Secondary Building Materials Planning System

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Abstract. The successful operation of construction and demolition waste management requires the development of appropriate planning systems. Today there are a large number of forecasting methods. In the area of construction and demolition waste, it is important to have a forecast not only for the economic effect, but also for the environmental consequences of the rates and volumes of waste generation. The article discusses modern forecasting methods that can be used in the field of construction waste management. The structure of the integrated forecast of the functioning of the territorial system of construction and demolition waste management is proposed, contributing to the rational planning of the development of waste-processing infrastructure in the region.

1. Introduction

The determination of the main forecast indicators for the prospective period is important for the stable functioning of any system consisting of several elements. The lack of a predictive model for the development of a project can significantly reduce its attractiveness to investors.

To date, many authors deal with the problems of building waste generation planning [1-4]. In the sphere of construction and demolition waste treatment, several directions should be planned at once. First, it is required to have a forecast of the economic effect from the implementation of resource-saving technologies. Secondly, it is necessary to forecast the possible environmental consequences from the rates and volumes of waste generation. Only with relevant, confirmed forecast data on the qualitative and quantitative indicators of the production and processing of building waste can one develop strategies for managing the flow of construction waste for the near future. In addition to the quantitative composition of the waste, it is necessary to know their qualitative characteristics. Construction production does not stand still, and building materials with new properties appear regularly. This requires timely improvement and modernization of existing processing lines and processing technologies [5-7].

2. Theoretical Basis

A significant number of forecasting methods have been published in modern literature, some of which can be used in the field of construction waste management [8-10]. Table 1 presents the formal and informal methods of forecasting with their brief characteristic.

Despite the variety of methods used, they can be divided into several groups:
Table 1. Forecasting methods and their characteristics

| Methods                                      | Short description                                                                 |
|----------------------------------------------|-----------------------------------------------------------------------------------|
| Informal forecasting methods                 | Special evaluative or intuitive methods                                           |
| Single or multivariate regression Method of  | Dependent variables are calculated as functions of one or more independent variables |
| factor analysis or regression Economic      | Systems for parallel evaluation of several multifactor regressions                |
| models                                        | Simplest                                                                          |
| Simple rules, for example, the predicted     | By linear, exponential or other types of functions                               |
| figure corresponds to the most recent real   | Forecast indicators are obtained as a result of smoothing,                       |
| value for the last year for the same month (+5%) | averaging, a number of past indicators by a linear or exponential type          |
| Trend Extrapolation                          | In a dynamic series of indicators, the tendency, seasonal and cyclical fluctuations, disturbing influences are singled out |
| Exponential Smoothing                         | The forecast is expressed as a linear combination of indicators of past periods.  |
| Decomposition                                | The forecast is expressed as a linear combination of indicators of past periods, |
|                                               | as well as past errors                                                          |
| Screening                                     | Each event is assigned a subjective degree of probability                        |
| Autoregression                                | Bottom-up method combining evaluations of sales agents                           |
| Decision Trees                                | The responsible persons for marketing, production and finance together prepare a forecast |
| Evaluation of trade workers                   | Acquaintance with the intentions of potential customers or business plans        |
| Jury of Managers                              | Uses the existing level of real knowledge for a broad assessment of future growth conditions |
| Service maintenance                          | It starts with an assessment of future tasks, needs, desired goals, etc., on the basis of which feedback is established with the activities necessary to achieve the goals |
| Mastering method                              |                                                                                   |
| Regulatory method                             |                                                                                   |

3. Results and discussions
When forecasting the volumes of construction and demolition waste generation, it is necessary to use the regulatory documents regulating the generation of waste: industry reference on waste generation;
collection of specific indicators of production and consumption waste generation; consumption rates of raw materials and materials of main and auxiliary production, etc.

From the guidelines for assessing the volume of production and consumption waste, four main approaches to determining the amount of waste generation can be distinguished [11]:

- direct calculation based on the material balance of use in a particular technological process (or production) of the raw materials and the production of products;
- calculation using specific indicators (or standards) of waste generation according to the consumption of raw materials and finished products;
- calculation according to the formulas drawn up on the basis of the data of the design and technological documentation, recipes, regulations, for the manufacture of products or the performance of repair and maintenance works, or procurement works;
- determination of the volume of waste generation on the basis of experience and analysis of reporting and statistical data on the actual generation of waste over a number of years.

Each of these approaches implies within its framework the possibility of having two (or more) methods for estimating the volume of waste generation, while maintaining a uniform methodology.

Forecast information on waste generation volumes allows planning the development of the relevant infrastructure in the region. First of all, it concerns the creation of new processing facilities, the number of specialized vehicles, containers, etc. The structure of the integrated forecast for the development of the system of construction and demolition waste in the region is shown in Figure 1.

The forecasting process is inextricably linked with the analysis of the structure of material flows. Construction companies after the completion of the period of operation of objects have three main options for disposal of construction and demolition waste:

- burial at specialized sites;
- sorting at the construction site and sending them to the processing enterprises;
- sending to incinerators for energy (the proportion of construction waste suitable for incineration is extremely small).

The maximum amount of waste must be sent for recycling. Today, the concept is actively spreading: “reduce, reuse, recycle”. According to this concept, it is necessary first of all to reduce the number of waste sources, and the resulting waste should be subjected to appropriate and rational processing [12].

To compile a correct forecast of the generation of construction waste in the region, statistical data from regional statistics bodies are required, which keep records of the output in the construction industry.

The volume of construction waste left unprocessed in the region at the beginning of the next billing period is taken on the basis of statistical data from waste processing enterprises. Having information about the number of buildings and structures planned for construction in the billing period, it is possible to calculate the volume of future waste, based on the experience of building similar objects in the past. In the production of building materials, the values of specific indicators of waste generation characteristic of the production of final products should be determined taking into account the technologies used [13; 14].

Decisions on demolition, disassembly, repair and reconstruction of objects, as a rule, are not made urgently within a few days. Conducting such work is planned for certain periods of time, which allows you to pre-determine the amount of waste construction materials. Unscheduled construction waste refers to waste resulting from emergency situations, natural disasters, etc. It is impossible to make an accurate forecast of their quantity, but it is advisable to lay out for the prospective period the proportion of possible generation of unplanned waste. This is especially true for regions where natural disasters are not uncommon and there is a statistics of the consequences of destruction.
Figure 1. Structure of a comprehensive forecast for the development of a system for the management of construction and demolition waste in the region.

The decision to dispose of construction and demolition waste is made taking into account the characteristics of the waste and the existing requirements for the methods of handling them, therefore information on the qualitative composition of the waste is crucial.

The list of construction waste suitable for incineration for the subsequent generation of energy is very small due to the inclusions of chemicals that form harmful gas emissions during combustion. Landfill disposal is the least preferred of the three paths of waste direction, therefore, the volume of waste along this path is sought to be reduced as much as possible. Thus, the bulk of waste in the region requiring management is construction waste suitable for recycling.

4. Conclusions
Predicting the qualitative and quantitative characteristics of the formation of construction and demolition waste is the key to the effective functioning of enterprises and the system for managing construction waste. The capacities of the construction waste processing enterprises in the region are
compared with the required number of forecasted capacities, and, if there is a negative difference, the discrepancy should be eliminated by upgrading production or creating new plants.

Constant monitoring of the movement of construction and demolition waste streams contributes to the effective development and improvement of forecasting and planning methods. The control allows assessing the accuracy of making forecasts at certain points in time and on the basis of this taking the necessary measures for the sustainable functioning of the sphere of construction waste treatment in general. The study proved the relevance of the use of forecasting and planning methods in the construction waste management system, which will ensure that the waste-processing infrastructure complies with the modern development conditions of a particular region.

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