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# Analysis of the information content of tenders for the removal of unwanted vegetation

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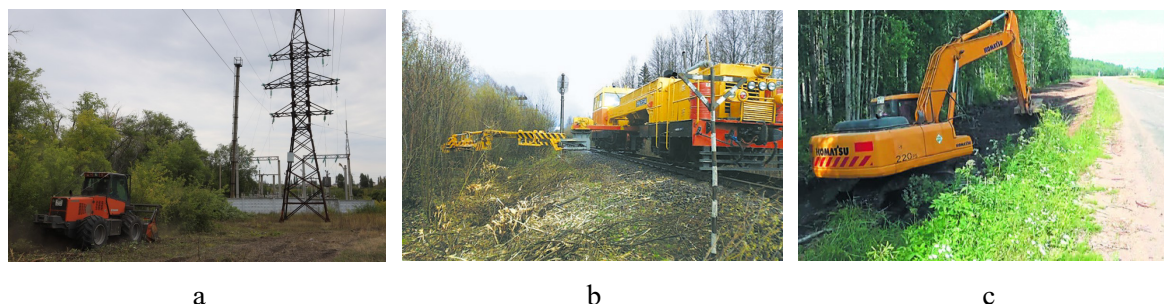
**Abstract.** To ensure the safe functioning of transport infrastructure facilities on their territory a set of works is carried out to remove unwanted trees and shrubs. The aim of the study is the formation of objective information about the most popular technological operations during the performance of these works and the development of recommendations on its basis for production. The methodological basis of our research was a complex of methods of logical, statistical and comparative analysis. Researchers analyzed more than 8,100 competitive bids for the removal of unwanted vegetation, according to a number of criteria. It was revealed that in 18.8% of the competitive bids, the technical task was completely absent, in 40.8% there was no mention of the necessary machines / mechanisms, in 66.4% there was no information about the necessary technological process for influencing unwanted vegetation, while the minimum 30% of the work involves only a manual way to remove it. The analysis of the distribution of the names of works by the relative demand coefficient is carried out, the expediency of reducing their nomenclature is established. The results of the work can be used by manufacturing enterprises engaged in the maintenance and operation of transport infrastructure facilities.

## 1. Introduction

Currently, work is ongoing to increase the reliability of various types of transport [1-3] in order to comprehensively solve such a strategic scientific and technical problem as ensuring the safe functioning of the respective transport networks [4-6]. Among the whole range of works [7] that ensure that the networks of automobile, railway and pipeline transport are in good condition, it is necessary to note the work [8-10] to remove and prevent further growth of unwanted tree and shrub vegetation (UTSV) from the territory of various objects of the corresponding infrastructures [11-13] (figure 1). The basis for such work is a series of regulatory documents of the respective joint-stock companies, as well as interstate and other standards [14, 15]. At the same time, despite the fact that the removal of UTSV through the tender application system is often entrusted to specialized organizations with the necessary equipment and qualified personnel, the development of terms of reference (TOR), work rules and technological maps is carried out haphazardly, but only on the basis of preferences persons responsible for the development of these Rules / Cards and traditions established in these organizations.



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**Figure 1.** Photographic visualization of works to remove unwanted vegetation: a – in the high-voltage line protection zone, Saratov Region, August 2019; b – in the right of way of the October Railway, March 2019; c – in the right of way highway, Arkhangelsk Region, July 2016.

In addition, we found that to date, there is no comprehensive theoretical base and progressive technical means necessary for the creation of new technologies for the removal of unwanted tree and shrub vegetation in the territories of various infrastructure facilities. The development of such scientific foundations and technical means should increase the efficiency and overall quality of work by expanding the functionality of the corresponding machines and equipment. At the same time, it seemed to us expedient, at one of the stages of solving this problem, to study the modern practice of organizing work to remove unwanted vegetation.

Thus, the purpose of this study was to generate objective information about the most popular technological operations when performing work to remove unwanted trees and shrubs and make recommendations on production based on it.

## 2. Methods and materials

To achieve this goal, we have analyzed more than 8,100 competitive bids (tenders) on the need to remove UTSV from the territory of various infrastructure facilities. Information was searched on the official website of the Unified Information System in the Procurement Sector (hereinafter referred to as the UIS Official Website), designed ‘... to provide free and gratuitous access to complete and reliable information on the contract system in the field of procurement and procurement of goods, works, services by certain types of legal persons, as well as for the formation, processing and storage of such information’ [16]. In this study, we used the word ‘tender’ as a synonym for the phrase ‘competitive bid’, the concept of which although, as noted in [17], is not defined in the current legal acts of the Russian Federation, but, nevertheless, it has massively taken root and it is universally used by interested individuals and legal entities, being at the same time also an analog of such competitive procedures as ‘price request’ and ‘request for proposal’.

The study of the above bids was carried out by us with the following parameters set for search:

- search keyword: ‘vegetation’ (including all possible forms of the specified word);
- date of the placement of competitive applications: from 2012 (automatically received by the UIS official website).

When accepting / rejecting the analysis of a particular competitive bid, we took into account a number of boundary criteria developed by us, namely:

- object of influence;
- initial price of the lot, rubles;
- scope of work performed, hectare;
- place of work.

Initially, we accepted for consideration such a criterion as the ‘scope of the technical task’. However, in the process of researching a selection of tenders, we excluded this criterion from further analysis due to the insufficient (about 0.55) correlation coefficient between this criterion and its specific content, which we consider separately below.

According to the criterion of ‘object of impact’, we accepted competitive bids containing information on the required removal from the territory of any objects of such undesirable tree-shrub vegetation (UTSV) as shrubs, light forests, undergrowth and overgrowth.

In order to avoid ambiguous interpretation of the provisions of competitive bids, we have adopted the following content of the basic concepts [18-20]:

- tree: this is a plant with a perennial, to some extent lignified, branched or unbranched main stem-trunk, which lasts throughout the life of the plant, and a crown;
- wood: this is the stem (stem) part, branches and roots of woody plants;
- tree-shrub vegetation (TSV): these are shrubs and trees growing together on the same land plot, having a trunk diameter of less than 11 cm at a height of 1.3 m from the surface of the earth;
- reeds: these are perennial (less commonly, annual) grasses of the sedge family, growing in excessively moistened places and in the water, and often forming extensive thickets;
- shrub: it is a perennial plant with a height of 0.8 ... 6 meters with tree or woody stems, which does not have a main trunk in adult condition;
- light forests: this is a low tree-shrub vegetation;
- unwanted tree and shrub vegetation (UTSV): it is a tree and shrub vegetation, the growth of which is contrary to the requirements of current regulatory documents;
- undergrowth: these are shrubby (less often - woody) species that grow under the forest canopy and are not able to form a stand under these conditions;
- overgrowth: these are young shoots emerging from sleeping or adnexal buds on the stump or roots of trees and shrubs.

According to the criterion of ‘initial price of the lot’, we accepted bids competitive a minimum price of 100,000 rubles, and according to the criterion of ‘scope of work performed’, bids competitive a minimum amount of work to remove UTSV of 2 hectares.

From the analysis we excluded tenders:

- with missing terms of reference (TOR);
- with a nominal presence (in the form of necessary documents), but not completed by the terms of reference;
- in the terms of reference of which provided for a chemical, biological or any other (except mechanical) method of combating with UTSV;
- in the terms of reference of which there was no necessary amount of work (indicated in hectares, m, m<sup>2</sup>, m<sup>3</sup> or linear meters);
- dedicated to work to the demolition / felling of the so-called ‘threat trees’ (emergency), as well as diseased trees and shrubs in the territory of municipal settlements (criterion ‘place of work’);
- providing for the maintenance of tree-shrubby vegetation (sanitary, molding, rejuvenating pruning while removing overgrowths) on the territory of municipal settlements (criterion ‘place of work’).

In the course of work, methods of systemic and logical analysis, as well as mathematical statistics, were used.

### 3. Results and discussion

We found that out of 1,671 competitive bids that meet the above criteria, 315 applications (18.8%) were completely absent or did not fill out a term of reference (or at least an estimate) for the work. Thus, about 1/5 of the bids were not accepted by us for consideration, which led to a further analysis of 1,356 tenders for the removal of unwanted vegetation.

We distinguished methods of dealing with UTSV in the process of viewing competitive bids directly (based on the name of the tender, which often denotes certain requirements by type of impact on the object), and in the direct analysis of TOR. We found that out of 1,356 tenders, 184 of it (13.5%)

provided for the method of chemical clearing of infrastructure facilities, which determined the final analysis of 1,172 tenders for the removal of unwanted vegetation.

A number of tenders provided for a combined (mechanical and chemical) method of removing UTSV (126 competitive bids; 10.7%). In these cases, for accounting, we accepted only the 'mechanical' part of the UTSV removal (scope, list of works, equipment, etc.), and the total amount (initial lot price) of the tender (due to the impossibility of isolating the 'mechanical' component from it) remained outside the scope of this analysis. In a number of TORs (namely, 5.3% of the total number of applications accepted for analysis), the amount of work to remove unwanted vegetation was indicated either in linear meters of the length of the linear part of the infrastructure subject to be cleared, or in square meters, which (if marked in the TORs of the required removal width) necessitated bringing the required amount of work to the unit of measure 'hectare'.

Based on the foregoing, to fix the main parameters of competitive bids (tenders) on the need to remove UTSV from the territory of various infrastructure facilities, we developed a map. The need for basic machines and mechanisms for performing UTSV removal, which we recorded in the column 'Equipment Used' the above map, was determined according to the tender TORs in accordance with the organizational and technological schemes for the production of these works, as well as on the basis of the required scopes / rates of work and taking into account the performance of the indicated machines and mechanisms. We found that out of 1,172 tenders for the removal of unwanted vegetation accepted in the analysis, in 479 competitive bids (40.8%) did not even mention any necessary machines / mechanisms, while 69 bids (5.8%) were indicated in the text a manual way of influencing UTSV, and in 302 bids (25.7%) - a combined (manual + mechanized) way of influencing UTSV.

Thus, we found that when removing unwanted vegetation from the territory of various objects, at least 30% of the work involves a manual method of exposure to UTSV without the use of simple means of mechanization (with the declared means of exposure - axes, hand saws, knife cutters such as machetes, shovels) or its use (with such declared means of exposure as chainsaws and motor-brush cutters). The aforementioned competitive bids card also recorded a description of the technological process for removing unwanted vegetation, information about which could be found both in the notice of the competitive procurement and in the accompanying documentation, namely, in the terms of reference or in the estimate for the performance of work. We found that out of 1,172 tenders for the removal of unwanted vegetation accepted in the analysis, only 394 competitive bids (33.6%) contain information about the necessary technological process for influencing UTSV on the territory of the infrastructure facility, which in our opinion is unacceptably small.

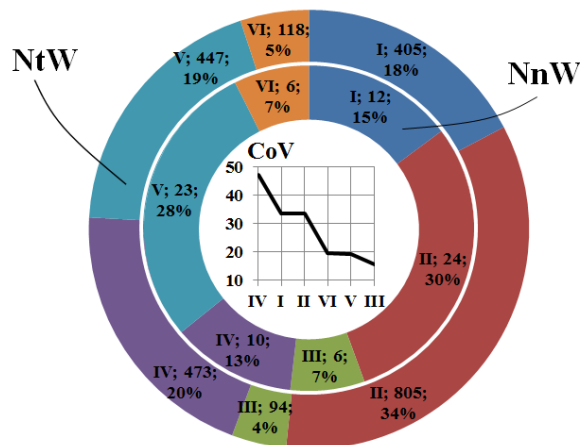
In addition to the above, in the competitive bids map we recorded the names of the works to remove UTSV from the territory of various infrastructure objects to the following criteria:

- ongoing impact on UTSV (cut, clean, crush, etc.);
- object of influence (shrub, light forest, reeds, etc.);
- place of exposure (road right-way strip, security zone of high-voltage power lines, etc.);
- characteristics of the object of impact at the time of the implementation of the impact (cut, chopped, uprooted, etc.).

### *3.1. Features of the distribution of names of work on the basis of 'Ongoing impact on UTSV'*

In total, for the analyzed period of time (2012-2019), in the competitive bids for the removal of UTSV, the presence of 2,342 (in many ways, repeating) names of works was established [21-23], at the initial stage of the analysis of which we revealed the absence of a generally accepted classification when assigning one or another type the impact on UTSV. In general, from the total selection of tenders, we identified 96 names of work that determined one or another type of impact on UTSV, and when combined, the required technological process, and its total number was subsequently reduced to 81. The names of works accepted in the study were divided into 6 groups, distributed according to one or another type of impact on undesirable vegetation at various infrastructure objects, while the analysis of these groups allowed us to form the ones presented in figure 2 distributions by the number of names of

work (in each of the above groups,  $NnW$  zone), the total number of work (belonging to each group,  $NtW$  zone) and by the ratio of the relative demand for works ( $CoV = NtW / NnW$ ):



**Figure 2.** Distribution of groups of items of work specified in the competitive applications for the removal of UTSV.

An analysis of the above distribution shows that by the absolute value of the number of names of work in each of the above groups (zone  $NnW$ ), the leading groups are those with an indefinite impact on UTSV ( $II$  group; with an ambiguously described effect on UTSV, on which it is difficult or impossible to imagine and organize the corresponding technological process; 30% of all works) and with a definite / indefinite effect on removed unwanted vegetation ( $V$  group; with an unambiguously or ambiguously described effect on UTSV, subjected to removal after the main impact on it; 28%). Such a distribution can be explained by the fact that the organizations that ordered the work, imagining in principle its desired result, find it difficult to find specific formulations for both the main way of influencing UTSV and the way that describes the further 'fate' of undesired vegetation eliminated from the original surrounding space. The same can explain the undeniable leadership of the group  $II$  of works with an indefinite impact on UTSV (34%) in terms of the absolute value of the total number of works relating to each group (zone  $NtW$ ). However, it should be noted that the indicated leadership was influenced by a large number of such places of influence on UTSV as 'protection zones of high-voltage line routes' with influences on UTSV very ambiguously described in the terms of reference (for example, 'Clearing of glades / tracks' - 323 cases; 'Clearing from TSV' - 127 cases, etc.). At the same time, a group  $IV$  of works with a certain impact on the ground and / or underground parts of UTSV (including those displaced from the place of its growth; it is expressed in its division into small parts and are concluded mainly in the crushing of chopping residues), having 1.7 times less total work than the leader (zone  $NtW$ ), also has a more compact the number of works on the impact on UTSV (zone  $NnW$ ). This allows the group of works under consideration to confidently lead in terms of the relative demand for works  $CoV$ , which is explained by a clear idea of the organizations that ordered the work of the desired result and specific wording of the name of the impact on UTSV. It is expected that the group  $III$  of works with a certain impact on the ground and / or underground parts of UTSV (expressed by its extraction from any surrounding base and it consists mainly in pulling / removing unwanted vegetation together with roots) is not claimed by any indicator due to the presence in it of those works that can be replaced by works belonging to other groups (for example, to the group  $IV$  related to the crushing (separation) of vegetation into small parts). We should also note the unclaimedness of the work related to the collection and concentration of chopping residues in the selected place for the purpose of their further shipping, crushing or burning (group  $VI$ ), as well as the unpopularity of indicating in the tender applications of the work of group  $I$  with a clearly defined impact (cutting and / or felling) the ground part of the UTSV.



### *3.2. Features of the distribution of names of work on the basis of 'Object of influence'*

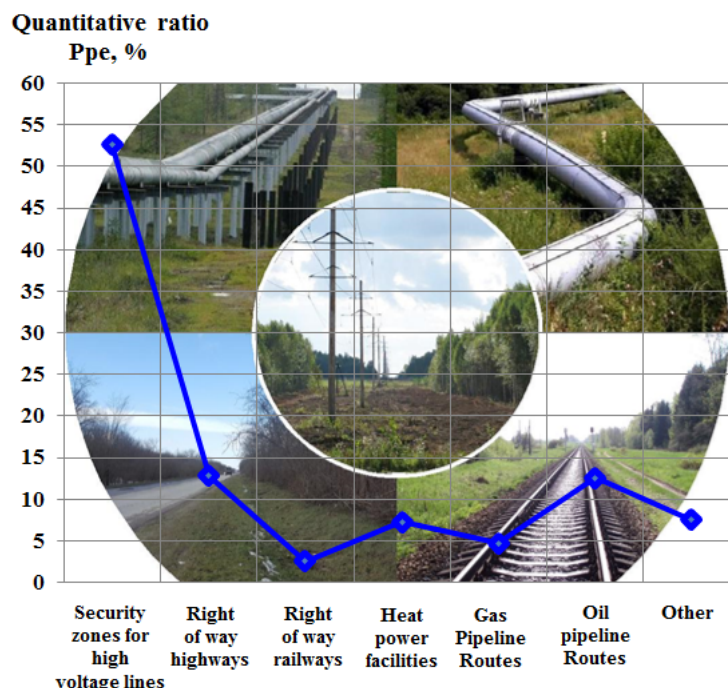
When analyzing the distribution of the names of works on the removal of UTSV from the territory of various infrastructure facilities according to the 'object of influence', we found that during the study period, 705 works (30.2%) were planned on the impact on felling residues, 674 works (28.9 %) on the effects on tree-shrub vegetation, 544 works (23.3%) on the effects on shrubs and light forests (undergrowth), 76 works (3.3%) on the effects on overgrowth. Unfortunately, a certain number of names of works (namely 332 works; 14.3%) could not be classified according to the object of influence. We referred to such kind of work of an undefined object of influence on UTSV 'Clearing of glades / tracks', 'Cleaning of a track' and 'Cleanup of glades', while the analysis of the texts of terms of reference (TOR) corresponding to the indicated names of works revealed such a primary purpose of these works as 'Maintaining in normative condition of the protection zones of high-voltage lines, as well as oil and gas pipelines'. In general, the use of such 'indefinite' objects of influence makes it difficult in our opinion the communication process between the organization-Customer and the organization-Contractor, especially in cases where there is no completed terms of reference. In view of the foregoing, it seems to us appropriate to provide in the text of the terms of reference more information about the objects of influence (UTSV), and also to exclude from the nomenclature of the names of works on removing UTSV the names associated with the uncertainty of both the effect and the object of influence.

### *3.3. Features of the distribution of names of work on the basis of 'Place of exposure'*

While analyzing the distribution of the names of works on the removal of UTSV from the territory of various infrastructure facilities by the 'place of exposure' feature, we found that in a number of cases there is no direct correlation between the name of the organization and the proposed a priori object of the corresponding infrastructure for the removal of UTSV. Initially, we allocated 89 places of exposure on unwanted vegetation, which, with further systematization, were enlarged by the additional attribute 'main place of exposure on UTSV'. At the same time, for a certain number of TOR (namely 7), we were not able to establish a 'place of exposure' on UTSV (including by the name of the organization that ordered the work), therefore, given its small (0.59% of the total number of tenders) quantity, such 'uncertain at the place of exposure on UTSV' terms of references we have not analyzed.

When we systematized the places of exposure on UTSV at various infrastructural objects, we have found the following their quantitative ratio *Ppe*, % (figure 3).

This distribution revealed that more than half (53%) of all the works indicated in the tenders for the removal of UTSV are carried out in the protection zones of high-voltage lines. The number of works carried out in the protected areas of the main oil pipelines is 2.67 times the number of works on the routes of the main gas pipelines, which indicates the growth prospects of UTSV removal for organizations involved in the operation and maintenance of the main gas pipeline transport. A similar perspective can be seen when comparing the amount of work to remove unwanted vegetation along the right of way of roads and railways for organizations involved in the maintenance of railways. However, it should be noted that at present, the so-called chemical method of combating unwanted vegetation is in the interest of Russian Railways, which explains the significant (4.7-fold) imbalance in the number of works to remove UTSV along the iron right of way public roads and security zones of power transmission lines for signaling and signaling in comparison with road transport. Thus, the implementation of the above perspective is currently possible only due to the more active involvement of a number of non-state companies in more thorough monitoring and bringing into the normative order the right of way of non-public railways.



**Figure 3.** Distribution of place of exposure on unwanted vegetation.

In addition, we found that of the 1,172 competitive bids for the removal of unwanted vegetation that were accepted into the analysis, any explanatory schemes and photographs of the places of exposure were present in 133 tenders, which makes up only 11.3% of its total number. In view of the foregoing, it seems to us appropriate to provide in the text of the terms of reference more information not only about future targets (UTSV), but also about the infrastructure surrounding it (including the provision of explanatory photographs and diagrams).

#### 4. Conclusion

Taking into account the above distributions of names of work, as well as a separate analysis of each of the groups of impact on unwanted vegetation (due to the limited volume not included in this article), we found that to designate work to remove shrubs and light forests (undergrowth, overgrowth) it is undesirable:

- use such names of work as ‘Felling TSV’ and ‘Sawing TSV’
- apply derivatives of the verb ‘collect’;
- use any derivatives of verbs with an ‘indefinite’ effect on vegetation (for example, ‘clean up’, ‘clear off’, ‘destroy’ etc.).

We have revealed that to indicate the work on removing shrubs and light forests (undergrowth, overgrowth) it is advisable to use the derivatives of the verb:

- ‘cut’: for work on impact on the ground part of UTSV;
- ‘crush’: for work on the impact on the ground and / or underground parts of UTSV (including those moved from its place of growth);
- ‘raking’: for work on the impact on the mundane UTSV (including the surrounding space);
- ‘carry’: for work on exposure to UTSV residues.

Thus, for a step-by-step solution to the problem of increasing the efficiency and overall quality of work to remove UTSV with a simultaneous expansion of the functionality of the relevant machines and equipment, when drawing up the corresponding bids, we recommend the following:



1. In the formation of the relevant applications, it is necessary to strive to provide both in the names of the works and in the text of the terms of reference more information not only about future targets (unwanted tree and shrub vegetation: UTSV), but also about the infrastructure surrounding it, including in the text terms of reference for information about the main machines and mechanisms for performing UTSV removal, accompanying it with information about the necessary technological process for affecting unwanted vegetation with explanatory photographs and diagrams.
2. To completely exclude the names of works with an 'indefinite' effect on UTSV (group *II* and partially group *I*), which are derived from verbs: 'liquidate', 'clear', 'reduce', 'clean up', 'delete', 'destroy'. The need for such an exception is explained by the fact that such works are characterized by ambiguously described influences on UTSV, for which it is difficult or even impossible to imagine and organize the corresponding technological process, especially in case of failure by the organization-customer to submit the relevant information (for example, in the text of the terms of reference).
3. It is more active to use when removing UTSV works whose names are associated with a specific effect on the ground and / or underground parts of UTSV (including the surrounding space, group *III*) and with a certain effect on the down-to-earth UTSV (including the surrounding its space, group *VI*), while expanding the scope of such works as 'Uprooting of shrubs and light forests', while reducing the proportion of work related to uprooting of the left roots. In addition, for competitive bids work on raking / collecting chopped residues, the practice of not providing information about any further impact on 'remote' (namely, heap-collected) vegetation should be excluded.
4. It is more active to use when removing UTSV works whose names are associated with a certain impact on the ground and / or underground parts of UTSV (including the group *IV* moved from its place of growth) and, in particular, with such methods of utilization of UTSV as 'Crushing of vegetation into chips' and 'Mulching'. In addition, it seems to us advisable to expand to form on the basis of these methods the so-called 'isolated' technological processes using modern means of mechanization
5. To exclude for the names of works associated with a certain impact on UTSV (including its residues; group *V*), use the derivatives of the verb 'utilize' if the terms of reference do not provide for the termination of the existence of undesirable vegetation with any kind benefits (profit). In this case, it is necessary to more carefully approach the formulations of the final termination of the existence of vegetation removed from infrastructure objects by taking into account the equipment planned for use when removing UTSV.
6. Intensify activities to remove unwanted vegetation by organizations involved in the operation and maintenance of gas trunk pipelines, as well as the maintenance and operation of non-public railways.

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