2).

Table 2. The results of primary data processing to perform a set of works on the inspection of the sewer

Ch.ch.	Name of elements	The total amount of time spent		Unit	Produced products per unit of measurement	Number of products in 60 minutes (one hour) $\frac{Coiumn\ 6}{Coiumn\ 3} \times 60$
		min	%			
1	South-West sewer in Kyiv	2068		100 r. m.	1	0.03
1.1	Collection and analysis of technical documentation	24		100 r. m.	1	2.50
1.2	Development of the program of inspections, the technical task for performance of works with definition of types of instrumental inspections and necessary measuring works	435		100 r. m.	1	0.14
1.3	Detailed visual inspection with assessment of technical condition	315		100 r. m.	1	0.19
1.4	Detection of defects and damage	300		100 r. m.	1	0.20
1.5	Measurement of defects and damage	100		100 r. m..	1	0.60
1.6	Sketching of defects and damages	70		100 r. m.	1	0.86
1.7	Photographing defects and damage	10		100 r. m.	1	6.00
1.8	Clarification of the calculation scheme and load collection schemes	124		100 r. m.	1	0.48
1.9	Establishment of places for instrumental inspection	180		100 r. m.	1	0.33
1.10	Analysis and processing of survey results	450		100 r. m.	1	0.13
1.11	Determining the conformity of the arranged structures to the working documentation	60		100 r. m.	1	1.00
2	Link composition: Expert Senior Engineer Engineer		 15 40 45			

Source: developed by the authors

The estimated productivity of the unit of specialists to perform a set of works on the inspection of reinforced concrete sewer collector with a diameter of 1860 mm is:

$$\mathrm{P_{spec}} = \frac{S_v \cdot \mathrm{T_n}}{\mathrm{T_{op}}} = \frac{100 \cdot 60}{2068} = 2{,}90 \text{ km/hour} \quad (1)$$

The norm of time (for 100 m) for a complex of works on check and adjustment of results of works on inspection of the reinforced concrete sewer collector with a diameter of 1400 mm will make:

$$\mathrm{N'_{часу}} = \frac{1}{\mathrm{P_{spec}}} \cdot 100 = \frac{1}{2{,}90} \cdot 100 = 34 \text{ hour} \quad (2)$$

Determine the norm of time in man-days based on the usual length of the working day 8 hours:

$$\mathrm{N_{time}} = \frac{34}{8} = 4{,}25\ \text{man} - \text{days} \quad (3)$$

The cost of inspection of a reinforced concrete sewer on the basis of estimated labor costs is determined by the formula:

$$C = (N_{time} \cdot \mathrm{V_{ch-d}}) + \mathrm{M} + V_v + \mathrm{I} \quad (4)$$

where V_{ch-d} - the cost of work per unit well, man-hour, set for the current period, UAH; M - material costs (cost of purchased basic materials and raw materials, devices, equipment, reagents, etc.), necessary for the direct performance of works, UAH; V_v - travel expenses of production staff, UAH; I - other costs, no taken into account in the cost per person-hour, UAH.

Below are examples of calculating the cost of a set of works on the inspection of the technical condition of the structures of the sewer using different methods.

Method 1. Calculation of the cost of a set of works in the case when the composition of the team is not disclosed (the salary of a specialist is equal to the average salary in the team, Table 3).

Table 3 Calculation of the cost of 1 person-day for a survey specialist

Position of the executor	Number of performers, people.	Number of people-days	Salary	
			For 1 day	Total (count 3 x count 4)
Examination specialist	1	1	1250	1250
1. Total salaries of contractors per 1 person-day, UAH				1250
2. Additional salary - leave (8.3% of row 1), UAH				103,75
3. Total labor costs (row. 1 + row. 2), UAH				1353,75
4. Deductions for social events (22% of row 3), UAH				297,83
5. Overhead costs (30% of row 3), UAH				406,13
6. Total cost of works (rows 3 ÷ 5), UAH				2057,70
7. Profit (8% of the cost of work)				164,62
8. Administrative expenses (25% of row 3), UAH				338,44
9. Total cost 1 person-day (row 6 ÷ 8), UAH				2560,75
10. Value added tax, UAH				512,15
11. Total cost of 1 person-day with VAT (row. 9 + row. 10), UAH				**3072,90**

Source: developed by the authors

Determine the cost of providing the service (in this case without material costs, travel expenses and other costs) for the inspection of the technical condition of the structures of the sewer (100 m):

$$C = 4{,}25 \cdot 3072{,}90 = 13059{,}84\ \text{UAH}$$

Method 2. Calculation of the cost of providing services in the case when the salary of each specific specialist is taken into account taking into account the time spent by each of the specialists in accordance with table 2 item 2 (table 4):

- expert - 4.25 x 0.15 = 0.64 man-days;
- Leading engineer - 4.25 x 0.4 = 1.7 man-days;

- engineer - 4.25 x 0.45 = 1.91 man-days.

Table 4. Calculation of the cost of providing the service, taking into account each specific specialist

Position of the executor	Number of performers, people.	Labor costs	Salary	
			For 1 day	Total (count 4 x count 5)
Expert	1	0.64	2000	1280
Senior Engineer	1	1.7	1000	1700
Engineer	1	1.91	750	1432,5
			Together	**4412,5**
1. Total salaries of contractors, UAH				4412,5
2. Additional salary - leave (8.3% of row 1), UAH				366,24
3. Total labor costs (row. 1 + row. 2), UAH				4778,74
4. Deductions for social events (22% of row 3), UAH				1051,32
5. Overhead costs (30% of row 3), UAH				1433,62
6. Total cost of works (rows 3 ÷ 5), UAH				7263,68
7. Profit (8% of the cost of work)				581,09
8. Administrative expenses (6% of row 3), UAH				1194,68
9. Total cost works (row 6 ÷ 8), UAH				9039,46
10. Value Added Tax (VAT), UAH				1807,89
11. Together with VAT				**10847,35**

**Source:* developed by the authors

Method 3. Calculation of the cost of providing the service as pre-design works and design works in accordance with DSTU B D.1.1-7:2014.

Calculation of the estimated cost of design work per 1 person-day at an average monthly salary for the category of complexity of construction work 3.8 - 11 000 UAH for 2021.

1. The level of average monthly earnings fees for the category of complexity of works in construction 3.8 - 7800 UAH according to DSTU B D.1.1-7:2014 change № 3.

2. The number of working days in 2020 is 250. The average number of working days in one month is 250/12 = 20,833 days.

3. The average salary for 1 day for the category of complexity of works in construction 3.8 = 7800 / 20,833 = 374,406 UAH.

4. The average salary for 1 day for the category of complexity of construction works 7.0 – 374,406×1.5864 = 593.9576 UAH.

where 1.5864 - the coefficient of transition from the category of complexity of work 3.8 to 7.0 (2,075 / 1,308 = 1,5864, annex A DSTU-N B D.1.1-2:2013).

5. The average salary, taking into account the SSC 22% – 593.9576×1.22 = = 724,6282 UAH.

6. Other components of the cost, in addition to wages, in the estimated cost per 1 person-day –1350-724,3718 = 625,3718 UAH. (ZVV, AB, profit).

For further calculation, we assume that only the increase in wages and the corresponding SSC will be taken into account, and the others - ZVV, AB and the profit will remain unchanged = 625,3718.

7. The level of average monthly earnings fees for the category of complexity of works in construction 3.8 – 11000 UAH.

8. The average salary for 1 day for the category of complexity of works in construction 3,8 – 11000 / 20,833 = 528,0084 UAH.

9. The average salary for 1 day for the category of complexity of work in construction 7,0 – 528,0084×1,5864 = UAH 837,6325.

10. The average salary taking into account the SSC is 22% = 837,6325×1,22= = 1021,9116 UAH.

11. The estimated cost per 1 person-day – 625,97 +1021,9116=1647,2834 UAH.

The indicator of the estimated cost of project works per 1 person-day at the average monthly salary for the category of complexity of works in construction 3,8 – 11000 UAH, which is 1647,00 UAH.

According to DSTU B D.1.1-7: 2014 the calculation of the cost of the survey is given in table 5.

Table 5. Calculation of the cost of providing the service examination in accordance with DSTU B D.1.1-7:2014

№ p/p	List of works performed	Performers		Number of man-days	Cost of 1 man-hour, UAH	Total cost of works, UAH
		Number	position			
1	Inspection of a technical condition of designs of a sewer collector (100 m)	1 1 1 1	Expert Senior Engineer Engineer Engineer	4.25	1647,28	7000,94
	Business trip of production staff:					0.00
	Total:					**7000,94**
	In addition, 0% VAT:					**0.00**
	Together:					**7000,94**

Conclusion. The proposed approach to the formation of a regulatory framework for assessing the technical condition of structures: tunnels, subways, collectors, railways, ports, dams, canals and others by resource method, namely the development of labor costs for different types of structures and the cost of one man-hour days), will allow more correctly economically justify the cost of different types of work, which is especially relevant in market conditions.

In the future, the developed standards will be refined, based on the statistical and analytical method of processing the source information on the actual work performed.

Without quality labor rationing and a reasonable price for the services of a consulting engineer, there can be no effective work planning, reliable evaluation and incentives for engineers, and ultimately it is impossible to achieve significant growth in productivity.

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