Development of Organizational and Technological Measures to Improve the Quality of Preparation of Project Documentation Section on the Example of a Construction Arrangement Design

Nadezhda Tatiana Kuzmina¹, Nina Laletina¹

¹Moscow State University of Civil Engineering (National Research University), Department of technology and organization of construction production, 129337, 26, Yaroslavskoye Shosse, Moscow, Russia

kuzminaTK@mgsu.ru

Abstract. The article has developed organizational and technological measures to improve the quality of project planning during design. Comments issued during the state examination of the project documentation for the construction arrangement design section (30 objects) were systematized; the most repeated comments were identified. The sample was made according to certain criteria with the highest relative frequency. The dependence of comments on groups (15 groups are highlighted) and types (the reason of comments) was determined. The authors proposed the “Regulations for the development of the construction arrangement design section”. After use of the “Regulations for the development of the construction arrangement design section”, the quality of the construction arrangement design section development by the design organization improved on average by 50%.

1 Introduction
The Town Planning Code establishes the requirement for examination for a certain category of objects. Obtaining a building permit is necessary for all objects, except the objects specified in Article 49 of the Urban Planning Code. Without a positive expert opinion it is impossible to obtain a building permit. To obtain a positive conclusion, it is necessary to agree on a section with an expert, but during the verification of the project, experts will have comments. In case of untimely elimination of comments on the project, the expert writes a negative conclusion; in order to change the conclusion to a positive, there is a need for a second expertise, and this entails a violation of the terms of the contract with the customer. Consequently, the goal of any design organization is to improve the quality of project documentation and minimize the review comments [1, 2, 3].

2 Methodology
Construction arrangement design is the basis for determining the duration of construction, the distribution of capital investments and the volume of construction and installation work by years and construction periods [4, 5, 6, 7].

One of the important documents to start the construction process is a building permit. It is impossible to start building process without this document.

To obtain a building permit, project documentation must undergo an examination and receive a positive conclusion [8, 9, 10].

The main points indicated in the conclusion of the examination:
- technological sequence of work;
- list and duration of operation of machines and mechanisms;
- provision of construction with electricity and water;
- total construction time;
- the number of employees.

According to GOST R ISO 9000-2015, the quality of an organization’s products and services is determined by its ability to satisfy consumers. In this case, the product is the project documentation section of construction arrangement design, and the consumer is the customer. The main goal of the customer at the design stage is to obtain the design documentation agreed after the examination [11, 12]. On its basis we make the definition of the quality of project documentation. The quality of project documentation can be assessed by a subjective criterion - the maximum satisfaction of customer requirements. Quality assessment is a positive conclusion of the examination, in other words, the fewer the comments, the better the construction arrangement design. Therefore, to improve the quality of the development of the construction arrangement design, it is necessary to systematize the comments of the examination and determine their reasons. To clarify the most frequently comments of the examination we will systematize the comments. The first stage is a selection of objects for study. We select 30 objects from the archive of the project organization. The sample is not accidental, in all objects a “Construction Arrangement Design” was developed and all objects were examined by project documentation.

At the next stage we use the method of object-analogues. For each object we learn the following characteristics:
1. Object location (city);
2. Object type;
3. Examination type (state, private);
4. Year of examination;
5. Technical and economic performance
   - number of storeys;
   - total area;
   - building volume.

All characteristics are summarized and presented in the summary frequency table (Table 1).

| Characteristic                  | Absolute frequency, objects | Relative frequency, % |
|--------------------------------|----------------------------|-----------------------|
| Construction area              |                            |                       |
| Moscow                         | 23                         | 76,67                 |
| Other cities                   | 7                          | 23,33                 |
| Object type                    |                            |                       |
| Non-industrial buildings        | 27                         | 90,00                 |
| Industrial buildings           | 3                          | 10,00                 |
| Examination type               |                            |                       |
| State                          | 27                         | 90,00                 |
| Private                        | 3                          | 10,00                 |
| Examination year               |                            |                       |
| Before 2008                    | 5                          | 16,67                 |
| After 2008                     | 25                         | 83,33                 |

The absolute frequency shows how many times a particular answer is repeated in the sample. The relative frequency shows what proportion of this value is from the total sample size.

Thus, in order to narrow the study, we will choose certain criteria that have a greater relative frequency:
- construction area - Moscow;
- object type - non-industrial buildings;
- examination type – state;
- examination year – after 2008.

These characteristics are occurred on 16 objects out of 30 previously selected, therefore, only these objects are considered further.
According to 16 objects, examination comments were systematized, received from various experts. The number of objects is equal to the number of experts.

All comments are divided into 3 main types due to their reason:
- type 1 - depends on the developer of construction arrangement design (comments that arose due to errors or omissions of the designer during the development of project documentation);
- type 2 - depends on the expert (the expert asks to make changes or add some information in the project documentation);
- type 3 - depends on the subcontractors (comments that arose during the development of project documentation due to a lack of source data or data from the subcontractors or their errors).

Combine the comments in groups:
- group 1: the number of workers - all comments that are associated with the calculation of the number of workers;
- group 2: the need for mechanisms - all comments that are associated with the need for machines and mechanisms;
- group 3: duration of construction - all comments that are associated with the calculation of construction duration;
- group 4: installation of construction mechanisms - all comments that are associated with the location of construction mechanisms;
- group 5: organizational and technological schemes - all comments that are associated with organizational and technological schemes, both in the text part and in the graphic one;
- group 6: monitoring organization - all comments that are associated with the monitoring organization events;
- group 7: disposal of construction waste - all comments that are associated with the development of technical regulations for the removal of construction waste;
- group 8: bills of quantities - all comments that are associated with the need to develop bills of quantities;
- group 9: requirement table - all comments that are associated with the need to develop the requirement table;
- group 10: technical and economic indicators - all comments that are associated with the need to develop technical and economic indicators;
- group 11: construction of the pit - all comments that are associated with the construction of the pit;
- group 12: questions of the project overlay - all comments that are associated with the “Project Overlay” drawing;

Figure 1. Diagram of the distribution of recurring comments on groups
group 13: questions of the time schedule - all comments that are associated with the “Time Schedule” drawing;
group 14: incompleteness of construction arrangement design - all comments that arose due to the lack of any data in the text or graphic part;
group 15: documentation - all comments that arose due to the lack of any documents.

When processing the results, it was determined which comments occurred most often. Results are summarized in a diagram and are presented in Figure 1.

3 Main part

Next, we determine what type of comments occurs more often. Then we calculate the proportion of similar comments (in percent) by the following formula:

\[ \% = \frac{a}{b} \times 100\% \]

where \( a \) is the total number of comments of a specific type, \( b \) is the total number of comments (\( b = 72 \)).

1. Depends on the developer of construction arrangement design – comments of this type occurred 33 times:

\[ \% = \frac{33}{72} \times 100\% = 48.6\% \] (1)

2. Depends on the expert – comments of this type occurred 31 times:

\[ \% = \frac{31}{72} \times 100\% = 43.1\% \] (2)

3. Depends on the subcontractors – comments of this type occurred 12 times:

\[ \% = \frac{12}{72} \times 100\% = 16.7\% \] (3)

The general diagram, which summarizes the types of comments by percentage, is presented in Figure 2.

![Figure 2. Diagram of the distribution of recurring comments on groups depending on the type](image-url)
The introduction of the “Regulations for the development of the construction arrangement design section” is offered as the main organizational and technological actions.

This regulation includes mandatory and optional actions. Mandatory actions are determined from the comments that arise because of designer errors. Optional actions are those that need to be performed to eliminate comments in the eventuality that this would happen.

Since the construction arrangement design section cannot influence the comments that arose due to subcontractors, measures to eliminate these comments are not included in the regulations.

Mandatory actions at the development of construction arrangement design section:
1. Perform the calculation of construction period guided by SNiP 1.04.03-85*.
2. In the absence of an exact norm in SNiP 1.04.03-85 *, the calculation should be carried out guided by part II, paragraph 3 “Non-production construction”, subparagraph 1 “Residential buildings”.
3. Timely request the cost of construction and installation work, calculate the number of workers strictly according to the cost of construction and installation work.
4. Timely request estimate documentation, develop a schedule with the distribution of capital investments.
5. The textual part of the construction arrangement design should be carried out strictly in accordance with the Decree No. 87 (including all clauses).
6. Timely request the technological regulations for disposal of construction waste and register the name, address and distance to the waste collection points.
7. Organizational and technological scheme should be worked out in the form of a numbered sequence of construction works.
8. Request the section “Constructive solutions”, select all machines and mechanisms with characteristics corresponding to the structures to be erected.
9. When using permanently installed lifting mechanisms, take into account the Order of Rostekhnadzor of 12.11.2013 No. 533.
10. Request the monitoring program in time and state the main conclusions on the monitoring program in the text part

Optional actions at the development of construction arrangement design section (performed to eliminate comments):
1. If there is a need to reduce the number of workers, it is necessary to increase the output per worker.
2. To indicate the data on the removability and turnover of sheet piling designs in the explanatory note.
3. If it is necessary to work out a technological scheme in the graphic part, use for example typical technological maps for the production of certain types of work.
4. If it is necessary to develop a technical and economic indicators section, the requirement table of basic building structures, products and materials and a list of the main volumes of construction, installation and special works one should guide by SNiP 3.01.01-85* or MDS 12-81.2007.

![Figure 3. The ratio of comments “before” and “after” the application of the regulations](image-url)
As a result of modeling organizational and technological measures to already completed projects at the design stage, the following problems would be eliminated:

- 7 objects – more than 50% comments;
- 4 objects – 50% comments;
- 5 objects – less than 50% comments.

The general correlation of comments is summarized in a diagram and is presented in Figure 3.

Calculate the average percentage of improvement in the quality of the development of the construction arrangement design section

\[ x = \frac{1}{n} \sum_{i=1}^{n} x_i, \]  

(4)

where \( x \) is the percentage of quality improvement of the construction arrangement design; \( n \) is the number of objects involved in the study (\( n = 16 \)).

\[ x = \frac{1}{16} (x_1 + x_2 + \ldots + x_{16}) = \frac{67+71+80+25+50+71+63+50+66+38+40+50+33+50+67}{16} = 50.9\% \]  

(5)

4 Conclusions

The article provides suggestions for improving the quality of development of project documentation on the example of the construction arrangement design. Comments of examination are analyzed and systematized. “Regulations for the development of the construction arrangement design section” are developed.

The modeling showed that using the “Regulations for the development of the construction arrangement design section”, the designer could initially improve the quality of the development of the “Construction Arrangement Design” section by an average of 50%.

The use of these regulations will facilitate the work of the designer and minimize the comments of the examination.

To improve the quality of the development of the construction arrangement design section, it is recommended to use the “Regulations for the development of the construction arrangement design section”.

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