Using neural networks for sustainable construction business development

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Abstract. The authors look at the application of neural networks to sustainable business development in the construction industry. The actual work of self-learning neural networks with statistical data tables in construction is studied. The possibilities of managing construction scheduling and material supply requirements from the point of view of work execution with the participation of neural networks are shown. Appropriate statistical indicators can be used in subsequent numerical calculations. Tables above all allow for the systematisation of numerical information. The study of large number of tables by neural networks allows statistical study not only of the collective as a whole, i.e., of the totality of objects and phenomena - macro-units, but also of subdivided collectives, i.e., separate parts of the whole - micro units and complex units (united by one attribute). Therefore, the subject of statistical sentence-table may be statistical population as a whole (macro units), aggregate dissected (separate observation units) - micro units and separate aggregate - complex units. This is quite understandable, because statistical judgement can refer to the object of observation at any stage of this process, i.e. as a result of the dissection of the population into micro units, combination of the latter into small populations (complex units) and generalization of micro units and complex units into units of the concept - macro units.According to the results of implementation of the automated control systems based on neural networks the high purity and quality of design solutions based on the automated data processing of production and economic activity of the construction organisation is achieved. Their actual economic efficiency is calculated.

1 Introduction

To build models of economic, organizational, technological and social phenomena or processes, a system of abstract mathematical expressions and relationships is used that simply describes real situations. Mathematical modeling refers to the description of production, organizational, technological and economic processes using mathematical expressions. The capabilities of modern information systems in the field of operational logistics business process management in construction are quite extensive. Today there are various specialized software products on the market that automate warehousing, transport and production logistics, which contain a huge number of functions. At the same time, they make it possible

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to widely use analysis tools to obtain reliable information about the current situation in the enterprise and make timely decisions, thus ensuring sustainable business development.

The functions of a construction organisation's management apparatus provide insight into its areas of activity and objects of force, allowing them to be systematized for working with neural networks. The main areas of activity of a construction organization are:

- Contracting activities determined by the performance of the production building units;
- auxiliary activities determined by the results of the auxiliary production of construction parts, semi-finished and semi-finished materials, tooling and fixtures;
- design, research and training activities determined by the results of the work design departments (teams), design and estimate teams.

These activities are reflected in the specific content of the management functions.

For the neural network to work efficiently, each group of functions should be divided into functions, sub-functions (work packages) and activities that have a specific nature and content and ensure the implementation of a certain part of functions. When dividing each group of functions into its individual components, regulations on the construction organization (association, plant, trust) and regulations on structural subdivisions of this organization can be used taking into account the specifics of the relevant ministry, conditions and specifics of construction in this area, information on actually performed types of managerial work.

The composition of the management work actually performed by the construction organisation's apparatus is identified by interviewing employees and examining the documents developed in each structural subdivision of the apparatus.

The documentary basis for implementation of recommendations on improvement of the management work organization depending on the goals and scope of research in a specific construction organization may be model and individual projects of work organization for employees (complete or reduced scope); project studies in specific areas of work organization (structure and staff schedule, provisions on services and job descriptions, operational programmes of work processes by functions, forms of documents, etc.); organizational, technical and socio-economic and other documents. The process of implementing the recommendations includes preparation for implementation, direct implementation of the planned recommendations, monitoring of the implementation, identification of the economic effect due to the improvement of the work organization. To prepare for implementation, measures (with deadlines and responsible executors) are prepared, which include a list of works to purchase the necessary equipment and materials, allocation of financial resources (if necessary), training of employees in working methods in the new environment, professional development of employees, publication of relevant instructions and other materials.

### 2 Materials and methods

Modern developments in science and technology have led to a large influx of digital documents in management and production. The sustainability of industrial relations and business thus depends to a large extent on the correct management of digital processes. Neural networks, as a new trend in science and technology, make it possible to optimise, concretise and simplify these processes. This will ensure the sustainable development of a large enterprise or industry as a whole. Let us consider the possibilities of applying neural networks in the analysis of technological processes in construction.

Every table in a construction document is also a statistical document, because it captures the essence of a real phenomenon in the language of numbers. Huge masses of digital material are used to study, justify, discover phenomena and processes in business and construction. Together with drawings and graphs, digital language is in many cases the main expression of
the content of the document.

However, numbers only gain the power of words when they are compared and contrasted. By comparing figures in different proportions, for different periods, in different systematisation and combination, the neural network puts them together into statistical tables. We use statistical tables to make reference, analyse phenomena, anticipate events. The table has grown out of Aristotle's "statistical descriptions", having passed through the form of "registration of facts" in feudal society and the form of "political arithmetic", it has become a tool for scientific research and production management.

In most scientific disciplines, as well as in law, commerce, industry and government, there is an ever-increasing accumulation of increasingly complex data recorded in the form of numerical documents and, in particular, statistical tables.

In administration, digital documents are used to establish various rules and regulations, in science to formulate and test scientific hypotheses. In these cases, it is convenient to summarise multiple data by applying an appropriate statistical method.

If the appropriate statistical indicators have been calculated, they can also be used in subsequent numerical calculations. There is no need to re-examine the source material in detail. Often, however, raw data needs to be kept almost entirely in its original form, both to verify various research methods and because some of them may be particularly important. In these cases, the use of tables is necessary.

Tables, therefore, primarily allow you to systematise numerical information. However, not every systematisation of material allows for an objective judgment of the subject under study. Only an objective systematisation based on a specific historical study, based on an examination of the totality of facts relating to the issue under consideration, allows for an objective analysis of what is being studied.

The study of a large number of tables by neural networks leads us to the following conclusions. Statistical research may refer not only to the collective as a whole, i.e. to the totality of subjects and phenomena - macro units, but also to subdivided collectives, i.e. separate parts of the whole - micro units and complex units (united by one attribute). Therefore, the subject of statistical sentence-table may be statistical population as a whole (macro units), aggregate dissected (separate observation units) - micro units and separate aggregate - complex units. And it is quite understandable, because statistical judgement may concern the object of observation at any stage of this process, i.e. as a result of dissection of a population into micro units, union of the latter into small population (complex units) and generalization of micro and complex units into units of concept - macro units. For example, the task is to study the construction volume of the city of Moscow. Consequently, the subject of this observation is the mass of construction volume. When this mass is divided into micro-units - buildings and work is done to study and measure each such unit - each building and then create small groups of buildings based on various attributes typical to microunits, i.e. when these buildings are divided by administrative-territorial features or types and forms of roofing, walls, etc., finally, when numerical characteristics of groups are received, a neuronet can easily build a table. The subject of the study will be the whole totality of buildings of Moscow, or a part of this totality (i.e., neural network will consider only masonry buildings), or individual specific units (individual specific buildings of the city). It should be noted that when the narrative will deal only with complex units or individual specific micro-units, the study should be based on the results of observations and changes in the whole mass of phenomena (i.e., all buildings of the city of Moscow). It is this method of presentation (construction of the table) that makes it possible to focus on individual specific micro-units. The above statement allows us to construct the following classification of the subjects of statistical proposals:

1) actors - specific units (micro Entities);
2) actors - collectives dissociated (complex units);
3) actors - generalised concepts (macro-subjects).

Let us consider each of these subjects. Micro-subjects will be considered as those subjects of the statistical supply that represent individual specific objects (construction volumes, materials, machinery).

Tables with such subjects are of great importance for the management of a company. Tables containing, microsubjects should perform one of the most important functions in an active struggle to meet the construction timetable. There can be several sub-tables in one table, where each "category" is a micro-entity. A micro-entity may consist of a set of specific simple or complex units, with the set as a whole without dividing it into parts or groups.

When constructing tables with simple entities, it is necessary to consider each unit in combination with the total population, i.e., neural networks consider the total population when analysing each individual microsubject. In some cases, microsubjects are combined into groups, which are specific observation units that are partitioned into homogeneous groups based on a single group characteristic. This type of subject is the result of only one grouping. For example, the students terminal "warehouse" in a tabular matrix structure by a neural network can be considered by groups: "cash materials", "incoming", "outgoing"; as well as "bricks"; "sand"; "plaster", etc.

These groupings will result in the following subjects being obtained by the neural network:

1. Availability - absence;
2. Type of material - status
3. Flow rate - timing of the work schedule

3 Results

This will allow real-time monitoring of the progress of the project schedule and the entire logistics of the construction organisation. The model, in this case, will be the relationship "entities - collectives dissociated - is a type of entities grouped". However, the units in this case are not grouped into one, but into several groups considered by the neural network simultaneously.

An example is figure 1 (fig. 1).

![Diagram of unsustainable project implementation with an actual fall in the evenness of plan implementation](chart by the authors)

Similarly to the classification of subjects we can classify predicates, i.e. processes of execution and movement of resources or progress of work on complex 3D spatial relations.
on the construction of a particular object. It was said above that our classification of subjects is based on the stages of a statistical narrative treated by a neural network as a numerical repartition. The classification of predicates is constructed in the same way on the basis of what kind of statistical population they describe. A predicate describes a population that has been dissected into micro-units, organised by one of the attributes.

Association predicates describe collectives that are dismembered. This category of predicates consists of indicators of distributions.

The generalisation predicate characterises subject-notions, i.e. it serves to statistically describe macro-units. As the degree of complexity of the subject of statistical sentences increases, so does the degree of complexity of the predicates attached to them. Consequently, the quality of the predicate entirely depends on the quality of the subject, the quality of the predicate is entirely determined by the objective pursued by the table compiler, i.e. the use of a neural network is closely connected with the stage of statistical research in the process of which the statistical judgement - a table and its subject or a particular state of a business process here and now at a particular unit of time - is born.

All predicates can be divided into two large groups: action predicates and state predicates.

It was said above that the predicate characterises the subject of a statistical sentence. By characterising the subject, it can answer one of the following two questions:

1. What does (did or will) the subject do?
2. What is the subject?

In answering the first question, the predicate describes the action of the subject by means of a verb or noun form. Action predicates expressed with a verb form can easily be found in the following sentences:

All of the predicates considered express the results of the actions of their subjects.

4 Discussion

In answering the second question (What is the subject?), the predicate indicates the scope or describes the structure of a technological, logistical or business process. In the latter case, it may define the number of elements - constituent units of a population that possess one or more homogeneous qualitative attributes or the number of those elements - constituent units of a population that possess one or more quantitative attributes. Additionally, the predicate can determine the sum of individual numerical variations in the values of a quantitative attribute inherent in the totality of the elements of the subject. The volume predicate is nothing more than the result of counting the units (elements) of the subject population.

It was mentioned above that predicates can also define the number of those units of the population-subject that have quantitative attributes. This category is the result of counting a computed mass of population units based on a quantitative attribute. Such predicates are often used in the construction of tables for statistical and economic analysis.

For example, tables of construction company activities with a dependency graph (fig. 2)
Fig. 2. Diagram of a construction company's activities with a dependency diagram (chart by the authors).

A second category of predicates, each of which is the result of counting individual variations in the numerical values of one or another quantitative attribute of the elements of the subject population:

Based on what has been said about the predicate of statistical sentences, the following conclusions can be drawn;

A predicate is the result of the subject's action and indicates what the subject does, has done or will do (e.g., an algorithm for technological operations in relation to the calendar of work, consumption and inputs;

The predicate is the volume (number) of the subject population. Answers the question: how many units in a monolithic entity - a collective (e.g., the amount of work completed in a schedule);

- predicate - the volume (number) of individual groups of an entity, i.e., a population divided into groups based on one or more, quantitative attributes (e.g. a labour force flow chart);
- predicate - the variation of a quantitative attribute that characterises the constituent units of a monolithic population entity (shows, for example, what changes in attributes have been in time or in space, i.e. how far the project has been completed and what changes have been made in the dynamics of the entire business plan).

Predicates can also be characterised in relation to the main purpose they pursue. In characterising a subject, a predicate can resolve one of three objectives:

1) characterise the statics of the subject, i.e., describe the results of its action or state at a particular point in time. This defines the subject's action at a given point in time, or the scope of the totality constituting the subject at a given period, or the structure characteristic of the subject at a given point in time;

2) to give a description of the dynamics of the subject, i.e., a picture of the change in the volume or structure of the population;

3) establish the facts of the links that exist between the characteristics of the constituent elements of the population that make up the subject.

So, predicates can be divided into three groups: static, dynamic and relationship predicates. Obviously, the third group of predicates is extremely important because it establishes the interrelations and interactions of things and phenomena in all areas of construction production.
5 Conclusion

Globally, there has been a steady increase in interest in the sustainability of the industry in the new digital economy, reducing costs and improving production efficiency. According to the results of the implementation of the automated control systems based on neural networks the high purity and quality of design solutions based on the automated data processing of production and economic activity of the construction organization is achieved. Their actual economic efficiency is calculated and financial incentives are provided to participants in the development and implementation of design solutions depending on the resulting savings, which ensures the motivation and sustainable development of industry processes in the construction business and the construction business itself.

References

5. I. Krizhevsky, G. Sutskever, Hinton, Communications of the ACM 60, 6, 84-90 (2017)
15. N.V. Abasov, T.V. Berezhnykh, V.V. Vetrova, Izvestia RAS, Energy 1, 49-57 (2012)