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Translation

CAPITAL CONSTRUCTION STATISTICS

By

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CAPITAL CONSTRUCTION STATISTICS

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ANNOTATION

The textbook examines the questions of capital investment and construction statistics and the methodology for calculating the statistical indicators for the use of capital investments and the completion of fixed capital, production operations and the economic effectiveness of capital investments and construction work.

The book is designed for students and instructors at the economic VUZes and faculties as well as for the employees of statistical bodies and construction organizations.

FOREWORD

In the USSR, under the leadership of the Communist Party and the Soviet government, grandiose tasks are being carried out in laying the material and technical base of communism, in improving the prosperity and cultural standard of living of the people and ensuring national security. Here an important role has been given to capital construction which must bring about a further growth and qualitative improvement in the national economy's fixed capital. The CPSU Central Committee and the USSR Council of Ministers, proceeding from the decisions of the 25th CPSU Congress, have adopted the Decree "On Improving Planning and Strengthening the Effect of the Economic Mechanism on Raising Production Efficiency and Work Quality" in which great attention has been given to capital construction. The effective activities of capital construction at the present stage are possible only on a basis of improving the organizational structure and management methods of the sector. These are based upon complete, reliable and scientifically sound information which is assembled and processed by capital construction statistics.

In the given textbook, the author has endeavored as fully as possible to shed light on the present tasks of capital construction statistics. For this reason in the book particular attention has been given to a statistical study of the economic effectiveness of capital investments and construction by reducing the construction time and lowering incomplete construction, technical progress and industrialization of the sector as well as to improving the methodology of calculating and analyzing the statistical indicators which characterize the result and conditions of the construction organizations' production activities.

The textbook's contents encompass the subjects and questions of a course on capital construction statistics within the limits of the curriculum of the economic VUZes and faculties. The subjects of the chapters and their sequence reflect the structure of the course adopted in the curriculum: the first four chapters are devoted to capital investment statistics and the remaining chapter to construction statistics.

The author expresses sincere gratitude to the instructors on the statistical chairs of the Moscow Statistical Economics Instutute who participated in a discussion of the manuscript, to the instructors of the statistics chair at the Moscow Order of the Labor Red Banner Management Institute imeni Sergo Ordzhonikidze and to coworkers from the section of the Scientific Research Institute for Construction Organization and Management under the Moscow Order of the Labor Red Banner Construction Engineer Institute imeni V. V. Kuybyshev for a thorough editing of the textbook.

CHAPTER I: THE CONCEPT OF CAPITAL CONSTRUCTION STATISTICS AND ITS ORGANIZATION

§1. The Subjects Studied by Capital Construction Statistics

The continuous growth of social production in our country's national economy is one of its essential development traits. The growth of Soviet social production and its material and technical base has occurred due to the accumulation fund with surplus product being its source. The Soviet state through capital investments has provided accumulation in the area of creating new factories, mills, mines, electric plants, railroads and highways, housing, hospitals, sanitoriums, schools and other projects in the production and nonproduction spheres of the national economy. From 1918 through 1978, 1,833,400,000,000 rubles of capital investments were channeled into the national economy and during the Tenth Five-Year Plan alone more than 620 billion rubles will be spent on adding to and replacing fixed capital.

In the creation of the material and technical base an important role has been assigned to construction. This can be judged from the following data. During the Tenth Five-Year Plan the increase in the capacity of electric plants should be approximately 60-70 million kilowatts. This means that over the five-year plan we will build power plants with capacity equal to 100 Dneproges [Dnepr Hydropower Plant] or 13 such as the Krasnoyarsk GES. During the same 5-year period we plan to build housing with a total usable area of 545-550 million m^2 and this is the equivalent of the available housing in 5 such cities as Moscow, 10 such as Leningrad or 35 such as Gor'kiy. Equal scales and rates of construction are planned in other sectors of the national economy's production and nonproduction spheres.

In line with the enormous scope and rate of capital construction, a socialist state is confronted with the need of generalizing economic practices involved in the use of capital investments and the describing of their effectiveness as well as estimating the state, results and development of construction. In this generalization an important role is assigned to capital construction statistics.

Capital construction statistics is a sector of economic statistics. It is based on the procedures and methods common to this science for studying phenomena and processes. At the same time, capital construction statistics is an independent science which differs from the other statistical sectors in its object and subject of study. Let us examine these important concepts of science.

Capital construction statistics has two objects of study: in the area of capital investments this is the aggregate of enterprises, organizations and institutions making capital investments, that is, participants in the investment process; in the area of construction activities this is a sector of material production, that is, construction. These objects each have independent significance but they are closely interrelated and as a consequence of this within capital construction statistics two independent parts are formed: capital investment statistics and construction statistics.

Capital investments are the expenditures channeled into the creation of new fixed capital, for the expansion and reconstruction of existing in both the production and nonproduction spheres of the national economy. Statistics studies capital investments in the broad sense, viewing them as a national economic financial and economic concept related to the patterns of socialist expanded reproduction. In accord with the established planning procedures, capital investments for the acquisition and construction of fixed capital projects are directly allocated and approved for industrial and agricultural enterprises, construction, transportation and supply organizations as well as for ministries, departments, VUZes, hospitals and other budget-supported institutions. All of them become the holders of capital investments and at the same time are the legal representatives of the state for which the fixed capital will be built or acquired in a finished form. The enterprises, economic organizations and budget-supported institutions which make capital investments are called in practice the builders or the title holders.

In studying the aggregate of builders as an object, statistics encompasses only their activities involving the use of capital investments related to the reproduction of the means of labor. But capital investment statistics does not examine the basic activities of the enterprises, organizations and institutions operating in the role of builders. A significant portion of the aggregate of builders is represented by the state enterprises, organizations and institutions making state capital investments. Another portion is formed by the aggregate of cooperative (including kolkhozes) and public organizations which invest money for acquiring and building fixed capital projects. In addition, the individual builders (the public) building for personal needs is also an object of statistics' study.

Construction as a national economic sector is the second object studied by statistics. Its activities is aimed at the creation of new fixed capital as well as the expansion, reconstruction and rebuilding of existing fixed capital. The end product of construction is production capacity, buildings, installations and other production- and nonproduction-end projects. Construction has a number of particular features making it possible to differentiate it from the other sectors of the national economic production sphere. An essential feature of construction is the territorial association of its products; the buildings and installations are fixed objects of fixed capital while the products of industry, agriculture and the other sectors are movable objects. The production cycle in construction is the longest and days, weeks, months and even years are used as the unit of measurement of its duration. Construction has vividly expressed individual production. The construction site is not fixed, it changes after completing the erection of the project while the means of production and workers move to another construction site.

Diverse activities are carried out in construction and these differ in terms of the purpose and nature of the product to be created, the particular features of the production process and other features. For this reason within construction as a national economic sector distinctions are drawn between subsectors or types of activities (production): research (geological prospecting), design-estimate and construction (construction work).

All types of construction production activities are carried out, respectively, by research, design and actual construction organizations which in their aggregate form the sector, that is, construction as an object of statistical study. In terms of the scale of activity in this sector an essential role is played by construction work which is based on the construction industry. The construction industry is the aggregate of contracting construction and installation organizations equipped with modern means of production and skilled workers for carrying out construction work using industrial methods. At present the construction industry possesses a diverse network of state contracting organizations (including repair-construction), inter-kolkhoz construction organizations and the construction organizations of the consumer cooperatives and public organizations.

In the sphere of construction work, along with contracting organizations there are also temporary construction organizations which are set up with the direct labor method of construction in the form of capital construction sections (OKS) and administrations (UKS). Since in organizational terms the OKS and UKS are directly part of the enterprises and organizations making the capital investments, the designated aggregate, in essence, is formed by the builders carrying out construction by the direct labor method. The result of individual construction by the public is also considered as part of construction work (activity) in the broad sense.

Figure I.1 shows the structure of construction as an object of study by statistics.

<table>
<tr><td colspan="3">Construction</td><td></td><td></td></tr>
<tr><td colspan="3">Construction work</td><td>Design estimate activities</td><td>Research activities</td></tr>
<tr><td>Construction industry</td><td>Construction by direct labor method</td><td>Individual construction</td><td></td><td></td></tr>
</table>

Fig. I.1. Composition of construction as the object of study by statistics

Thus, capital construction statistics has two objects of study which differ in terms of their economic content. The uniting of the two different objects into a single science cannot be considered fully sound. The reason for such a solution to the question is to be found in the particular features of organizing and accounting for fixed capital reproduction. In the construction stage capital investments are made into the designing, manufacturing and acquiring of equipment and into construction work per se. As a consequence of what has been stated, accounting for capital investments and construction activities is concentrated in the same organizations, enterprises and institutions, that is, it coincides in time and place. However an examination of two objects by one science does not mean their merging into a single object as capital investment statistics and construction statistics are independent but closely interlinked sectors of economic statistics. From the viewpoint of the science's content it would be more correct to call "capital construction statistics" as "capital investment and construction statistics."

§2. The Subject, Method and Tasks of Capital Construction Statistics

Capital investments and construction are studied not only by statistics but also by other economic and technical sciences, for example, construction economics and planning, construction technology and so forth. The content of each of these sciences is determined by its subject which differentiates one science from another. Statistics studies the quantitative aspect of economic phenomena in an inseparable link with their qualitative features which are manifested in their development patterns.

The subject of capital construction statistics is the quantitative expressions and ratios of mass economic phenomena and processes which arise and develop in the sphere of fixed capital reproduction which is carried out by capital investments as well as in construction as a national economic sector under the specific conditions of place and time.

Capital construction statistics works out and scientifically establishes systems of indicators which reflect the dimensions, directions, structure and effectiveness of capital investments made into fixed capital reproduction as well as the state, dimensions and ratios of labor, material and financial resources of the construction and design-research organizations, the result of their work, technical progress in construction, the econonmic effectiveness of construction work and other economic phenomena.

Political economy and sectorial economics serve as the theoretical basis for capital construction statistics. In accord with the laws of these sciences, capital construction statistics provides a numerical description of phenomena and processes. Marxist-Leninist dialectics is the general methodological basis of statistics, as it is for other social sciences. At the same time capital construction statistics employs procedures and methods for calculating indicators which are characteristic for all statistical science. These include the methods of mass observation, statistical groupings, average values, index and balance methods, correlation-regression analysis and others.

Capital construction statistics is closely tied to capital construction economics, organization and planning as well as accountancy in construction. Construction economics examines and formulates the developmental patterns and paths of the sector and studies the principles of construction organization, its specialization, combining and concentration and so forth. On the basis of the theoretical premises of sectorial economics, capital construction economics elaborates the indicators and their systems which in a numerical form characterize the dimensions and relationships of the economic concepts, the degree of interaction of phenomena and processes and establishes the boundaries and conditions for employing the statistical methodology in the study of capital construction. The statistical data are used by construction economics for the further development of the science.

Statistics is also directly linked with capital construction planning and this link is expressed, in the first place, in the fact that statistics provides information on the state and development of capital construction for drawing up the current and long-range plans and, secondly, statistics monitors the carrying out of capital construction plans and discloses reserves for overfulfilling the plans and saving resources. For these reasons the range of indicators employed in planning and statistics, as a rule, coincides. At the same time the aggregate of indicators employed in statistics is significantly greater than the aggregate of planning indicators as statistics studies phenomena and events which have occurred and many of these could not be planned ahead of time, for example, the amount of rejected work, unproductive expenditures and so forth. Capital construction statistics is also linked to accountancy the data of which serve as the source for obtaining and calculating many statistical indicators, in particular, censuses and other special statistical surveys. In order to gain the fullest notion of the content of the subject of capital construction statistics, let us examine the tasks of this science.

The chief task of capital construction statistics consists in the prompt obtaining and processing of reliable and scientifically sound data on construction and capital investments into the reproduction of the nation's fixed capital. Under the conditions of a planned economic system, great significance is assumed by the task of monitoring the course of carrying out capital construction plans on all levels from the individual enterprises and organizations up to the sector and the national economy as a whole. Among the general tasks of capital construction statistics are the elaboration of new systems of capital investment and construction indicators and the improving of the existing ones. This task is particularly acute in line with the implementing of a system of measures to accelerate the completion of production capacity and projects and to improve capital investment effectiveness as envisaged by the Decree of the CPSU Central Committee and the USSR Council of Ministers "On Improving Planning and Strengthening the Effect of the Economic Mechanism on Raising Production Efficiency and Work Quality."

The carrying out and improving of the economic reform in capital construction have increased the role of statistical economics analysis in the aim of disclosing the intrasectorial reserves for increasing production, saving expenditures, shortening construction times, reducing its cost and increasing effectiveness. At present particular importance is being assumed by cautionary information as based upon comprehensive analysis of capital construction reporting. Finally, among the tasks of capital construction statistics is the improving of the forms of observation, processing and collating statistical data on the basis of computers which are the technical basis for the automated state statistical system (ASGS).

In the Ninth Five-Year Plan a new stage of the ASGS was adopted with the creation of installations to electronically process the statistical information. Work is being done on developing the second stage of the ASGS which will be based on functional subsystems for the most important national economic sectors and, in particular, capital construction.

As was shown above, capital construction statistics consists of two independent parts, each of which has an independent object and subject of study. For this reason capital investment statistics and construction statistics, along with common tasks, also have specific ones determined by the corresponding object of study.

Among the basic tasks of capital investment statistics are the following:

1) A study of the volume, structure, direction and concentration of capital investments and an elucidation of their role in bringing about an acceleration in scientific and technical progress as well as in the reequipping and reconstruction of existing production capacity;

2) Supervising the course of carrying out capital investment plans for the departments, ministries, as well as the sectors and national economy as a whole. The task of statistics includes not only evaluating plan fulfillment but also elucidating the soundness of the plan itself, the supply of the planned projects with material and monetary resources and the observance of measures which prevent the scattering of capital investments;

3) Evaluating plan fulfillment for the completion of capacity and fixed capital in terms of the volume, dates, quality and composition of the projects and the establishing of reasons for deviation from the plan and changes in the projects to be put into operation, their capacity and cost;

4) Studying the volume of incomplete construction, its conformity to the planned level or norm and disclosing instances and the analysis of reasons for the scattering of capital investments over projects;

5) A description of the dynamics of capital investment volumes, production capacity put into operation and fixed capital in operation. An important part of this task is the elaboration of a methodology to calculate the capital investment indexes;

6) A study of capital investment economic effectiveness. This task is a task of primary importance. In carrying it out, statistics should improve the system of indicators which describe actual capital investment effectiveness.

Construction statistics should solve the problems which directly involve the area of design and research activities and construction work. The central task of construction statistics is to study the entire result of production activities in this sector and to assess plan fulfillment for construction products. This task contains questions which involve a description of construction products as a national economic sector as a whole as well as the result of activities carried out by its component parts, that is, design-research activities and construction work. In studying the result of construction work a special place is held by the construction industry's product and, in particular, monitoring the fulfillment of the production programs by the construction organizations.

The next task of statistics is to study labor. This encompasses the questions of labor resources and their use, measuring the level and dynamics of labor productivity as well as wage characteristics.

A study of the means of production is also a major task of construction statistics. This involves a group of questions among which an important place is held by the study of the efficient use of fixed capital and subjects of labor and elucidating reserves for saving the employed means of production.

A description of technical progress and industrialization in construction is an important statistical task since the employment of new highly productive equipment and advanced production and technical methods has a decisive impact on the growth of labor productivity, the saving of expenditures and the improving of product and work quality.

A study of the costs of construction products, the ways to reduce these as well as an examination of the financial state of the construction and design-research organizations are the final task of statistics.

The designated tasks determine the content and sequence of laying out the theoretical material in the textbook's chapters.

§3. The Organization of Capital Construction Statistics in the USSR

Construction, as a national economic sector, was formed only after the Great October Socialist Revolution. For precisely this reason in prerevolutionary Russia there was no capital construction statistics either as a sector of scientific knowledge or as a sector of practical activity. Only scattered information on the construction of fixed capital projects was gathered by the Central Statistical Committee under the Ministry of Internal Affairs. The completeness and reliability of this information were extremely unsatisfactory.

Capital construction statistics, along with the other economic statistics sectors, arose along with the formation of the socialist state. On 25 July 1918, by a Decree of the Soviet of People's Commissars over the signature of V. I. Lenin there was ratified the "Regulation Governing State Statistics" which served as the basis for the creation of the Central Statistical Administration (TsSU). However, during the period of the reconstruction of the national economy and the establishing of state statistics, that is, up to the 1930's, capital construction statistics did not have organizational independence.

In line with the elaboration of the first five-year plan for the development of the national economy, the leading departments of the nation (the Gosplan, the people's commissariats and so forth) needed detailed and accurate information on construction and its resources on a statewide scale. This circumstance served as an impetus for the rise of capital construction statistics in the USSR as a sector of practical activity of state statistics with corresponding organizational independence. In 1932, as part of the Central Administration for National Economic Accounting (TsUNKhU) under the USSR Gosplan, a sector was organized for the accounting of capital work and construction. Subsequently, along with the development of capital construction in the nation, this area of work for state statistics also developed, was improved and became an important sector in statistics' practical activities.

A characteristic feature of statistical practices in the 1930's and 1940's was the departmental approach to organizing the observation, collecting and processing of statistical material. With such a system, the elaboration of report data and the very forms for capital construction was carried out not only by the state statistical bodies but also to a significant degree by the USSR people's commissariats and departments. However, as of January 1951, new standard reporting forms were introduced for all the nation's construction organizations.

The improvement in the organizational forms [illegible] managing capital construction brought about a further reorganization in accounting and statistics. In 1960, the USSR Council of Ministers adopted a new regulation governing the USSR TsSU and this became a Union republic body which provided centralized leadership over accounting and statistics throughout the nation. Since this time the entire elaboration of data, and in particular for capital construction, has been centralized and concentrated in the state statistical bodies. The USSR TsSU carries out this work through the Union republic TsSU, the statistical administrations of the oblasts, krays and autonomous republics as well as the rayon state statistics inspectorates.

At present the Capital Construction Statistics Administration of the USSR TsSU and analogous bodies in the Union republic TsSU are the leading capital construction statistics center. The Administration includes capital construction sections organized along sectorial and functional principles, for example, sections for endustrial construction, housing and municipal construction, contracting and design-research work, methodology and others. Within the oblast, kray and city statistical administrations capital construction statistics sections have been set up and these provide methodological leadership, the preparation of statistical collections, statistical economics analysis for the party and soviet bodies as well as computer centers engaged in the collecting of statistical materials, their monitoring, processing, grouping and summarizing of data.

Departmental statistics holds a significant place in capital construction statistics. The Union and Union republic ministries and departments include sections and sectors which carry out statistical work. The USSR TsSU provides overall leadership and control over the organization of departmental statistics.

Finally, in the construction, design and research organizations, the employees of the planning and other economic sections are engaged in statistical work related to the collecting of data, the filling out of forms for annual and current reporting and conducting statistical surveys for the needs of the associations, ministries and departments.

§4. Organizational Forms of Statistical Observation in Capital Construction

Statistical observation as the planned and scientifically organized collecting of mass data on economic phenomena is carried out in capital construction in accord with the state statistical tasks. Work in the area of obtaining and monitoring statistical data is carried out by the city, oblast and kray statistical administrations and in individual instances also by the central statistical bodies. Methodological leadership over the organization of statistical observation, that is, the establishing of data which must be obtained, the procedure, periodicity, place, time and methods of obtaining them, is carried out by the Capital Construction Statistics Administration of the USSR and Union republic TsSU.

Statistical observation in capital construction should ensure the obtaining of scientifically sound data needed for drawing up the current and long-range capital investment and construction plans as well as for monitoring plan fulfillment. The assembled statistical information should be reliable and fully cover the entire aggregate of studied economic phenomena in capital construction. These demands are reflected in the observation programs, in the instructions for filling out the statistical forms as well as in the instructions of the central statistical bodies.

Capital construction has employed various forms of statistical observation and these have been of varying significance in the individual historical development states of the Soviet state. Starting with 1917 and almost up to the end of 1930, a large portion of the statistical information on capital construction was based on materials of so-called construction registration. Its essence was that each construction project was registered with the local statistical organization and for this the appropriate statistical form was filled out. This gave the name of the project, the production capacity of the objects, estimated cost and other information. After the completion of construction on the same blank additional information was given and changes made in the initially indicated information. Construction registration in essence was not a form of current or periodic observation and it did not contain a complete coverage of the aggregate of sites and projects and information about them was not always correct. This form of observation was very primitive and for this reason could not satisfy the needs of capital construction statistics. The other part of information on capital construction was collected in conducting population censuses and various industrial surveys which, as a rule, were organized by the individual departments and people's commissariats.

In 1932, as part of the TsUNKhU under the USSR Gosplan, a sector was organized for the accounting of capital work and construction. The main task of this sector was to organize a new form of statistical observation, that is, reporting in capital construction. This became the basic form for collecting statistical data on capital construction.

The statistical reporting on capital construction has been systematically improved and altered in accord with the tasks and directions of national economic development and with its management and planning. At present, this form of observation has reached a high level of organization and virtually solves all the basic problems confronting state statistics. Along with introducing reporting in capital construction, primary accounting has been systematized in the nation's construction organizations and projects. Subsequently extensive work was carried out to standardize the primary accounting documents and to introduce them into practice.

Along with reporting in capital construction, specially organized statistical observation was also employed, that is, censuses, one-shot counts and surveys. In 1932, for the first time in the history of capital construction statistics, using a program elaborated by the TsUNKhU under the USSR Gosplan and an organizational plan, a census of the construction industry was carried out. This census assembled extensive statistical material on the number and composition of construction organizations, on the amount of work carried out by them and, most importantly, on the number, composition, capacity and state of the fleet of construction machines in 1932. The extensiveness of the program for the construction industry census for a long time held up the elaboration of its materials and led to a decline in its timeliness.

Subsequently this form of statistical observation was developed, improved and became an important source of information complementing the basic source of data, that is, the statistical reporting on capital investments and construction. Among the most important of this type of work for the national economy we must mention the censuses for incomplete construction carried out according to a very extensive survey program, the construction machinery and equipment censuses, the annual accounts of construction-installation organizations, the censuses of inventories of materials and equipment at construction projects, of individual housing construction, sampling surveys for the length of construction, for the influence of factors on labor productivity dynamics and others.

One of the particular features in organizing and conducting censuses and surveys in capital construction is that they are carried out on the basis of data from the primary and bookkeeping accounting of the construction organizations and projects (the builders). For this reason in capital construction the censuses have the nature of and are termed one-shot counts and surveys.

§5. Reporting--The Basic Form of Statistical Observation in Capital Construction

State statistical reporting is the most significant source in terms of importance and scale (scope) for obtaining information on capital construction. The organization and configuration of reporting should conform to the tasks of capital construction statistics, to the essence of its objects of study, to the forms and principles of capital construction management, planning and organization.

Considering all these requirements in capital construction statistics traditionally a system of reporting has developed in which two independent but closely related groups of forms of reports have clearly been formed. These are for capital investments and for construction as a national economic sector. In addition, as part of the construction reporting there is an independent subgroup for design and research activities.

Reporting for capital investments and for construction differs both in the composition and nature of the report units as well as in the contents of their survey programs. At the same time, capital investment statistics and construction statistics have much in common, for example, the same indicators, the same report units and so forth.

The initial stage of the given statistical observation is the drawing up of lists of report units, that is, a list of all the operating enterprises, institutions and organizations which should submit reporting on their operations to the statistical bodies and to the superior departments. In capital investment statistics, the basic report unit is the builder, that is, the enterprise, institution or organization which is legally empowered by the state to represent the client and carry out the capital investments. Here each construction project should be entered on the title lists which are approved in the established procedure and are the official permission for the legal existence of the construction project and for the builder. The title lists of the construction projects become permanent planning documents for the entire construction period.

All industrial, agricultural and transport enterprises, construction, supply and other organizations as well as ministries, departments and budget-supported institutions having administrative-managerial independence may be granted the right to be a builder. Such enterprises, institutions and organizations which make capital investments solely for the acquisition of equipment, machinery and farm equipment without the involvement of construction are also conditionally considered builders. They also act as reporting units in a statistical observation.

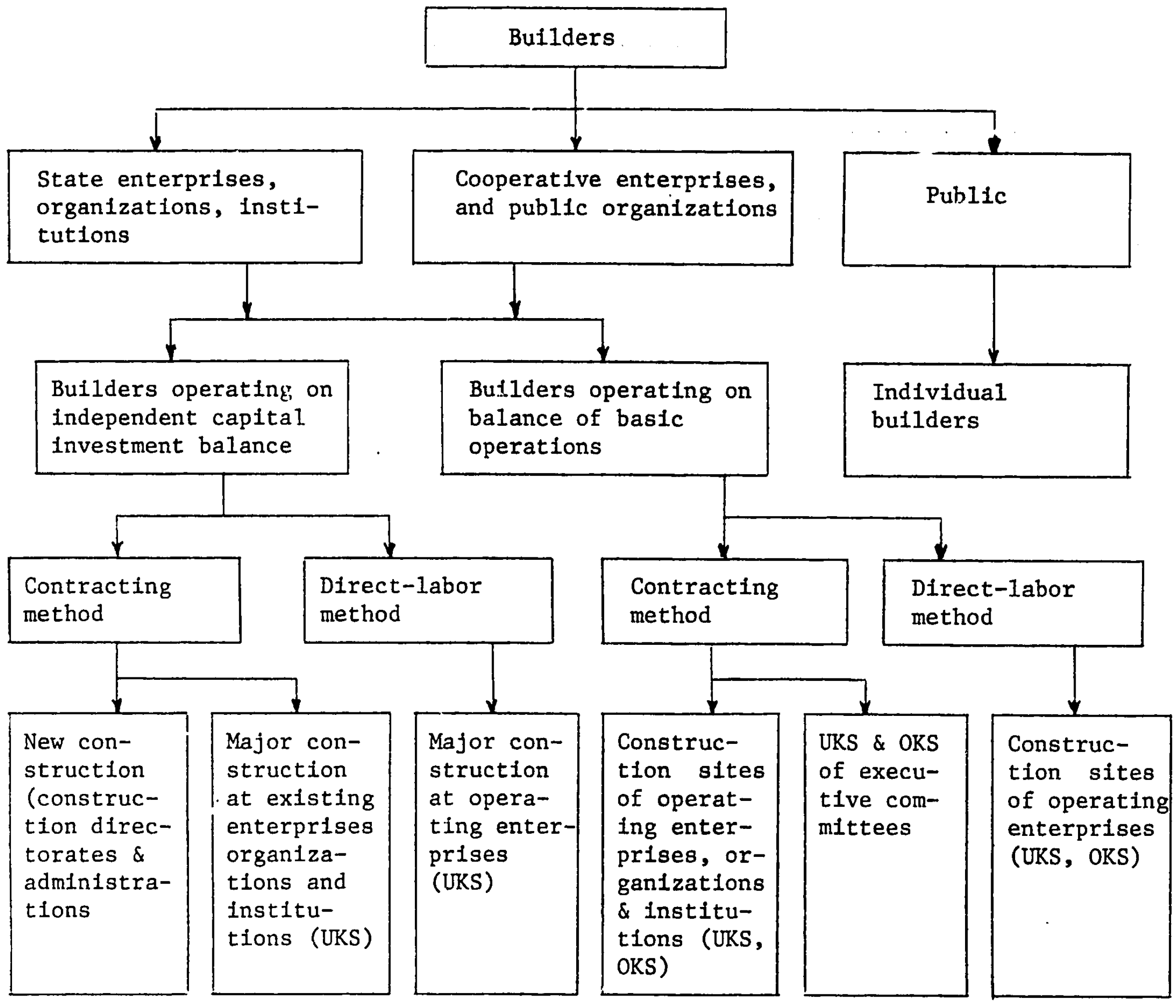

Fig. I.2. Composition of builders as an object of study by capital investment statistics

The aggregate of builders is extremely heterogeneous. Certain differences among the builders, for example, in terms of the forms of ownership, the volume of capital investments, the method of making them and so forth, are considered in organizing the reporting. A notion of the composition of builders in terms of features which are of importance in the organizing of a statistical observation and, in particular, in reporting, can be gained from Fig. I.2.

The groups of units given in the diagram, that is, builders, submit various forms of reports according to the numbering and content of the programs which characterize the activities of the builders in the area of capital investment use.

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A builder's capital investment plan may include not one but rather several construction sites. The sites can be large numbering scores of projects or small consisting of one or several projects. The large construction sites of the ministries and departments are usually made separate in administrative-management terms, that is, they are put on an independent balance sheet for the capital investments and they form a site directorate or construction administration. Such sites become independent report units.

Below we have given a list of the basic forms of capital investment reporting as submitted by the builders for a year.

No 1 (builder)	Balance sheet for capital investments
No 7-ks	Report on capital investment financing
No 2-ks	Report on fulfillment of plan for completion of capacity, fixed capital and capital investment plan
Appendix to Form No 2-ks	Production capacity and estimated construction cost of enterprises and projects in backlog
Appendix 1 to Form No 2-ks	Report on construction cost of housing and civil projects
Appendix 2 to Form No 2-ks	Report on capital investments for measures to protect and rationally utilize natural resources
Appendix 3 to Form No 2-ks	Statement on completion of fixed capital, capital investments and housing construction in territorial breakdown
Appendix to Form No 1-ks and Form No 2-ks	Report on quality of construction projects put into operation

In addition to the listed forms, in a number of instances the builder submits specialized reporting forms on capital investments, for example, Form No 2-ks (agriculture) "Report of Agricultural Enterprise on Fulfillment of Plan for Completion of Capacity, Fixed Capital and Capital Investment Plan." The standard forms of periodic reporting for capital investments, as a rule, coincide in terms of names, numbering and basic indicators with the annual reporting, but its survey program is significantly narrower than the annual.

Construction reporting is more diverse than that for capital investments, for it encompasses various forms of construction activities as an object of statistics (see Table I.1) In accord with the sectorial construction structure, two reporting subgroups have traditionally existed: for the activities of the construction organizations and of the design and research organizations.

Reporting on construction activities should encompass all its areas where construction per se is carried out independently of the method, that is, the contracting construction method[1] and the direct labor method. The activities of the population

[1]The contracting method encompasses all construction organizations and enterprises which carry out construction-installation and other work under contract. Industrial enterprises which perform contracting work, like the enterprises carrying out construction by the direct labor method, are not included in the system of the construction industry.

in individual construction are not reflected in the reporting but rather are accounted for by a specially organized observation, the annual one-shot surveys.

Table I.1

Number of Report Form	Name of Reporting Form	Reporting Units		
		Builders (Direct Labor Method)	Contracting Construction Organizations	Design, Research Organizations
No 1 (contractor)	Balance sheet for basic operations of contracting organization		X	X
Appendices 1, 2 and 2a to Form No 1	Appendix to balance sheet of contracting organization		X	X
Form No 3	Movement of charter capital		X	X
Form No 10 (construction)	Movement of financing money and special funds		X	X
Form No 11 (construction)	Report on availability and movement of fixed capital and amortization fund	X	X	X
Form No 12 (construction)	Presence and composition of fleet of construction machinery on balance sheet of reporting organization	X	X	X
Form No 20 (construction)	Profit and loss	X		
Form No 1-ks	Report on fulfillment of plan for completing capacity and plan for contracting work		X	X
Form No 2-ks	Report on fulfillment of plan for completion of capacity of fixed capital and capital investment plan	X		
Form No 3-t	Report on fulfillment of labor plan in construction	X	X	X
Form No 2-s	Report on cost of construction and installation work			X
Form No 4-ks	Report on fulfillment of plan for design and research work			X
Form No 11-ks	Report of interkolkhoz construction organizations on fulfillment of plan for completion of capacity and contracting plan		X	

Within the contracting construction organizations, in terms of the type of ownership of the means of production, a distinction is drawn between the state, cooperative and public organization enterprises. Reporting for the construction industry is organized in a corresponding manner. The basic production elements of the state organizations in the construction industry are the construction and installation trusts, the housing construction combines (DSK), the plant construction combines (ZSK) and the rural construction combines (SSK). As a rule, these are covered by the Regulation Governing a Socialist State Production Enterprise. The above-listed contracting organizations and combines have been adopted in construction statistics as the basic report units.

Trusts are ordinarily made up of construction and installation administrations, offices, construction detachments and other subunits which are termed the primary contracting construction organizations. Like the trusts, they are given administrative and managerial independence. These self-financing construction subdivisions of the trusts are also considered report units in construction statistics. With such a system for organizing the report units for study in statistics, the reporting of the trusts will always be summary in relation to the reports of the primary organizations.

The system of trusts and their subordinate primary construction organizations is part of the departments organized along territorial lines (Glavmosstroy [Main Administration for Housing and Civil Engineering Construction in Moscow City], Glavleningradstroy [Main Administration for Housing, Civil Engineering and Industrial Construction of the Leningrad City Executive Committee] and so forth), along sectorial lines as well as along territorial-sectorial lines together. In a number of instances, the statistical bodies receive summary reports from the ministries and departments (the reporting of which is not centralized) and this significantly facilitates their work in summarizing the statistical data.

For obtaining information on construction acvitivies of enterprises carrying out construction by the direct labor method, these builder enterprises or more precisely their capital construction sections and enterprises are adopted as the report units. This is caused by the fact that in the given instance the builder, simultaneously with the function of the client, carries out the function of the construction organization in performing the work. The direct labor method of construction, as a consequence of the temporary nature of activity, does not create the conditions for industrial construction. For this reason its employment is justified for small amounts of construction and installation work or in instances when it is difficult to carry out the work by contracting organizations.

A majority of the builders, regardless of the method of carrying out the work, in the form of the OKS and UKS perform the functions of general management and leadership of construction. These functions consist in coordinating the activities of the design-research and construction-installation organizations and the industrial enterprises manufacturing equipment for the construction sites. In addition, the builder accounts for the expenditure of capital investments for the creation and acquisition of fixed capital and for putting it into operation. Thus, the builder, in terms of the nature of the activities performed by him in the reproduction of fixed capital, acts as a report unit in the statistical study not only of capital investments but also of construction as a national economic sector. However, the

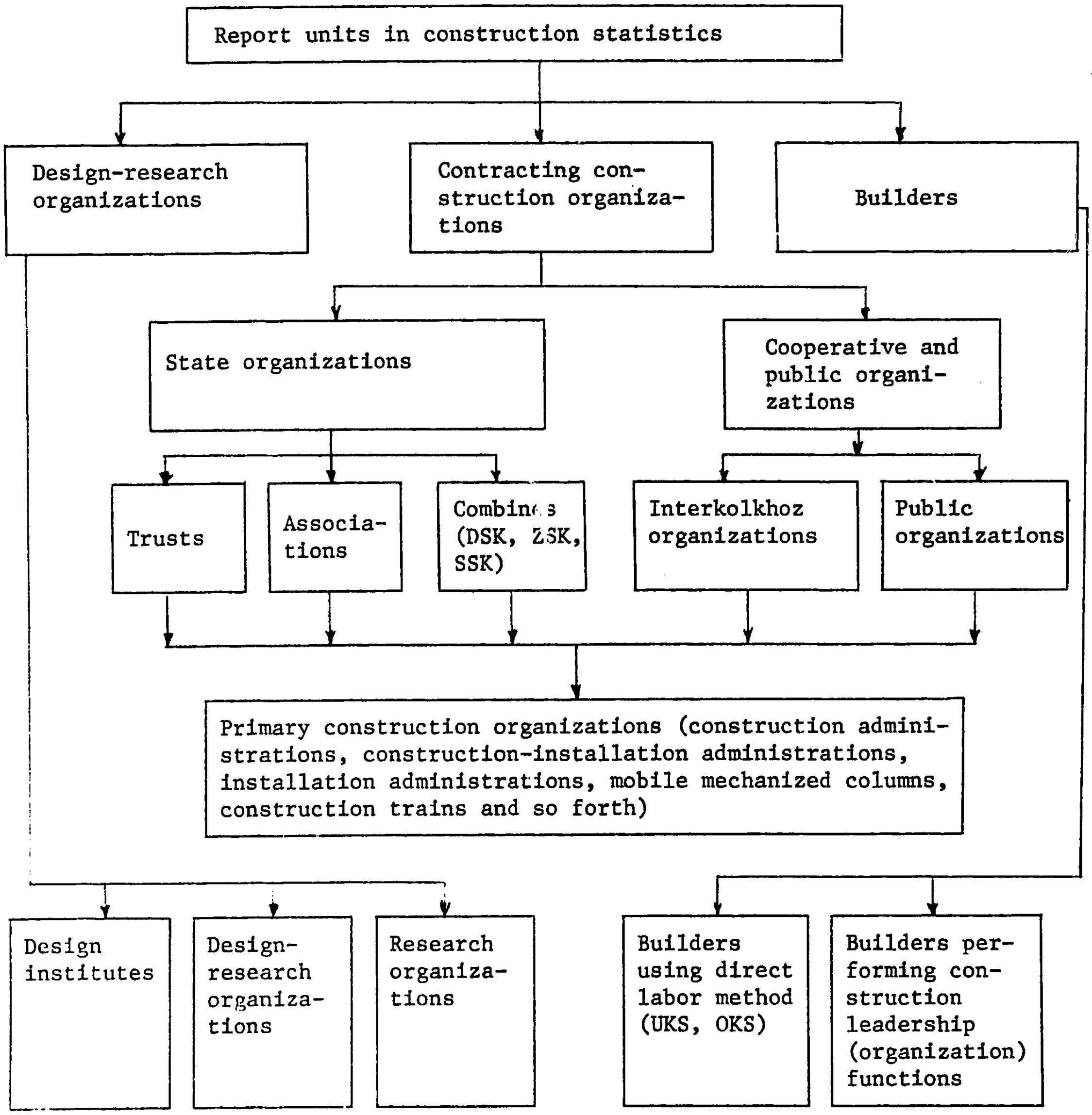

Fig. I.3. Composition of report units in construction statistics

builder does not submit reporting on capital investments and construction separately but rather together and this is completely justified in practical terms, for example, Form No 2-ks and the appendices to it.

In the statistics of design and research activities, the design and research organizations are used as the report units when these operate with the rights of cost accounting and work out the necessary documents for construction. In practice these are usually named institutes for designing and engineering-research organizations (Promstroyproyekt [State Planning Institute for General Construction and Sanitary-Engineering Planning of Industrial Enterprises], Gipromez [State All-Union Institute for the Planning of Metallurgical Plants] and others).

The composition of report units for construction statistics by types is shown in Fig. I.3. The report units of each of the groups given in the diagram present statistical reporting according to the forms and programs established for them and determined by the functions performed by them in construction. The composition of construction reporting as a whole (and for the designated forms of the reports to a certain degree also the content of their programs) can be judged from the list of basic forms of annual reporting (see Table I.1).

All questions related to the organization of reporting (composition, periodicity, dates of submission and so forth) are settled by the Methodology Section of the Capital Construction Statistics Administration under the USSR TsSU. The reporting provided for in the list is approved by the USSR TsSU jointly with the USSR Ministry of Finances, the USSR Gosstroy and other involved departments.

CHAPTER II: THE STATISTICAL STUDY OF THE VOLUME, COMPOSITION AND DYNAMICS OF CAPITAL INVESTMENTS

§1. The Concept and Technological Composition of Capital Investments

In the USSR fixed capital is reproduced chiefly by capital investments. The aggregate of expenditures going to create productive and nonproductive fixed capital in the national economy is termed capital investments. Statistics studies capital investments not only as a financial category but primarily as a many-sided process of fixed capital reproduction. Several production sectors of the national economy are involved in this process, but it is chiefly construction and industry.

In terms of the nature of the expenditures included in them and their purpose, capital investments are extremely heterogeneous. Depending upon the structure and the specific features of the fixed capital to be created, in varying proportions capital investments include expenditures on research, designing and construction-installation work to erect the buildings and structures, expenditures to purchase equipment and so forth. For this reason statistics should primarily describe the production-technical or, as they say, the technological structure of the assets invested into the creation of fixed capital.

A study of the technological structure of capital investments is of importance for coordinating the capital investment plans with the development plans of all the national economic sectors, for setting the needs of construction for material, labor and monetary resources, in estimating capital investment effectiveness and in studying other problems.

In the technological composition of capital investments, a distinction is made between the following types of expenditures.

For design and research work. These include only expenditures on individual designing and the engineer and research work to build the fixed capital projects and complexes. Expenditures on geological prospecting to establish mineral resources as well as for working out the standard plans of buildings and installations, the projects for regional planning and development of cities and others not related to construction are financed directly from the state budget and not from captial investments. Theoretically these expenditures should be accounted for in determining the overall amount of reproduced fixed capital, that is, related to the capital investments.

For construction work. Expenditures on this work comprise the most significant share of capital investments. Among construction work is all the work related to the erection, expansion, reconstruction and restoring of buildings and installations as envisaged in the plans, for example, drilling work, the digging of foundation pits, the laying of foundations and building walls, the installation of metal and reinforced concrete structural elements of buildings and installations, the work of installing sanitary-technical equipment, the landscaping of territory and other work.

For work to install equipment. In the installation of equipment is put the work related to installing and assembling production, power and other equipment and production structural elements, the bringing in of utilities, insulation work and so forth.

Work related to the installation of equipment which is a part of the buildings and installations is not considered in the given type of capital investments.

For the acquisition of equipment requiring installation. This includes production, power, transport and other equipment which can be put into operation only after its assembly and attaching to supports, for example, steam turbines, electric generators, metal-cutting equipment, textile looms, printing equipment and much else. Expenditures for this equipment comprise a high proportional amount.

For the purchasing of equipment not requiring installation. In terms of the nature of use, this equipment does not require assembly, attachment or other installation work, for example, motor vehicles, internal combustion engine and battery operated plant trucks, bulldozers, excavators and other types of equipment. This type of capital investment in planning and statistical practices also makes separate provision for expenditures on equipment which is not included in the construction estimates. This includes equipment for replacing worn out machines or adding to the fleet of machines at an existing enterprise as well as the equipment which, in accord with the adopted procedure for elaborating the plans, is not included in the construction estimates.

For production tools and supplies. This includes all types of production tools as well as rapidly worn out and inexpensive articles expenditures on the acquisition of which are included in the capital investment volume for the construction estimate.

For the purchasing of draft animals, that is, the purchasing of adult draft animals (horses, mules and so forth) which are included as fixed capital.

Expenditures which do not increase the cost of fixed capital. These include expenditures on the training of operational personnel, forestry and land use measures, for totally cancelled construction and installation work ("throw-away" work) and others. A majority of these expenditures is not involved in construction but from the national economic viewpoint they are inevitable.

Other capital expenditures. These include expenditures on the purchasing of structures from cooperative organizations and kolkhozes, for resettlement from areas allocated for construction, for the support of the administration and technical supervision and for the planting and raising of perennial crops (orchards, preserves and so forth).

The technological composition of capital investments is periodically revised in planning and statistical practices. For example, expenditures on design and research work were not included as part of capital investments during the period from July 1950 through October 1959, since during the designated period the activities of the design and research organizations were financed directly from the state budget. Up to 1950, capital investments did include expenditures on geological prospecting as well as for forming the producing herd [of animals]. The change in the capital investment composition must be considered in studying the dynamics of its volume.

Capital expenditures on all types of works and equipment requiring installation have come to be termed capital work while expenditures on equipment (except that requiring installation), production tools, supplies and draft animals are considered capital acquisitions. In planning and statistical practices, the technological composition of capital investments is represented by three consolidated groups (Table II.1). Here in the statistical reporting within the first group special provision is made for expenditures on the installation of equipment; as part of the second group expenditures on equipment not included in the construction estimates; in the third group, expenditures on design and research.

Table II.1

Types of Capital Investments	Sixth Five-Year Plan	Seventh Five-Year Plan	Eighth Five-Year Plan	Ninth Five-Year Plan
Construction-installation work	69	65	62	60
Equipment, tools, supplies	26	29	31	32
Other capital work and expenditures	5	6	7	8
Total	100	100	100	100

Capital investments do not include expenditures on the major overhaul of fixed capital objects, although the construction organizations carry out this. This is due to the fact that, in the first place, as a result of a major overhaul only the previously created consumer value is restored and, secondly, a major overhaul is carried out from a certain portion of the amortization fund which is earmarked for the partial rebuilding of the fixed capital.

The data given in the table on the technological structure of USSR capital investments (in percent) show that a predominant portion of the capital investments (around two-thirds) goes to carry out construction-installation work, approximately one-third for equipment, supplies and so forth, and here one can clearly trace a tendency for a rise in the proportional amount of expenditures for equipment. This tendency means an improvement in the technological structure of capital investments and leads to an increased proportional amount of the active part of fixed productive capital in the national economic sectors and, consequently, to a rise in the economic effectiveness of capital investments.

§2. Indicators of the Capital Investment Volume

In studying the use of capital investments, in planning and statistics use is made of a number of indicators which reflect the economic features and result of this process, starting out with research and designing of the projects up to their completion. Among the most important of them are the indicators describing the capital investment volume, the investment structure, incomplete construction, the completion of capacity and fixed capital, the readiness of projects and construction sites, capital investment effectiveness and others.

The capital investment volume is a generalizing indicator which in monetary terms describes the amount of expenditures on fixed capital reproduction by capital construction and for the acquisition of equipment not included in the construction estimates and plans. Being a cost indicator, this is formed as the total of financial expenditures going for the creation and acquisition of fixed capital and, thus, characterizes the result of using the capital investments. The economic sense of this indicator makes it possible to successfully apply it not only in studying fixed capital reproduction but also a nation's economic potential, the directions, pace and scale of the development and placement of the material and technical base for all the national economic sectors.

The capital investment volume is planned for the national economy as a whole broken down for the sectors, ministries, departments and so forth, down to the individual builders. The task of statistics is to establish the actual amounts of capital investments and in establishing control over the fulfillment of the current and long-range capital investment plans on the various organizational levels. For carrying out this task it is essential first of all to determine the actually completed capital investment volume.

As was stated above, the builders are the immediate disposers of the capital investments. Capital investment accounting is concentrated in the technical supervision sections and the bookkeeping offices of the builders (OKS and UKS). For this reason the builders are the primary report units in capital construction statistics and they submit data on the completed volume of capital investments using the established reporting forms. Control over the fulfillment of capital investment plans starts with the builders.

The amount of capital investments is expressed by the estimated cost and this is set in the designing of the projects and installations for fixed capital. For each construction site, along with a plan, an estimate is drawn up and this contains information on the monetary outlays for creating each individual object and the entire project as a whole, that is, the estimated cost of the objects and the project. Here the monetary outlays are determined for the types of capital investments in accord with the specific features of the fixed capital to be built or acquired.

The setting of the estimated cost of construction, installation, design and research work is based on the methodological provisions formulated in the Construction Standards and Rules and is marked by labor intensiveness and complexity. A detailed exposition of the methodology for calculating the estimated cost of this work has been given in the chapter on construction product of which all the above-listed work is a component part. Here we will merely point out that the estimated cost of construction-installation work is set by estimate rates for the expenditure of production resources, by the wholesale prices and rates for transporting materials put in effect on 1 January 1969 considering the increased wages of construction workers in 1970 and the reduction factors for construction-installation work as of 1 January 1976, the corrections to reduce the rates and the change in the prices for individual types of materials and equipment.

The methods for determining the estimated cost of production equipment differ depending upon whether its acquisition is related to construction or not. Thus, the estimated cost of equipment for projects under construction is set from the wholesale industrial prices on 1 January 1973 considering its delivery, storage, crating and assembly at the estimate rates and charges for preparatory-warehousing and transport expenditures. The cost of equipment and machines not included in the construction estimates in the completed capital investment volume is accounted for at wholesale prices adopted in drawing up the capital investment plan. To a certain degree this marks a deviation from the general rule.

The estimated cost of design and research work is determined in the designing estimates on the basis of special manuals for consolidated rates which contain the price lists for this work. The estimated cost of other capital work is set according to rates on the basis of the design data.

Capital investments are an interval indicator characterizing their volume over a report period. The actually completed capital investment volume includes the estimated cost of all capital work produced during the report period, the acquisitions as well as all other capital expenditures made from capital investments. Here, from the viewpoint of accounting, the types of capital investments which are considered actually completed are those which satisfy the set requirements for the state and completeness of the corresponding work, acquisitions and expenditures and have been formulated in approved documents of internal project accounting regardless of the level of completeness of the projects under construction.

The heterogeniety of the technological composition of capital investments predetermines the use of various methods for calculating the types of capital investments. These fundamental provisions are given in the Construction Standards and Principles and in the capital construction financing rules.

The principles of incorporating the cost of construction product in the completed capital investment volume are correlated to the adopted payment systems between the builders and executors and, in particular, with payments for the finished project and work stage without intermediate payments. The builder considers as completed capital investments the cost of only that construction-installation work which relates to completed projects and work stages as formulated in the proper documents. Such official documents for a complete project is the statement of Form No 2 and the statement of Form No 2a for a completed construction stage. In addition, as an exception the completed capital investment volume may include the value of work where the volume, nature and methods of executing this work become clear only in the course of construction. In these instances the work is accepted by the clients according to the percentage of technical completeness (the statement of Form No 2b) and for completed structural elements and consolidated types of work (the statement of Form No 2c). With monthly payments in these instances the information of Form No 3 is employed.

The changeover to the new form of payments has led to certain complications and disruptions in the uniform methodology for calculating actually completed capital investments. In the first place, for the construction organizations there was a sharp rise in the volume of incomplete construction work, that is, work on projects and work stages that were incomplete and not turned over to the client and thus kept on the balance sheets for the basic operations of the organizations. Naturally this amount of work could not help but be reflected in the capital investments. Secondly, in payments for completed projects and work stages a significant portion of them could have been completed not in the report but rather in the preceding periods. With the turning over of completed projects and work stages to the builders the statements would show their full cost regardless of when they had been started.

As a consequence of what has been described, in determining the volume of the actually made capital investments a number of troublesome methodological questions arise. For example, is it necessary or in what manner is it possible to account for incomplete production within the volume of capital investments. Should the completed amount of capital investments include the work done on completed projects, stages or groups of work at the full estimated cost or for the portion of the cost of the work done only in the report period and so forth. The solution to these questions depends upon the economic tasks in studying capital investments. From the position of the national economy the economic sense of an indicator describing the full volume of used capital investments demands that this be calculated as the total of all monetary outlays made in the report period by the builder in reproducing the fixed capital. In terms of the construction industry this means that the capital investment volume should take into consideration the value of the work done only in the report period for all projects regardless of the level of their completeness. In accord with this principle it is possible to determine the capital investment volume since each month the builders receive information from the contracting organizations on the amount of work carried out in the report period for all incomplete projects (the information of Form No 3).

However, in capital investment planning, as a consequence of a number of circumstances incomplete work is not always taken into account. It may also happen that a capital investment plan considers the full cost of the work on projects, stages and groups of work to be completed in the report period. These and other questions in statistical practice are resolved depending upon the planning procedure employed in the reporting organization, namely: the actually completed capital investment volume is determined using the same methodology as the planning indicator. For example, if incomplete construction work was included in the capital investment volume under the plan, then it should also be considered in the actual capital investment volume.

Such a solution to the question cannot be viewed as successful, since, in the first place, it takes into account only the conditions of comparability between the actual and planned capital investment indicators; secondly, there is no correlation to the acceptance of incomplete production by the client and this disrupts the methodological unity.

In carrying out construction by the direct labor method, the completed capital investment volume also includes the work according to the estimated value and in the same procedure as with the contracting method, only these calculations are made by the builder or its OKS and UKS.

The carrying out of capital investments for installation work is accounted for with certain deviations from the general rules. The estimated cost of work related to the installation of equipment is included in the completed capital investment volume if the installation of machine tools, machinery, units and so forth has been completed and formally accepted. With the installation of large units and machines, for example the turbines or boilers at GRES or rolling mills, the estimated cost of the work related to installing parts of the units which have been formally accepted by the appropriate statements is accounted for in the completed capital investment volume.

Design and research work is accounted for in the capital investment volume according to a methodology analogous to the one examined for construction-installation work. In instances when payments with builders are made for completed plans for projects or work stages, the statement of Form No 4 is used as the basis for including their value in the capital investment volume. Information on the value of design and research work relating to incomplete projects and stages is submitted by the executor to the builder in the information of Form No 3.

The estimated cost of equipment requiring installation is accounted for in the completed capital investment volume under the condition that the given equipment has been installed. The actual fact of the beginning or completion of installation is established by any acceptance document or by the inventorying of installation work. The estimated cost of equipment not requiring installation as well as tools and supplies are accounted for in the completed capital investment volume after they have been delivered to their destination, usually to the construction site, and after they have been accepted by the builder's bookkeeping office, that is, with the presence of a statement, bill or invoice on the acceptance of the given equipment. The official documents drawn up in the established order (statements, lists, bills and so forth) are the grounds for including other capital work and expenditures in the completed capital investment volume.

Depending upon the nature of fixed capital reproduction, the volume of capital investments can be determined, in the first place, as an indicator describing the capital investment volume to be carried out through construction; secondly, as an indicator describing the capital investment volume for the purchase of completed fixed capital without the involvement of construction; in still other instances, as the total capital investment volume for the creation and acquisition of fixed capital.

Let us give an example which illustrates the methodology of calculating the capital investment volume. Let us assume that during the report year a capital investment plan has been established for a machine building plant totaling 1.58 million rubles and the volume of construction-installation work is to be included only for the projects completed during this year for their full cost. Over the report year the plant's OKS has made the following capital expenditures (Table II.2).

Table II.2

Name of Capital Work, Acquisitions and Expenditures	Name of Documents	Estimated cost, 1,000 rubles
I. For plant reconstruction and expansion		
1. Construction-installation work for erecting building of machine shop (second stage)	Statement No 2a	1,450
Including work carried out in report year		380
2. 12 DS-2 machine tools accepted by warehouse for installation	Acceptance statement	36
3. Work of installing 12 DS-2 machine tools	Statement of incomplete installation	1.8
4. Construction-installation work carried out in report year for incomplete projects and stages	Information of Form No 3	280
5. Expenditures on the training of operational personnel	Bill	1.6
II. Acquisition of equipment and supplies outside construction estimates		
1. 14 battery operated trucks accepted by warehouse	Invoice	7.8
2. 3 trucks accepted by garage	Acceptance statement	24.4
3. Equipment and supplies acquired for nursery (under Article 12 of the budget)	Bill	5.2
III. Designing of reconstructed shop	Statement No 4	88
IV. Major overhaul on main plant building	Statement No 2	164

The total volume of capital investments as the total value of all the capital work actually carried out in the report period, the purchases and other capital expenditures will be:

$$380 + 36 + 1.8 + 280 + 1.6 + 7.8 + 24.4 + 88 = 819{,}600 \text{ rubles.}$$

The actually completed capital investment volume in terms of the planning procedure adopted by the builder as a whole equals:

$$1{,}450 + 36 + 1.6 + 88 = 1{,}607{,}800 \text{ rubles,}$$

while the percentage of the capital investment plan fulfillment will be, respectively:

$$\frac{1{,}607.8 \cdot 100}{1{,}580} = 101.76;$$

the volume of capital investments to be made by capital construction equals:

$$1{,}450 + 36 + 1.6 + 88 \;=\; 1{,}575{,}600 \text{ rubles;}$$

the volume of capital investments to be made by purchasing outside the construction estimates equals:

$$7.8 + 24.4 \;=\; 32{,}200 \text{ rubles.}$$

According to the established planning procedures the capital investment volume does not account for a number of expenditures also made for the acquisition and creation of fixed capital but paid for out of other financing sources. These include expenditures on the acquisition of equipment and supplies by state institutions under Article 12 of the budget classification, for the planting of forests and shelter belts, for the forming of the basic livestock herd, major overhauls and certain others. As a consequence of what has been stated above, the need arises to define the volume of all outlays on the reproduction of fixed capital, that is, the planned capital investments plus the expenditures not reflected in the capital investment plan. Thus, in the USSR, over the period from 1918 through 1978, the capital investment volume was 1,833,400,000,000 rubles, and considering all expenditures on fixed capital reproduction, 2,023,000,000,000 rubles. Around 10 percent of all expenditures on fixed capital is for outlays not accounted for as part of capital investments.

In the given example (see Table II.2), the actual amount of expenditures on fixed capital reproduction from all financing sources was: $1{,}607.8 + 5.2 + 164 = 1{,}777{,}000$ rubles.

§3. Basic Groupings in Capital Investment Statistics

The grouping method assumes important significance in studying many questions of capital investment statistics and primarily in aggregating the builders' data and in assessing the fulfillment of capital investment plans. The capital investment groupings make it possible to gain a notion of the diversity of the fixed capital reproduction process, to detect the formed and insipient forms of this process, to describe the structure of the studied object using features expressing the qualitative features of fixed capital reproduction under the conditions of the socialist management of the economy as well as carry out other tasks of economics and statistics.

Let us examine the basic groupings employed in summarizing, in planning and supervising the fulfillment of capital investment plans. From the national economic standpoint among the most important are the capital investment groupings by economic purpose, national economic sectors and then for subsectors and types of production, for the direction, forms of ownership, for the financing sources and for other features. For a correct understanding of each type of grouping it is essential to disclose its purpose, the essence of the grouping features, the nature of the aggregate and the methodological features of the groupings.

Of great interest in studying the economic development of a nation and the conformity of this development to the economic and political tasks posed in the given period is a classification of the capital investments. This is a sort of complex grouping formed according to several economic features: according to the spheres and sectors of the national economy, the subsectors, types of production and activity. In terms of the national economic spheres, two groups are formed: capital investments into production-end projects and capital investments into nonproduction projects. Among the production-end projects are those which are involved in creating any products and production services, for example, power plants, mines, railroads and so forth. The nonproduction projects are destined for serving state institutions and public organizations, the cultural, educational and other needs of the public, for example, housing, schools, theaters, hospitals and so forth.

Capital investments into the production and nonproduction spheres of the national economy are in turn allocated over the national economic sectors. In the first instance these are industry, agriculture, transportation and other sectors, and in the second instance these are housing construction, municipal construction and other sectors. Subsequently the capital investments of each national economic sector are distributed in terms of types of production and activity.

The designated complex capital investment grouping has been organized in accord with the national classifier of national economic sectors as approved in 1972. Its application has made it possible to supervise the observance of correct proportions in national economic development and ensure the more rapid development of the leading production sectors and the systematic rise in the material and cultural level of the workers.

The allocating of capital investments over the sectors of their classification is ordinarily carried out in the process of summarizing the statistical data. Here not the capital expenditures and not the builders are subjected to grouping but rather the aggregate of construction projects or sites. In the report of Form No 2-ks the information can be found for the construction projects as required for this grouping. In instances when the construction project consists of a number of installations which differ in terms of economic purpose or sectorial affiliation, these are classified in one or another sector or group according to the predominant purpose of the project as a whole

From what has been stated it follows that a construction site is a consolidated unit of an aggregate which in the grouping will lead to an inaccurate allocation of the capital investments in terms of sectorial purpose. For this reason in the given capital investment grouping it is advisable to use an individual construction project as a unit of the aggregate. However, the appropriate data cannot be found in the reporting and they can be gained from the accounting carried out by the builders. In order to fill out this grouping, it is essential to formulate precise statistical concepts of the construction site and the construction project. By the construction site in planning and statistical practices one understands the aggregate of construction projects the erection, expansion and reconstruction of which are carried out according to a single plan and estimate. For example, construction sites include the construction of a power plant, plant, mine, sanitorium and so forth. A construction project is considered to be a separate standing building or installation with all related equipment, additions, utilities for the erection of which a plan and estimate have been drawn up.

Also known in the practice of a statistical summary is a grouping of capital investments by the areas of fixed capital reproduction, and as a consequence of this it is also termed a reproduction grouping. In terms of purpose, all capital investments are divided into the following groups: New construction, expansion, reconstruction, technical reequipping of operating enterprises and the maintaining of existing capacity.

The erection of buildings, installations, enterprises and so forth is considered to be new construction (a new construction site) when this is carried out at new construction sites according to the initially approved plans, for example, new mines, power plants, plants and so forth. The expansion of operating enterprises means the building of new shops, installations, stages and so forth at operating enterprises, for example, a new assembly shop at a motor vehicle plant. The reconstruction of operating enterprises is the partial or complete reorganization of enterprises, for example, the reequipping of a foundry for employing new piece-casting technology. The technical reequipping of operating enterprises includes the carrying out of a range of technical measures provided for by the technical development plan for introducing new equipment, for mechanizing and automating existing production as well as for replacing old worn out equipment with new, more productive and economic equipment. The maintaining of capacity at operating enterprises includes measures to replace fixed capital which has been withdrawn as a consequence of complete wearing out and decrepitness. In this grouping the construction site must be considered as the unit of the aggregate and this facilitates the summarizing of capital investments using the reporting data.

In the various historical stages of the nation's development, the party and government have given varying significance to one or another area of capital investments. At the present stage of our nation's economic development, a large portion of the capital investments is going into the reconstruction and technical reequipping of existing enterprises thereby making it possible to obtain the greatest economic effect with the same expenditures.

Under the conditions of a socialist state, the grouping of capital investments by forms of ownership is of important significance. According to this principle, a distinction is made between the capital investments of the state enterprises and organizations, the cooperative and public organizations and by the public for individual construction. This grouping is made by the data of the builders which legally represent one or another form of ownership.

The grouping of capital investments by financing sources is of importance for describing not only the sources for the formation of assets for capital investments but also in studying their reproduction structure by formation sources and the role of national income and the amortization fund in fixed capital reproduction. Among the basic sources of assets for capital investments are: funds from the state budget (the centralized source) and various noncentralized financing sources (the funds of enterprises and the amortization fund). In addition to these groupings, data on capital investments are summarized in a territorial breakdown (for the republics, oblasts and so forth), in terms of subordination (to the ministries, departments) and by forms of subordination (Union, Union republic, republic).

§4. Methods of Studying the Dynamics of the Capital Investment Volume

For studying changes in the capital investment volume over time or space, statistics employs the index method. The aggregate formula for the index of the capital investment volume has the following form:

$$I = \frac{\Sigma q_1 p_{cm}}{\Sigma q_0 p_{cm}},$$

where q_0 and q_1--capital work and purchases in physical units, respectively, in the base and report period;
p_{cm}--estimate prices taken for comparison.

The observance of comparability of the compared levels is a fundamental methodological question for constructing the time series and for calculating the index of the capital investment volume. This is achieved by meeting two basic requirements: in the first place, the composition of capital investments in terms of the types of compared periods should be the same; secondly, the capital investments of the compared periods should be expressed in the same (comparable) estimate prices.

In order to bring the composition of capital investments to a comparable form, one should proceed in the following manner. From the capital investment volume of the preceding period (periods), those types of investments are excluded which according to the adopted planning procedures are not entered as part of them for the report date. Conversely, to the capital investment volume of the previous period (periods) one should add those types of investments which according to the adopted planning procedure are part of the capital investments on the report date but were not considered as part of them in the previous period (periods). In instances when the necessary information is not available, only those capital investment elements ~~which were found in both indicators are left in~~ the compared capital investment volumes.

For reducing the capital investment volumes to a comparable form from the viewpoint of prices it is essential to recalculate them in estimated prices adopted for the comparison. In statistical practices the capital investment volumes are recalculated by estimated price indexes (previously these were called conversion factors) which ordinarily are set for the basic types of capital investments, including: construction-installation work, equipment which does and does not require installation and design-research work. The estimated price index is calculated from the formula of the aggregate index:

$$I_y = \frac{\Sigma q_1 p_{cm_1}}{\Sigma q_1 p_{cm_0}},$$

where p_{cm_1} and p_{cm_0}--new and previous estimated prices.

The price index is ordinarily determined for the year preceding the year the new estimated prices come into effect, and for this information on capital investments in the old and new estimated prices is given in Form No 2-ks or a special form. Using these data, the price indexes are calculated for the types of capital investments broken down for the ministries, republics and so forth. In statistical practices the recalculating of the capital investments in estimated prices used for the comparison is frequently done by multiplying the volume of the given type of capital investments by the appropriate estimated price index. Theoretically, such a calculation is not beyond reproach as the requirements of methodological comparability are violated. But the use of other procedures leads to even greater conditionality.

It is possible to calculate the index of the capital investment volume directly using the above-given formula without any adjustments and constraints over a period of time that the same estimated prices are in effect and under conditions of a stable composition of capital investments according to the adopted planning procedure. For calculating the index of the capital investment volume when either changes do occur, it is essential: in the first place, to bring the technological composition of the capital investments to a comparable form; secondly, to establish the estimated price indexes for each type of capital investments; thirdly, using the estimated price indexes to recalculate the capital investment volume for a comparable composition in estimated prices adopted for the comparison; fourthly, using the above-given formula to calculate the index of the capital investment volume.

During the 1960's and 1970's, the composition of capital investments was not changed and for this reason the methodology for calculating the indexes of the capital investment volume was simplified. However, during these years there were repeated general or partial changes in the estimated prices and this somewhat complicated the calculating of the indexes and a comparison of the time series for the capital investment volume. In these instances, the capital investment volumes in estimated prices adopted for the comparison (usually current prices) are recalculated by the chain method, that is, according to the formula:

$$Q_{pc} = Q_{po} \cdot I_{p1} \cdot I_{p2} \cdots,$$

where Q_{pc}--the capital investment volume of the base period recalculated in comparable estimated prices;

Q_{p0}--the capital investment volume of the base period in estimated prices of this period;

I_{p1}, I_{p2}, ...--estimated price indexes for the corresponding time segments of the overall period.

Table II.3 gives an example illustrating the methodology for calculating the index of the capital investment volume using data for one of the RSFSR oblasts.

The volume of capital investments (col. 7) was established by multiplying the data of cols. 4, 5 and 6. The index of the capital investment volume in 1978, in comparison with 1953, will be: $\frac{528-14}{105.1} \cdot 100 = 489\%$. Since there are no data on the expenditures for research and design in 1953, for the observing of comparability expenditures on this work have been excluded from the capital investment volume.

In addition to the designated demands which ensure compatibility of the capital investment volumes, in constructing time series and calculating the indexes it is essential to clarify the limits of the studied aggregate (the number and composition of builders in a ministry, department, rayon and so forth).

Table II.3

Technological composition of capital investments	Capital investments in 1978 in estimated 1969 prices, million rubles	Capital investments for 1953 in 1950 estimated prices, million rubles		Estimated price index in portions of a unit		Capital investments for 1973 in 1969 estimated prices, million rubles (col. 4 x col. 5 x col. 6)
		for 1953 composition	for compared composition	1955/1950	1969/1955	
1	2	3	4	5	6	7
1. Construction-installation work	322	62	62	1.02	0.96	60.7
2. Equipment, tools and supplies	180	40	40	1.04	1.02	42.4
3. Geological prospecting	--	4	--	--	--	--
4. Design-research work	14	--	--	--	--	--
5. Other capital work and expenditures	12	2	2	1.0	1.0	2.0
Total capital investments	528	108	102	--	--	105.1

In statistical practices, for characterizing the developmental intensity of the capital investment time series, frequently the average absolute increase, the average increase rate and increment are determined. Usually the average absolute increase is calculated for the formula of the arithmetic average and the average growth rate for the formula of the geometric average. However statistical theory does not consider these indicators universal. In particular, the designated method for calculating the average indicators for a time series is related solely to the growth rate which is common to the entire period and this is determined by the ratio of just the beginning and end levels of the series and does not depend upon the intermediate levels of the series while the total calculated levels of the time series does not equal the total of its actual levels.

At the same time, in studying capital investment dynamics, very often one encounters the problem of determining the average absolute increase, the average growth rate and average increase rate which would be related to the overall capital investment volume during the period limiting the time series. For example, in a five-year plan it is important to monitor not only the fulfillment of the plan over the years but also the annual growth rates of capital investments and their absolute increase in order to see what indicators have been achieved and what ones must exist for the use of capital investments to carry out the five-year plan as a whole.

For calculating the average absolute increase of capital investments ($\overline{G}$) which would satisfy the above-advanced condition, theory recommends the following formula:[1]

$$\overline{G} = \frac{2\left(\sum_{i=1}^{n} y_i - ny_0\right)}{n(n+1)}, \qquad (1)$$

where $\sum_{i=1}^{n} y_i$--the total of all the terms for the levels of the time series with the exception of the base one;

y_0--the base (initial) level of the time series;

n--the number of terms in the series with the exception of the initial (base) level.

Statistical theory recommends that the average growth rate satisfying the above-advanced condition be defined as the parabolic average which is the positive root of a n-order polynomial:

$$\overline{T} + \overline{T}^2 + \ldots + \overline{T}^n = \frac{\sum_{i=1}^{n} y_i}{y_0},$$

where $\overline{T}$--average parabolic growth rate.

It is possible to cetermine the sought root of this equation only by approximate methods.[2]

Let us give an example which illustrates the calculation for indicators showing the average rate and intensity of change in the time series for the volume of Soviet capital investments in the Ninth Five-Year Plan. According to the plan, the Soviet capital investment volume for the Ninth Five-Year Plan was to be a total of 501 billion rubles. In actual terms over the years of the five-year plan, capital investments were allocated in the following manner (billion rubles):[3]

1970 (y_0)	1971 (y_1)	1972 (y_2)	1973 (y_3)	1974 (y_4)	1975 (y_5)	$\sum_{i=1}^{n} y_i$
82	88.0	94.3	98.7	105.7	114.9	501.6

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1 See: L. S. Kazinets, "Tempy rosta i absolyutnyye prirosty" [Growth Rates and Absolute Increases], Moscow, Statistika, 1975, p 84.

2 Ibid., pp 104, 105.

3 See: "Narodnoye khozyaystvo SSSR v 1975 g." [The Soviet National Economy in 1975], Moscow, Statistika, 1976, p 502.

Let us calculate the average absolute increase and the growth rate of capital investments as correlated to the overall absolute increase and growth rate for the 5-year period:

$$\bar{G}_{ap} = \frac{y_n - y_o}{n} = \frac{114.9-82}{5} = 6.58 \text{ (billion rubles);}$$

$$\bar{T}_g = \sqrt[n]{\frac{y_n}{y_o}} = \sqrt[5]{\frac{114.9}{82}} = 1.0698.$$

It is easy to check that $y_5 = 82 \cdot 1.0698^5 = 114.9$ billion rubles and the total of the calculated levels for these data over the five-year plan will be 508.7 billion rubles and this is 7.1 billion rubles more than the actually used capital investments. However, in studying the dynamics and the fulfillment of the capital investment plan much more often in practice the task is set of determining these same indicators but correlated to the overall capital investment volume for the five-year plan. Let us calculate the average annual absolute increase of capital investments over the Ninth Five-Year Plan:

$$\text{according to plan } \bar{G}_{p\ell} = \frac{2(501-5\cdot 82)}{5\cdot 6} = \frac{182}{30} = 6.067 \text{ billion rubles;}$$

$$\text{actual } \bar{G}_f = \frac{2(501.6-5\cdot 82)}{5\cdot 6} = \frac{183.2}{30} = 6.107 \text{ billion rubles,}$$

that is, the actual average annual increase in capital investments during the Ninth Five-Year Plan was above the planned.

Let us determine with these same conditions the average growth rate of capital investments. We have according to the plan $\bar{T} + \bar{T}^2 + \bar{T}^3 + \bar{T}^4 + \bar{T}^5 = 501/82 = 6.1098$. Hence, using the table of average parabolic rates for n = 5 given in the book of L. S. Kazinets, $\bar{T} = 1.067$.

In actual terms

$$\bar{T} + \bar{T}^2 + \bar{T}^3 + \bar{T}^4 + \bar{T}^5 = \frac{501.6}{82} = 6.117,$$

hence $\bar{T} = 1.068$, that is, above that envisaged in the plan.

Let us check the conformity of the average growth rate to the capital investments volume for the five-year plan and for this we determine the calculated levels of the series and add them up. We have: 87.576 + 93.531 + 99.891 + 106.084 + 113.938 = 501.62 billion rubles, that is, the error is 0.02 billion rubles, or 0.004 percent.

Let us formulate the problem differently. The capital investment volume carried out over the first 3 years of the Ninth Five-Year Plan was 281 billion rubles. What average annual increase and growth rate of capital investments must be ensured during the last 2 years of the five-year plan in order to carry out the 5-year plan? The capital investment volume over the last 2 years will be 220 billion rubles (501 - 281). The average annual absolute increase will be:

$$\overline{G}_{ap} = \frac{2(220-2 \cdot 98.7)}{2 \cdot 3} = 7.533 \text{ billion rubles,}$$

while the average annual growth rate will be

$$\overline{T} + \overline{T}^2 = \frac{220}{98.7} = 2.229,$$

hence $\overline{T} = 1.074$, that is, 107.4 percent. This means that for carrying out the five-year capital investment plan, during the remaining 2 years, the average annual growth rate must be increased by 0.7 percent in comparison with the planned.

As a consequence of the fact that the fulfillment of the capital investment plan for the five-year plan as a whole and not the achieving of a set level for its last year is of the greatest importance for the national economy, the designated methodology for calculating the average indicators of the time series assumes predominant significance for studying the dynamics and fulfillment of the capital investment plan. In instances when the intermediate levels of the series are of no importance in analyzing capital investment dynamics and the achieving of the end level, on the contrary, is seen as the chief condition of the economic problem, the indicators for the average absolute increase and growth rate must be figured, respectively, using the formula for the arithmetic average and for the geometric average.

§5. Incomplete Construction and Its Composition

The enormous, ever-growing scale of capital construction requires significant and annually increasing capital investments. Under the conditions of a protracted construction cycle, in the country's national economy a large number of incomplete buildings, installations, production capacity and other fixed capital objects is formed. The aggregate of incomplete and not operating projects and construction sites in planning, accounting and statistical practices is termed incomplete construction. The task for statistics is to work out the indicators describing the absolute amount of incomplete construction, its relative level and the conformity of the actual absolute and relative amounts of incomplete construction to the established plans and standards, to study the composition of incomplete construction and to detect and prevent the scattering of capital investments.

Incomplete construction is among the momentary indicators, that is, its absolute amount is determined as of a certain date, usually at the beginning (end) of a report period. The volume of incomplete construction can be expressed in physical and monetary units.

The accounting for incomplete construction in physical terms is carried out in various units of measurement the choice of which is determined by the aims and tasks of research. In form they are analogous to the units employed for describing the completion of projects. For general purposes the volume of incomplete construction is characterized by the number of sites or projects as of the end (start) of a report period. However, the significant conditionality of this measurement narrows the limits of its use. Information on the number of incomplete projects and sites is given in the reports in Form No 2-ks at the beginning and end of the report year and in the appendices to it.

The amount of incomplete construction is also expressed in units of production capacity, volume capacity or the dimensions of the buildings and structures under construction. For example, for industrial enterprises under construction this is expressed by the annual product output, for railroads and highways by their length, for housing by the total and net living area and so forth. The use of such physical measurements for summary indicators is restricted to structures of the same type.

In statistical and planning practices the most widespread is the indicator of incomplete construction in monetary terms, as this makes it possible to generalize data on any organizational and territorial level regardless of the degree of completeness of the projects. Incomplete construction in monetary terms is the actually used capital investments for construction projects which have been commenced but have not been completed to any degree or are in operation as of a certain date. usually in practice this cost indicator is simply termed incomplete construction. It characterizes only the capital investments into fixed capital created as a result of construction and does not encompass the expenditures on equipment outside of the construction estimates.

Incomplete construction can be expressed both in terms of estimated and actual cost for the builder. The latter estimate is established from bookkeeping data and differs from the estimated by the amount of expenditures (compensation and benefits above the estimated cost) which are formed because of changes in wholesale prices, wage rates and other circumstances not accounted for in the estimate.

Incomplete construction is determined primarily at the lowest element of a sector, the builder. However, the information contained in the builder's accounting on incomplete construction is not sufficient to establish its full volume. Because of the new forms of payment, the builder's accounting reflects only the portion of construction product represented by the value of the construction-installation work on work stages which have been completed and turned over to the clients. The remaining portion of the construction product, that is, the amount of work on incomplete projects, stages and groups of work, is shown in the accounting of the contracting construction organizations. Consequently, the full amount of incomplete construction can be obtained by adding up the two components: 1) the volume of capital investments accounted for by the builder for incomplete projects as of the report date, and 2) the amount of incomplete construction work accounted for on the balance sheet for basic operations of the contracting organizations as of the same date. The contracting organizations submit information on incomplete construction work to the builders each month in the statement of Form No 3.

In planning and statistical practices, an indicator is employed which describes the relative level of incomplete construction:

$$U_{OT} = \frac{\text{incomplete production at end of period}}{\text{volume of capital investments for period}} = \frac{U}{K}.$$

In this indicator, incomplete construction and capital investments are accounted for in the same prices, that is, according to the estimated cost or according to the actual cost for the builder. The relative level of incomplete construction is of no use determining for an individual construction site and particularly for a project. It gains economic importance only in assessing an aggregate of construction sites for builders (sector, department and so forth). In the dynamic comparisons it is essential to consider the dependence of the indicator upon the size of the period for which the capital investments have been taken. With an increase in this period the indicator declines while with a shortening of the period its amount rises. In practice most often incomplete construction is compared with the annual volume of capital investments.

Table II.4

Indicators	1975	1976	1977
1. Capital investments for year, billion rubles	102.3	105.1	108.7
2. Incomplete construction at year's end, billion rubles	76.7	84.1	92.4
3. Relative level of incomplete construction (line 2:line 1), %	75	80	85

In Table II.4, from an example of hypothetical data on capital investments and incomplete construction, the result has been shown of calculating the relative level of incomplete construction.

Incomplete construction represents an aggregate of diverse projects and sites which have not been completed for various reasons. For this reason a study of the composition of incomplete construction is an independent task for statistics. By grouping the projects, sites and builders it is possible to investigate the incomplete construction structure and disclose actual disruptions of the normal course of construction, the scattering of capital investments and other particular features of their use. The composition of incomplete construction can also be studied from the previously examined capital investment groupings (see §3, Chapter II). In addition, statistics recommends grouping them according to features showing the varying state of the construction projects and sites.

In terms of the state of production activities at the projects and sites the latter can be distributed into the following groups:

Projects under construction which encompass projects or sites where construction is underway. This group also includes the projects which have been put into operation but the acceptance statement has not been drawn up;

Temporarily halted construction. This includes projects and sites where construction and installation work has been halted temporarily upon instructions of the departments and construction organizations;

Mothballed construction is comprised of projects and sites where construction has been halted and financing ceased for an indeterminate time upon a ruling of the ministries, the USSR Council of Ministers or the Union republics and the projects have been mothballed;

Totally halted construction is comprised of projects the further erection of which is considered ill-advised for various reasons and all the expenditures made for these projects upon a decision of the departments are to be written off and are net losses for the national economy.

Of the above examined groups of incomplete construction, only the first one describes a normal state in capital construction. The presence of the last three groups within incomplete construction shows serious shortcomings in planning and designing.

In terms of the time for commencing construction, the aggregate of projects or sites is distributed into two groups: a) carryover from previous years, b) newly started in the given year. An analogous grouping of incomplete construction is made in terms of the time of completing construction and this also is comprised of two groups: a) nearly completed projects, that is, projects which are to be put in operation in the report year, b) construction of projects which is to be carried over to the following year. This grouping is employed in planning capital construction and in studying the supply of the sites with material and labor resources as well as financing. The composition of incomplete construction is further studied in terms of the length of construction, in terms of the degree of completeness and other featurs characterizing particular questions in the process of utilizing the capital investments.

Statistical information on incomplete construction is found in two basic sources: reporting and censuses. The statistical reporting on capital investments found in Form No 2-ks with the appendices to it in their annual version is a stable source of data. The program for this reporting provides information on the volume of incomplete construction in monetary terms broken down for the technological composition of capital investments and in physical terms for the individual groups characterizing the state of the projects and sites. Prior to 1968, in the aim of obtaining the data necessary for long-range planning, the USSR TsSU periodically carried out specially organized surveys (censuses) for incomplete construction in following very extensive programs.

§6. A Statistical Study of Plan Fulfillment, the Dynamics and State of Incomplete Construction

A task for statistical study of incomplete construction is a description of the conformity of its actual volume to the level set by the plan or norm. In the working out of capital investment plans by the departments, the volume of incomplete construction is set as an obligatory indicator and in practice this is called the production backlog. The volume and composition of the backlog are determined by the procedure set in the plan on the basis of standards which ensure the completion of the fixed capital at the dates stipulated by the plan. Here capital investments by the builder for the acquisition of equipment and machinery which are not part of the site estimates are not considered nor are the expenditures that do not increase the value of the fixed capital. The planned volume of incomplete construction also does not include expenditures on projects the erection of which has been temporarily or permanently halted or mothballed or those put into operation but without the proper documents drawn up.

The above-examined planning features should be considered in assessing plan fulfillment for incomplete construction and this can be characterized by a relative indicator, the index and absolute ratio of the planned volume, that is:

$$I = \frac{\Sigma q_1 p_{cm}}{\Sigma q_{p\ell} p_{cm}} \quad \text{and} \quad \Delta_u = \Sigma q_1 p_{cm} - \Sigma q_{p\ell} p_{cm},$$

where q and $q_{p\ell}$--capital work and acquisitions in physical units according to projects accounted for in incomplete construction on the report date actually and by the plan;

p_{cm}--estimated prices.

The plan fulfillment indicators for incomplete construction can be calculated without corrections for its actual volume and with adjustments of its amount in accord with the adopted planning procedure. In the first instance the indicator will reflect the influence of all the factors shaping the actual level of incomplete construction on the deviation from the planned. In the second instance, when the actual volume of incomplete construction is brought into accord with the adopted planning conditions (in terms of the composition of the projects and expenditures on them), its deviation from the planned volume will reflect the degree of conformity to the production backlog and thereby the support for the programs to complete capacity and fixed capital in the following report period. The specific interpretation of the plan fulfillment results in terms of incomplete construction is such that the overfulfillment of the plan, like its nonfulfillment, is considered a violation of planning and production discipline. In observing the established technology, the rational organization and rates of construction duration and with correct planning of the capital investment volume, the actual volume of incomplete construction should correspond to the planned backlog.

Let us give an example. Let us assume that for an oblast at the end of a report year the incomplete construction according to the plan is 228 million rubles (according to the estimated cost). Actually this indicator according to the data of Form No 2-ks on the same date reached 263.5 million rubles, including 17.3 million rubles for temporarily halted and mothballed construction, 2.4 million rubles for permanently halted construction and 16.7 million rubles for operable projects the completion of which has not been formalized. It is known that the expenditures which do not increase the value of fixed capital for the projects under construction on the report date equal 1.2 million rubles.

The percentage of plan fulfillment for incomplete construction without correcting its actual volume equals: $\frac{263.5}{228.0} \cdot 100 = 115.6$, that is, the production backlog was exceeded by 15.6 percent or by 35.5 million rubles.

The percentage of plan fulfillment for incomplete construction in accord with the adopted planning procedure equals:

$$\frac{263.5 - (17.3 + 2.4 + 16.7 + 1.2)}{228} \cdot 100 = \frac{225.9}{228} \cdot 100 = 99.1,$$

that is, the planned backlog for the end of the report year actually was not achieved.

The significant discrepancy between the first and second indicators for plan fulfillment points to the presence within incomplete construction of expenditures not related to the formation of a normal production backlog. The absolute amount of economically unjustified capital investments into incomplete construction is determined by the total expenditures not caused by production necessity, for example, expenditures on projects the construction of which has been temporarily or permanently halted, mothballed and so forth. In our example this amount is: 17.3 + 2.4 + 16.7 + 1.2 = 37.6 million rubles, or 14.2 percent (37.6:263.5). The difference of 100 - 14.2 = 85.8 percent characterizes the share of the production backlog which had actually formed by the year's end in incomplete construction.

Along with the volume and structural characteristics of incomplete construction, an important place in studying it is held by the indicators reflecting the state of completeness of the projects and sites. The overall completeness level of incomplete construction is reflected by the shares (by the proportional amount) of the actually completed construction volume for commenced and uncompleted projects and sites in the total construction volume needed to put them into operation. The indicators reflecting the completeness level of incomplete construction differ in their economic content and calculation methods. In practice two methods of calculating them are known, one of which is based on data on capital investments at the estimated cost and the second on data on normed labor expenditures. In the first instance the indicator is termed simply the degree of completeness and in the second, the degree of technical completeness.

For calculating the technical completeness of incomplete construction and the backlog, information is needed on the normed expenditures of working time not only for the project (site) as a whole but also for the individual parts of the project and types of construction-installation work. This information is far from always available in the design and estimate documents for the projects and sites and this significantly impedes the application of this method.

In statistical practices the most widespread are the indicators calculated using estimated cost since the builders, departments and statistical bodies have available all the initial data needed for the calculation by this method. The degree of completeness is calculated for the individual projects and sites as well as for the aggregate of projects and sites. The semantic and methodological differences of these indicators are caused by the fact that in certain instances a project has been used as the unit of observation (counting) and in others it has been the site as a whole.

If a project is adopted as the counting unit, then the degree of completeness is determined for the projects which are in incomplete construction on the report date. In instances when the site as a whole is used as the counting unit, the calculating of the indicator will also include the projects of the site which have either not been started at all or are already in operation. Let us examine the indicators of the degree of completeness and the methodology for calculating them using a hypothetical example of two construction sites in a rayon (Table II.5; thousand rubles of estimated cost).

Table II.5

Name of sites and projects	Full estimated cost	Capital investments made from start of construction	Fixed capital put into operation from start of construction	Incomplete construction at end of report year
I. Textile mill-- total	5,240	3,386	--	2,270
1) Main building	3,164	2,003	--	2,003
2) Boiler shop	1,116	1,116	1,116	--
3) Administrative building	960	267	temporarily halted	267
II. Motor pool-- total	3,782	2,997	--	460
1) Garage	2,537	2,537	2,537	--
2) Machine shop	1,245	460	--	460
Total for sites	9,022	6,383	3,653	2,730

Let us calculate the completeness indicators in which a project has been adopted as the counting unit.

$$\text{Degree of project's completeness} = \frac{\text{capital investments made from start of project's construction}}{\text{estimated cost of project}}.$$

We have: for site I, respectively, for the projects: No 1 $\frac{2003}{3164} \cdot 100 = 63.3$ %, No 2 100%, No 3 $\frac{267}{960} \cdot 100 = 27.8$ %;

For site II, respectively, for the projects: No 1 100%, No 2 $\frac{460}{1,245} \cdot 100 = 36.9$ %.

$$\text{Degree of completion of incomplete construction} = \frac{\text{Incomplete construction at end of report period}}{\text{Estimated cost of projects in incomplete construction}}.$$

We have: for site I $\frac{2,270}{3,164+960} \cdot 100 = 55\%$; for site No II $\frac{460}{1,245} \cdot 100 = 36.9\%$; for the two together $\frac{2,270+460}{3,164+960+1,245} \cdot 100 = 50.8\%$.

$$\text{Degree of completion of production backlog for projects} = \frac{\text{Backlog for projects under construction at year's end}}{\text{Estimated cost of projects under construction at year's end}}$$

We have: for site I $\frac{2,003}{3,164} \cdot 100 = 63.3\%$; for site II $\frac{460}{1,245} \cdot 100 = 36.9\%$; for the two sites together $\frac{2,003+460}{3,164+1,245} \cdot 100 = 55.9\%$.

Let us determine the completion indicators in which the site as a whole is used as the counting unit.

$$\text{Percentage of completeness of site (sites)} = \frac{\text{Capital investments since start of construction for all projects of the site (sites)}}{\text{Estimated cost of site (sites)}}.$$

We have: for site I $\frac{3,386}{4,250} \cdot 100 = 64.6\%$; for site II $\frac{2,997}{3,782} \cdot 100 = 79.2\%$; for the two sites together $\frac{3,386+2,997}{5,240+3,782} \cdot 100 = 70.7\%$.

In contrast to the first group, all the projects of the sites regardless of their state have been considered in the base of comparison (the denominator) for the indicators of the second group. For this reason they describe, in essence, the share of used capital investments in their total volume for building the entire fixed capital complex.

For analysis indicators are also calculated for the completeness of the sites in terms of the projects completed and put into operation. These include the completeness percentage of the site in terms of putting into operation and the coefficient for the output of end construction product; these can be determined for the individual sites and their aggregate.

$$\text{Percentage of completeness for putting site (sites) into operation} = \frac{\text{Estimated cost of projects put into operation}}{\text{Estimated cost of site (sites)}}.$$

This indicator expresses the share of the estimated cost of a site (sites) which is represented by completed projects. In the example it will equal: for site I $\frac{1,116}{5,240} \cdot 100 = 21.3\%$ and for site II $\frac{2,537}{3,782} \cdot 100 = 67.1\%$; for the two sites together $\frac{1,116+2,537}{5,240+3,782} \cdot 100 = 40.5\%$.

$$\text{Coefficient for output of end construction product} = \frac{\text{Estimated cost of projects put into operation}}{\text{Capital investments since start of construction}}.$$

In the example this indicator equals: for site I $\frac{1,116}{3,386} \cdot 100 = 33\%$ and for site II $\frac{2,537}{2,997} \cdot 100 = 84.6\%$; for the two sites together $\frac{1,116+2,537}{3,386+2,997} \cdot 100 = 57.2\%$.

The calculated indicator characterizes the share of capital investments made for the projects completed and put into operation.

In addition to the examined questions, the constructing of time series and the calculating of analytical indicators are part of the problem of a statistical study of incomplete construction. Indices hold an important place among these indicators. For calculating the index of the volume of incomplete construction, the same formula and methodological principles are employed as for the capital investment volume (see

Chapter II, §5). Here incomplete construction can be taken in terms of estimated cost and in terms of actual cost for the builder. In the first instance this will reflect the dynamics of the volume of incomplete construction and in the second, the dynamics of actual expenditures. In either instance it is essential to observe the conditions of comparability as was already mentioned in §5 of Chapter II. In particular, for eliminating the influence of the seasonal factor it is essential to compare the levels of incomplete construction on the same date.

In analyzing plan fulfillment and the dynamics of incomplete construction it is very important to bring out the reasons and influence of various factors on its deviations from the base conditions. In instances when these factors can be expressed by statistical indices correlated into a system of comultipliers, it is always possible to construct a system of factor indexes and on their basis to establish in absolute and relative terms the impact of each factor. For example, incomplete construction (U) can be represented as the product of the estimated cost of all the projects accounted for in incomplete construction (C) and the degree of its completeness ($F = U:C$), that is, $U = C \cdot F$. Hence the influence of a change in the total estimated cost of projects under construction on the change in incomplete construction can be determined from the formula $\Delta_C = (C_1 - C_0)F_0$, and the influence of a change in the degree of completeness of incomplete construction by the formula $\Delta_F = C_1(F_1 - F_0)$.

CHAPTER III. THE STATISTICS OF PUTTING CAPACITY AND FIXED CAPITAL INTO OPERATION

§1. The Tasks of Statistics for Putting Capacity and Fixed Capital into Operation

The completion of construction on enterprises, roads, canals, housing and other installations and their putting into operation are the ultimate aim of capital construction and, in particular, the use of capital investments. The decisions of congresses and plenums of the CPSU Central Committee, the sessions of the USSR Supreme Soviet and the governmental documents have repeatedly emphasized the enormous importance of the prompt completion of construction on the dates stipulated by the plan.[1]

The great attention shown by the party and the socialist state to the above-examined economic questions gives great importance to a statistical study of the completion of capacity and fixed capital. The range of statistical problems includes: the elaboration of the indicators which characterize the amount of completed capacity and other fixed capital projects in physical and monetary terms; the studying of the fulfillment of the plans for the completion of capacity and fixed capital and the dynamics of their volume; the elaboration of indicators for the construction time of fixed capital projects and installations; the carrying out of comprehensive analysis for the fulfillment of plans and the dynamics of completion in the aim of disclosing reserves for accelerating construction rates, reducing its cost and improving the quality.

Before moving on to an examination of these problems, it is essential to bring out the economic content of the completion of projects. In accounting and statistics completion is characterized by the fact of the concluding of construction on the projects and their installations and the putting of them into operation as fixed capital in accord with their purpose as provided by the plans. The designated level of completion means that at the given project or group of projects, the construction and installation work envisaged in the plans has been fully carried out, the technical and other production equipment has been installed and has been provided with the supplies, production tools and attachment envisaged in the estimate. For example, a grain elevator has been built, if all the construction work of erecting it is carried out, the production equipment installed, the supplies and other articles

[1] See: "Materialy XXV s"yezda KPSS" [Materials of the 25th CPSU Congress], Moscow, Politizdat, 1976, p 211.

envisaged in the estimate acquired and the utilities attached, the grain elevator is ready to receive and store grain.

In capital construction practices a distinction is made between complete and partial putting into operation. Complete putting into operation means that all the projects of the site envisaged in the plans have been completed and put into operation. Partial putting into operation means that the plans envisage different times for putting individual projects of the site into operation, for example, the starting up of a sulfuric acid shop before completing the construction of a superphosphate plant as a whole. In the power industry, the extracting, metallurgical and other industrial sectors, the completion of a construction stage is considered to be partial putting into operation and by this one understands the planned portion of the enterprise or group of installations which ensure the output of the product. For example, in designing the construction of thermal power plants, two, three and more construction stages are designated for the power units.

In the practice of constructing large industrial, transport, agricultural and other national economic enterprises it is far from always economically advisable to complete all the projects of the site by a single date in order to begin producing the product or operating the fixed capital. In designing an enterprise often provision is made within the projects of the site for a group of production projects in basic and auxiliary activities which ensure the production of the product under normal labor conditions. Such a group of projects at a site is termed the starting-up group and the finishing of its construction marks the putting of production capacity into operation.

The accounting for fixed capital which has been completed and put into operation, like capital investments, is carried out by the builder. In accord with the provisions of the Construction Standards and Rules on the procedure for accepting and putting buildings and installations into operation,[2] the projects which have beedn completed for construction and are ready to operate are submitted by the builders to the state acceptance commissions.

The statement of the state acceptance commission is the accounting document which varifies the fact that the project (group) is in operation. This statement is approved by the authority which appointed this commission. The date of signing the statement is officially considered the date for putting the project or group of fixed capital into operation.

Along with the putting of projects and groups into operation, in practice there are instances when at operating enterprises machinery and equipment which are not included in the construction plans and estimates are put into operation, for example, agricultural machines, means of transport, equipment requiring installation but designated for inventory (reserve). Such equipment is considered as put into operation as it is received at the operating enterprise. Here the entry of the equipment on the balance sheet of basic operations as fixed capital is considered to be the formal indication of its putting into operation.

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[2]See: "Construction Standard and Rule III-3-76," Moscow, Stroyizdat, 1977.

§2. Accounting for the Putting of Fixed Capital Projects into Operation in Physical Units

The putting of capacity and fixed capital into operation is the main indicator for the national economic capital investment plan. In order to assess the fulfillment of the plan for this indicator, it is essential to correctly determine the amount of fixed capital projects put into operation.

The amount of projects put into operation can be characterized in physical and monetary terms. Each of these methods of measuring the amount of completion is of independent significance in solving the economic problems of capital investment statistics.

An accounting of the putting of capacity and fixed capital projects into operation in physical units is essential for planning and supervising the observance of proportional development for the sectors in the production and nonproduction spheres of the national economy. For these purposes it is important to know in what amounts and at what pace capacity should be increased for the output of electric power, metal, motor vehicles, machine tools, agricultural machinery and so forth, how many highways and railroads must be built and have been built and how much housing, schools, hospitals and other nonproduction projects have been built. A physical accounting for putting into operation makes it possible also to run international comparisons.

In planning and statistics different scales and units of measurement are employed for physically expressing the completion of capacity. From the above-examined general provisions in the methodology for accounting for putting into operation it follows that the project, starting-up installation and site as a whole are the primary units of observation in the statistics for putting into operation. For precisely this reason in statistical practice these are also employed as a unit for measuring the amount of putting into operation in physical terms. In determining the summary data for putting into operation, the projects and enterprises are grouped according to features of sectorial purpose, departmental affiliation, size and other features adopted in the capital investment grouping (see Chapter II, §3). For example, according to the data of the USSR TsSU, in 1978, 230 new major state industrial enterprises went into operation.

Regardless of the simplicity and clarity of accounting for the putting of projects and enterprises into operation, it far from always provides an exhaustive description of the true amounts of completed construction, since the aggregates formed in the summary bring together enterprises which differ in terms of purpose, capacity, size and other features. More accurate information on the amount of putting into operation in physical terms is provided by measurements of production capacity, length, volume capacity and other consumer properties of the projects.

For expressing the capacity of production-end projects more often the annual (daily or shift) product output or the quantity of processed basic raw material in physical units is employed and more rarely this is done in cost terms. For example, the putting of capacity into operation for the production of iron, steel and rolled products is characterized by metal production over the year in tons, while the completion of capacity for producing sugar (granulated) is by beet processing per day in tons. For determining the amount of production capacity for a project or group to be put into operation, it is possible to adopt a certain technical parameter or directly use the capacity of the basic equipment, for example, the construction of a railroad or its electrification can be characterized by the length in kilometers or its daily traffic capacity, the completion of a power plant is expressed by its capacity in kilowatts and so forth.

For nonproduction-end projects and in a number of instances also for production-end ones, measurements for the volume and area of projects as well as indicators of their volumetric capacity are employed as physical units of measurement. For example, the construction volume of hospitals is characterized by their capacity, that is, by the number of beds, school construction is described by the number of student seats, theaters by the number of seats and so forth.

Since production- and nonproduction-end buildings are one of the predominant forms of product in construction, an opportunity arises to employ measurements of area and volume for a general description of putting into operation. This is also widely employed in practice. Thus, the capacity of buildings is characterized by their total and effective volume. The total volume is determined by multiplying the area bounded by the external perimeter of the building by its height from the floor of the first floor to the ceiling of the top story. In practice the indicators of the effective volume of a building are employed and this is the total volume of the basic and auxiliary spaces of the building, for example, in housing, the cubic volume of dwelling rooms and auxiliary quarters.

The area of buildings is measured in an analogous manner. A distinction is drawn between the built-up area which is bounded by the external perimeter of the building walls and the effective area which describes the inner area of the building without counting the stair landings, that is, the floor area of all stories of the buildings. In production buildings, the area of the space allocated directly for the production process is termed the production area; the putting of enterprises into operation in the machine building industry is often expressed in units of this area. As part of the effective area of housing, the dwelling area is considered apart, that is, the area of the dwelling rooms.

The accounting of completed projects in physical terms carries an element of some conditionality. For example, in adding up the production capacity for iron casting, we bring together, in essence, projects which are the same in terms of purpose but which differ in their design, size, in the composition of the projects and the amount of work performed. In permitting such conditionality, we are able to calculate general indicators for putting into operation in physical terms. Detailed information on the putting of capacity and fixed capital projects into operation is found in the statistical reporting on state capital investments in Form No 2-ks and the appendices to it.

§3. Indicators for the Amount of Fixed Capital Put into Operation

The accounting for putting into operation in physical terms, regardless of its importance, does not make it possible to fully carry out the statistical and planning tasks using general indicators. The cost of the projects is the sole all-incompassing measure of diverse construction projects making it possible to obtain general indicators. The putting of projects and sites into operation in monetary terms is usually called the putting of fixed capital into operation. Accounting in monetary terms makes it possible to establish the volume of fixed capital put into operation for any aggregate of builders and, consequently, to determine the summary indicators for plan fulfillment and dynamics on a varying organizational level and to obtain diverse general quality characteristics for the fixed capital put into operation.

The putting of fixed capital into operation in accounting and statistics is expressed both in terms of the estimated and the actual cost for the builder. The estimated cost is the base estimate which is used as the basis for determining the actual cost for the builder. This is kept in the summary estimate for the technical construction plans. The plans and the estimate contain information on the labor, material and monetary expenditures for construction as a whole and its individual projects. They reflect the socially necessary expenditures on construction and, consequently, the estimated cost of the individual projects and the site as a whole performs the function of the price for the fixed capital to be created.

A distinction is drawn between the estimated cost of a project and the site as a whole. For an individual project the full estimated cost and the so-called estimated construction costs are determined. The former reflects all the expenditures which are made directly in erecting and equipping the given project, considering the general site and other expenditures related to the entire site as a whole in a share proportional to the estimated construction cost of the project. The general site expenditures include the leveling of the construction site, the building of various utilities, the landscaping of the territory, the erection of temporary buildings and structurea and so forth. Most often in practice the estimated construction cost of a project is employed and this is set by the estimate as the total expenditures provided directly for its erection. These total expenditures are formed by the estimated cost of the construction work, the work of installing equipment, equipment and not requiring installation, attachments and supplies provided for in the estimate for the project.

The estimated cost for the fixed capital of the site as a whole is characterized by the expenditures on erecting the basic, auxiliary, service and temporary projects of the site as well as all general construction expenditures provided for in the summary estimate. This cost can be determined by adding up the estimated construction cost of all the projects, the general site expenditures, the expenses for the support of the administration and technical supervision and the estimated cost of design and research.

Let us give an example. Let us assume that we know the following data for a production association from the summary estimate for the construction of a footwear mill consisting of three projects (Table III.1). The general site work and expenditures on the mill are 146,000 rubles, expenditures for the support of the administration and technical supervision are 68,000 rubles, design and research are 184,000 rubles and the training of operating personnel is 152,000 rubles.

The estimated construction cost of each project is represented by the total of the table's corresponding column. The full estimated cost of the main building is:

Table III.1

Types of work and purchases	Construction projects, 1,000 rubles		
	Main building	Raw materials warehouse	Boiler plant and garage
Construction work	436	192	102
Installation work	87	19	114
Equipment requiring installation	643	134	193
Equipment not requiring installation	102	---	107
Production tools and supplies	18	2	4
Total	1,286	347	520

$$1,286 + (146 + 68 + 184) \cdot \frac{1,286}{1,286 + 347 + 520} = 1,286 + 398 \cdot \frac{1,286}{2,153} = 1,523,700 \text{ rubles;}$$

for the raw materials warehouse $347 + 398 \cdot \frac{347}{2,153} = 411,100$ rubles;

boiler plant and garage $520 + 398 \cdot \frac{520}{2,153} = 616,100$ rubles.

The full estimated cost for the fixed capital of the footwear mill is: $1,286 + 347 + 520 + 146 + 68 + 184 = 2,551,000$ rubles.

The volume of capital investments according to the estimate for the construction and putting of the footwear mill into operation is: $2,551 + 152 = 2,703,000$ rubles.

From the given example it follows that the estimated cost of the projects and the fixed capital of the mill as a whole does not include the so-called expenditures which do not increase the cost of the fixed capital (in this example, expenditures on personnel training), although these are carried out from the capital investments.

The expressing of the putting of fixed capital into operation according to the estimated cost makes it possible to characterize its physical volume and, consequently, to provide an estimate for plan fulfillment and dynamics for this indicator. However, in a number of instances when the estimated prices change in the course of construction, an important condition of the methodology is violated. The problem is that the capital investment volume at projects put into operation is accounted for by the builder in estimated prices of the corresponding years and namely, before the change, in the old estimated prices and after their change in the new ones. For this reason the total cost of the fixed capital put into operation in this instance in essence is a mixed estimate. Such a methodology ensures the commonness of the bookkeeping and statistical data on the estimated cost of fixed capital put into operation. But since these changes are reflected both in the plan and in the report, the estimate for the carrying out of the plan for putting fixed capital into operation is virtually not distorted.

But in studying the dynamics of this indicator, the designated features of the methodology for determining estimated cost complicate the calculating of indexes for the putting of fixed capital into operation and the compared levels of the time series. In order to obtain an estimated cost of the fixed capital calculated according to the uniform price methodology, in the program for the statistical survey (Form No 1-ef), the volume of capital investments (projects put into operation) used prior to the date of the change in the estimated prices is recalculated in new prices by the index for the estimated capital investment prices. The estimated price index in the given instance is determined by the relating of the new (recalculated) estimated cost of the capital investments remaining after the change in the prices to the estimated cost of the investments before the recalculation.

Let us give an example. Let us assume that initially the approved estimated cost for a textile mill which started construction in 1975 was 3.72 million rubles. As of 1 January 1976, the estimated cost was changed as a consequence of introducing new prices for equipment and the reduction factors. Prior to the change in prices, 1,246,000 rubles had been used on building the mill. The remaining total of capital investments was recalculated and considering the new prices and correction factors was 2,721,400 rubles.

In the report from the builder, the estimated cost of the mill put into operation (the mixed cost) was set at $1,246 + 2,721.4 = 3,967,400$ rubles. For the recalculation let us determine the estimated price index for the capital investments as a whole: $\frac{2,721.4}{3,720-1,246} = 1.1$. Hence the estimated cost of the mill in the new (recalculated) estimated prices will be: $1,246 \cdot 1.1 + 2,721.4 = 4,092,000$ rubles.

The initial data for recalculating the estimated cost of the projects are found only in the builder's figures. They do not exist in the statistical reporting.

After the completion of construction and the fixed capital is in operation, the actual cost for the builder is determined and this describes the real total of expenditures made by the builder in the construction period. The need to determine this is caused primarily by the fact that as a consequence of various circumstances the actually developing construction conditions differ from those envisaged in the plans and estimate. Consequently, the amount of the builder's expenditures is changed. The accounting for putting into operation at the builder's actual cost is also important for supervising the observance of estimate and financial discipline in construction as well as for establishing the full initial value of the fixed capital. For this reason in accounting and statistical practices, the actual cost for the builder is termed the inventory cost.

The inventory cost is usually determined for each project built and put into operation and is given in the statement of the state acceptance commission. For an individual project its amount can be represented as the total of the following three components: 1) The project's estimated construction cost; 2) the estimated expenditures related directly to the given project but not incorporated in its estimated construction cost; 3) the general site expenditures, compensation and benefits above the estimated cost, losses, the cost of temporary structures and other expenditures of a general construction nature considered in the proportional estimated construction cost of the project, with the exclusion of the expenditures that do not increase the cost of the fixed capital.

Let us calculate the inventory cost of fixed capital put into operation using the data in the example shown on page 48 supplemented by the following information: Compensation above the estimated cost for building the main building was 89,000 rubles and losses for construction as a whole were -21,000 rubles. Hence the inventory cost of the main building put into operation will be:

$$1,286 + 89 + (146 + 68 + 184 + 21) \cdot \frac{1,286}{2,153} = 1,625,300 \text{ rubles.}$$

The putting of fixed capital into operation is determined by the builder using actual and estimated costs on the basis of the established documents. The total volume of fixed capital put into operation is obtained by adding the following: a) The cost of the enterprises, starting-up complexes, installations, buildings and other projects which have been provided for in the plans and estimate and have been completed and put into operation (completely or partially); b) the cost of equipment and machinery acquired by operating enterprises, organizations and institutions outside the construction estimates (means of transport, agricultural machinery, equipment requiring installation but earmarked for reserves and so forth). In those instances when the acceptance statements have established uncompleted construction and installation work (unfinished work) and their cost has been given, then the full estimated or actual cost of the projects put into operation (the first component) should be reduced by the estimated cost of the unfinished work. If the projects or capacity are actually in operation but their putting into operation has not been formalized by the proper documents, then their cost is not to be included in the volume of fixed capital put into operation.

Using the data from builder reports, these statistical bodies on various levels determine the summary indicator for putting into operation the fixed capital which has been created and acquired by capital investments. At the same time according to the existing planning and financing procedures, fixed capital can be acquired and purchased also using other funds aside from capital investments (see 2, Chapter II). Consequently, in order to establish the full volume of fixed capital put into operation in a report period, it is essential to add the expenditures made on the creation and acquisition of fixed capital from funds of the state budget and other sources aside from capital investments to the value of the fixed capital put into operation from capital investments. Regardless of the seeming simplicity for determining the sought indicator, the methodology of calculating it in actuality encounters difficulties caused by the presence of expenditures which are only partially linked to the given volume of fixed capital put into operation (the plans for the layout and building up of residential districts and so forth).

Let us assume that in the preceding example it has become known that in putting the mill into operation, the statement of the state acceptance commission pointed to incomplete work and incomplete supply of production tools (according to the estimate) totaling 310,000 rubles. During the report year for the association, out of capital investments motor vehicles and machine tools were acquired for reserves (outside of the construction estimates) at prices envisaged in the plan and for a total of 624,000 rubles. In addition, equipment and supplies under Article 12 of the budget estimate worth 74,000 rubles were purchased for the vocational training school and the nursery. Then the volume of fixed capital put into operation (according to the estimated cost) from capital investments for the association as a whole will be in the report year 2,551 - 310 + 624 = 2,865,000 rubles, while the total volume of fixed capital put into operation from all financing sources will be 2,865 + 74 = 2,939,000 rubles.

Information on the putting of fixed capital into operation from capital investments will be found in statistical reporting in Form No 2-ks and the appendices to it. In these reports the data on the putting of fixed capital into operation are given in terms of estimated cost broken down for the sectorial purpose of the fixed capital projects and their structure and as a whole also for actual cost.

§4. Studying Plan Fulfillment and the Dynamics of Putting Capacity and Fixed Capital into Operation

The carrying out of the grandiose tasks to develop the Soviet national economy to a significant degree depends upon the successful implementation of the capital construction programs. The task for statistics is to thoroughly describe the result of plan fulfillment and namely to give a general estimate and disclose the structure for carrying out the plan for putting projects into operation, to disclose the reasons impeding the prompt and complete finishing of construction for capacity and projects and to disclose reserves for accelerating and reducing the cost of construction.

A most general notion of the studied question can be gained by determining the percentage of plan fulfillment for putting capacity and fixed capital into operation and the absolute deviations from the plan. The indicators calculated for data in physical units make it possible to disclose the material and physical content of fulfilling the plan for putting projects into operation. However the opportunity of obtaining general descriptions on the basis of physical measurements is extremely limited. An overall approximate estimate for plan fulfillment can be gained by comparing the number of projects actually put into operation (starting-up complexes, enterprises and so forth) with that provided in the plan during the report period. The conditionality of such an indicator is obvious as one is comparing aggregates which consist of projects which are extremely different in terms of purpose, size, capacity and other features.

The total percentage of fulfilling the plan for putting capacity into operation is calculated only for groups of projects and starting-up complexes which are the same in terms of purpose and functions performed and as expressed in uniform units of their capacity. For example, the fulfillment of the plan for putting into operation power plants, blast furnaces, rolling mills, housing and so forth is described in this manner. In determining the indicators for plan fulfillment it is essential to consider the capacity and the projects which are included only in the given aggregate of builders (a department, republic, economic region and so forth) and, naturally, those which were envisaged by the plan in the report period.

The methodology of calculating the relative and absolute indicators for the fulfillment of the plan for putting fixed capital into operation is analogous to the one examined above for capacity with the sole difference that in the given case the estimated cost of the projects put into operation is compared, that is:

$$I = \frac{\Sigma q_1 p_{cm}}{\Sigma q_{p\ell} p_{cm}} \text{ and } \Delta = \Sigma q_1 p_{cm} - \Sigma q_{p\ell} p_{cm},$$

where $q_{p\ell}$, q_1--the projects put into operation in physical units according to the plan and actually;
p_{cm}--estimated prices (estimated unit cost).

These indicators, in contrast to the ones examined above (in physical units), can be calculated for any aggregate of projects, starting-up complexes or builders (in terms of affiliation, sectorial jurisdiction, territorial placement and so forth) and, consequently, they are applicable for a general description of the fulfillment of five-year as well as annual plans in a running total. In turn, the high degree of commonness in these indicators raises a number of demands in terms of observing the comparability of the actual and planned amounts of fixed capital put into operation. The provisions of the methodology for calculating the indicator of plan fulfillment are given in the instructions on drawing up the plan and for filling out the statistical reporting forms. In particular, in observing the principle of comparability for the range of objects under study, the actual volume of fixed capital put into operation should include the projects (starting-up complexes and so forth) which are designated in the plan for the report period. However, in practice, for the purposes of encouraging accelerated construction, a deviation from this principle is permitted and namely the projects put into operation ahead of time are accounted for in the fulfillment of the plan but the plan itself is not changed here.

The builder is the primary element in which plan fulfillment is determined for completing capacity and fixed capital. Let us show a calculation of the designated indicators using the example of a production association for the report year (Table III.2).

Table III.2

Name of Projects	Putting of fixed capital into operation, 1,000 rubles of estimated cost			
	According to plan		Actual	
	Report year	Previous years	Total	Including ahead of time
Compressor station	286	---	274	---
Raw materials warehouse	--	---	212	212
Boiler plant and garage	1,314	1,314	1,298	---
Liquid fuel warehouse	118	---		
Model shop	--	310	280	---
Total	1,718	1,624	2,064	212

The percentage of fulfilling the plan for putting fixed capital into operation during the report year for the production association will be:

$$\frac{274+212+1,298}{1,718} = \frac{1,784}{1,718} = 1.038, \text{ or } 103.8 \text{ percent,}$$

which means the overfulfillment of the plan by 3.8 percent or 66,000 rubles (1,784 - 1,718). The calculated indicator is a balance one and it has been obtained as a result of adding the deviations from the plan for putting fixed capital into operation in the direction of overfulfillment (212,000 rubles) and nonfulfillment (-146,000 rubles), that is, 1,784 - 1,718 = 212 + (274 - 286)+(1,298 - 1,314) + (0 - 118); 212 + (-146) = 66.

The result of the calculation made can be used in analyzing the fulfillment of the plan for putting fixed capital into operation by the builder. Here it is important to draw attention to the total nonfulfillment of the plan at the expense of the cost of work provided in the estimate but not carried out at the project put into operation and because of the incomplete delivery of equipment. The nonfulfillment of this portion of the plans is the reason for the discrepancy in the estimated cost of projects put into operation according to the plan and the actual one. The cost of the unfulfilled work and undelivered equipment is usually indicated in the statement of the state acceptance commission but it can also be determined by calculation as the difference of the full estimated cost of the completed project as given in the plan and the estimated cost of the fixed capital actually put into operation for this project. In our example this amount will be (286 - 274) + (1,314 - 1,298) = 28,000 rubles.

The evaluation and analysis of fulfillment of the plan for putting fixed capital into operation for the aggregate of builders differ from the above-examined methodology in the more complicated calculations since in a summary description there are additional factors which are not of significance in evaluating the work of an individual builder. The task of summary analysis consists not only in an overall estimate of plan fulfillment but also elucidating the role of the component parts (deviations from the plan) characterizing the result of the specific organizational actions of the builders. From an example let us demonstrate the possibilities of summary analysis for the fulfillment of the plan to put fixed capital into operation on a departmental level (Table III.3).

The percentage of fulfilling the plan for putting fixed capital into operation for the department as a whole is determined by comparing the fixed capital actually put into operation and planned for the builders during the report year and that completed ahead of time with the volume of putting into operation according to the plan, that is,

$$\frac{21,472 + 1,793}{25,486} \cdot 100 = \frac{23,265}{25,486} \cdot 100 = 91.3 \text{ percent},$$

or the nonfulfillment of the plan by 2,221,000 rubles which is 8.7 percent.

In analyzing the overall result for fulfilling the plan for putting fixed capital into operation, it is advisable to determine its component parts formed from the deviations in the direction of an overfulfillment and nonfulfillment of the plan by each builder. For this let us separately add up the results of the same-sign deviations from the plan, that is, with the sign (+) and with the sign (-). In the example (col. 8) the volume of nonfulfillment of the plan for putting fixed capital into operation is: 1,694,000 rubles, that is, (1,015 + 679), while the volume of fixed capital envisaged by the plan but not put into operation is -3,915,000 rubles (-814) + (-1,601) + (-1,500). The total deviations equal the balance indicator, that is, 1,694 + (-3,915) = -2,221,000 rubles.

Table III.3

a Наименование застройщиков (завод)	b Ввод в действие основных фондов по плану в отчетном году, тыс. руб. сметной стоимости		c Фактически введено в действие основных фондов в отчетном году, тыс. руб. сметной стоимости			d Стоимость предусмотренных сметой, но не выполненных работ, тыс. руб. сметной стоимости		k Отклонение от плана ввода в действие (гр. 3 – –гр. 1 + + гр. 5)
	e всего	f в том числе предусмотрено впервые	g предусмотренных планом отчетного года: e всего	h в том числе впервые	i досрочно	e всего	j в том числе впервые по планируемым объектам	
	1	2	3	4	5	6	7	8
l Лакокрасочный	5 846	4 498	5 032	3 712	—	216	188	—814
m РТИ	2 550	2 550	2 485	2 485	1 080	65	65	1 015
n Удобрений	9 842	6 222	8 241	4 694	—	118	45	—1 601
o Сангигиены	5 600	4 236	4 100	4 100	—	136	136	—1 500
p Пластмасс	1 648	—	1 614	—	713	34	—	679
q Всего	25 486	17 506	21 472	14 991	1 793	569	434	—2 221

Key: a--Name of builders (plant); b--Putting of fixed capital into operation according to plan in report year, 1,000 rubles of estimated cost; c--Fixed capital actually put into operation in report year, 1,000 rubles of estimated cost; d--Cost of work envisaged in estimate but not carried out, 1,000 rubles of estimated cost; e--Total; f--Including planned for first time; g--Envisaged in plan of report year; h--Including for first time; i--Ahead of time; j--Including for the first time for planned projects; k--Deviation from plan for putting into operation (col. 3 - col. 1 + col. 5); l--Paint; m--Industrial rubber products; n--Fertilizers; o--Sanitary-hygiene; p--plastics; q--Total.

The absolute deviations from the plan can be shown in a relative expression if they are compared with a common base, that is, with the amount of fixed capital put into operation according to the plan. In the example, we have:

$$\frac{-3{,}915}{25{,}486}\cdot 100+\frac{1{,}694}{25{,}486}\cdot 100 = \frac{-2{,}221}{25{,}486}\cdot 100; \quad -15.3+6.6 = -8.7 \text{ percent.}$$

From the analytical calculations it can be concluded that, as a consequence of the early putting of the projects into operation, the overall plan fulfillment was increased by 6.6 percent and because of the nonfulfillment of the plan by individual builders this was reduced by 15.3 percent. This led to an overall nonfulfillment of the plan for putting fixed capital into operation of 8.7 percent for the department.

In using the accounting data of the builder, it is possible to go further in analyzing the fulfillment of the plan for putting fixed capital into operation. In particular, in possessing information on the composition of the projects and starting-up complexes completed in the report period, similar to that given in cols. 2, 4, 5, 6 and 7 of Table III.3, it is possible to disclose additional component elements in the deviation from the plan and thereby disclose certain common factors for this phenomenon and the force of their action which are of importance for managing the department's activities. A balance sheet comparison of the composition of the planned and actual completion of fixed capital lies at the basis of this analytical calculation.

The composition of the fixed capital put into operation (q) in capital construction planning practices includes, in the first place, the cost of the projects the completion of which is envisaged for the first time in the plan (a), and secondly, the cost of projects the completion of which was planned for previous years (b). The actual putting of fixed capital into operation is formed from the same component parts and, in addition, it can also include projects put into operation ahead of time (c). Under the conditions of scientifically sound planning and normal production operations in capital construction, the putting of fixed capital into operation should consist solely of the first group of projects. The presence of projects from the second group shows violations in planning, designing and construction. The actual putting of fixed capital into operation can also deviate from what was established by the plan by the value of the work provided for in the estimate for the projects but not carried out as well as by the cost of undelivered equipment, tools and supplies also envisaged in the estimate (d).

Let us solve the posed analytical problem in a general form. For this in addition to the previously indicated let us adopt the following index designations:

Δ_a and Δ_b--the estimated cost of projects not put into operation in report period and included, respectively, in the plan for the first time and repeatedly;

d_a and d_b--the estimated cost of incomplete work for projects put into operation in the report period and included, respectively, in the plan for the first time and repeatedly.

By the symbols "0" and "1" we will designate, respectively, the plan and report data. Let us represent the putting of fixed capital into operation by the component parts needed for analysis. According to the plan we have $q_0 = a_0 + b_0$, and actually

$$q_1 = a_1 + b_1 + c_1 = (a_0 + \Delta_a + d_a) + (b_0 + \Delta_b + d_b) + c_1.$$

In the given algebraic expression, the deviations from the plan (Δ_a, Δ_b, d_a, d_b) theoretically can be accepted as both positive and negative values. However, in practice these deviations can either equal zero (the plan was fulfilled by 100 percent) or characterize the nonfulfillment of the plan, that is, assume negative values. The overfulfillment of the plan, that is, the early putting into operation, in the given expression is represented by an independent, always positive value (c). Let us subtract the planned from the actual indicator and let us regroup the terms into a combination which makes economic sense. Here it is essential to bear in mind that depending upon the quantity of data, the problem of analyzing the fulfillment of the plan for putting fixed capital into operation can be carried out with a varying degree of detailing. Let us show several variations.

The first variation:

$$q_1 - q_0 = [(a_0 + \Delta_a + d_a) + (b_0 + \Delta_b + d_b) + c_1 - (a_0 + b_0)] =$$
$$= (\Delta_a + \Delta_b) + (d_a + d_b) + c_1 = \Delta + d + c_1.$$

In this instance, Δ characterizes the full estimated cost of the projects envisaged in the plan but not put into operation during the report period; d expresses the overall estimated cost of the work envisaged in the estimate but not carried out and the undelivered equipment, supplies and so forth for the projects put into operation; c_1--the cost of the projects completed ahead of time and put into operation. These component parts of the overall deviation from the plan can easily be determined: c_1 is the total of col. 5, d is the total of col. 6, while $\Delta = (q_1 - q_0) - c_1 - d$, that is, [-2,221 - 1,793 - (-569)] = 3,445,000 rubles.

The second variation:

$$q_1 - q_0 = (\Delta_a + d_a) + (\Delta_b + d_b) + c_1 = h_a + h_b + c_1.$$

In this expression, $h_a = \Delta_a + d_a$ characterizes the overall estimated cost of fixed capital not put into operation (completely and partially) for projects the completion of which is planned for the first time, $h_b = \Delta_b + d_b$--the overall estimated cost of fixed capital not put into operation (completely or partially) for projects the completion of which was already planned in previous years, that is, for them the first planned date for the completion of construction has already been passed. In the example, the absolute value h_a which is a part of the deviation from the plan is defined as the difference between the actual and planned putting of fixed capital into operation for the projects envisaged in the plan for the first time, that is, col. 4 - col. 2, or h_a = 14,991 - 17,506 = -2,515,000 rubles, while the absolute amount h_b is determined from the example's data as (the total of col. 3 - col. 4) - (result of col. 1 - col. 2), that is:

$$h_b = [(21{,}472 - 14{,}991) - (25{,}486 - 17{,}506)] = -1{,}499{,}000 \text{ rubles.}$$

The third, most developed variation for analyzing the fulfillment of the plan for putting fixed capital into operation for the aggregate of builders is represented by five components which make economic sense:

$$q_1 - q_0 = \Delta_a + \Delta_b + d_a + d_b + c_1.$$

Regardless of the fact that all the remaining parts of the general deviation from the plan are simple indicators, they can be directly determined only from the accounting data of the builders. In our example, there are no direct data for each of the five components but they can be obtained by calculation. We will determine the value of Δ_a if, from the total value of the fixed capital envisaged in the plan for the first time but not put into operation ($h_a = \Delta_a + d_a$) equal to -2,515,000 rubles (14,991 - 17,506) we subtract the value of the work envisaged in the estimate but not carried out (d_b) with this cost being a component part of the overall deviation and equal to (-434,000 rubles) (col. 7), that is, (-2,515) - (-434) = -2,081,000 rubles.

The total cost of projects not put into operation but repeatedly provided for in the annual plans (Δ_b) can be determined by subtracting from the expression $h_b = \Delta_b + d_b$ the value d_b which is also a component part of the general deviation. The value of d_b is obtained as the difference of the total of col. 6 and col. 7, that is, (-569) - (-434) = -135,000 rubles. Hence Δ_b = (-1,499) - (-135) = -1,364,000 rubles.

Thus, in our example, the complete breakdown of the total deviation for the component parts is as follows:

$$-2,221 = (-2,081) + (-1,364) + (-434) + (-135) + 1,793.$$

A study of the dynamics of the volume of putting capacity and fixed capital into operation is an independent problem in statistics. In solving it, statistics discloses the scale and rate of fixed capital reproduction, the role of capital construction in this and its impact upon the development of the material and technical base of all national economic sectors.

The time series and indexes (growth rates) provide an overall notion of the change in the volume of putting capacity and fixed capital into operation over time. The methodology for calculating the relative indicators for the dynamics of the amount of putting capacity and fixed capital into operation is not fundamentally different. In particular, the volumes for the fixed capital put into operation for comparable periods in calculating the index and in the time series should be expressed in the same estimated prices, usually in the current ones (see §3, Chapter III). In this indicator it is essential to consider all the projects which have been completed and put into operation and which relate to the given aggregate, regardless of the adopted planning procedure. Depending upon the set task, it is essential to also consider the other statistical requirements for the comparability of time series levels (comparability in terms of the unit of measurement for capacity, territorial, departmental and methodological comparability).

The dynamics of putting capacity and fixed capital into operation, like the fulfillment of the plan for these indicators, is better described in various aspects, and namely within the limits of construction as a national economic sector, from capital investments, for fixed capital created and acquired from all financing sources, that is, capital investments, the state budget and the personal funds of the public taken together. An evaluation of plan fulfillment and the dynamics of putting fixed capital and capacity into operation in statistical practices is made in a breakdown for the major capital construction groupings in terms of economic purpose and national economic sectors, areas of fixed capital reproduction, according to affiliation and the territorial placement of the builders, according to forms of ownership and others.

§5. The Statistical Study of the Duration and Intensity of Construction

Important statistical characteristics for construction are the indicators for the duration and intensity (rate) of carrying out the process itself. A rise in the intensity and a shortening of the construction time have a direct impact upon increasing the volume of capacity and fixed capital put into operation, on lowering the cost of erecting the projects and on increasing capital investment effectiveness. The task for statistics is to elaborate a system of indicators which characterize the duration and speed of construction both for the individual projects, enterprises and so forth as well as on an average basis for their aggregate. There must also be a methodology for determining the impact of these indicators on capital construction effectiveness.

A solution to this problem requires a clarification of the concept of the construction duration. The overall calendar time of the entire investment cycle, from the start of research to the moment of complete operational readiness of the project or enterprise (starting-up complex) characterizes the duration of construction. This period encompasses the time of research, designing, construction, installation and the starting up of equipment, that is, the putting of the project into operation. The time of construction work is considered to be the most important, crucial period in the investment cycle, that is, the period from the moment (day) of starting construction work in the preparatory period to the putting of the project, capacity or enterprise as a whole into operation. The duration of construction is viewed precisely in this sense in planning and statistical practice.

The duration of construction can be accounted for in days, weeks, months and years. In practice a distinction is made between the normative, design, planned and actual length or duration of construction. The normed duration of construction is set from standards approved by the USSR Gosstroy (Construction Standards 440-72). The design and planned duration of construction is determined on the basis of approved standards. Statistics records the actual duration of construction.

The date for the actual start on construction is set by a bilateral statement of the builder and general contractor. The date the state commission signs the statement for putting the project (enterprise) into operation is considered to be the end of the construction period.

In solving many questions related to capital construction planning and statistics the need arises to determine not only the duration for erecting individual projects, starting up complexes and enterprises but also the average length of construction for their aggregate. Regardless of the seeming simplicity in solving this problem, in 1972-1974, on the pages of the journal VESTNIK STATISTIKI there arose a major discussion over the methodology of determining the average duration of construction.[3] This made a number of important scientific clarifications for selecting the type of average and for elucidating the tasks to be carried out using various types of averages.

For a general description of the length of construction, statistical theory recommends the calculating of several types of averages for the given aggregate of projects. These averages differ not only in the method of calculation and numerical value but chiefly in their economic meaning, the essence of which also determines the choice of the problems for their use. Let us take up certain types of averages for the duration of construction, illustrating their calculation from the example of building reinforced concrete products plants (Table III.4).

From the data in Table III.4 it is possible to determine the arithmetic average and the harmonic average, both simple and weighted. As the "weights" it is possible to use the capacity or cost of the plants. A multiple-valued solution to the problem confronts statistics with the need for scientifically establishing the choice of the type and method for calculating the average duration of construction. Here,

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[3]VESTNIK STATISTIKI, No 9, 1972, Nos 6-9, 1973; No 4 and 8, 1974.

Table III.4

Plant number	Annual plant capacity, 1,000 m^3 of products (N)	Estimated cost of plant, 1,000 rubles (Q_p)	Duration of plant construction (T)		Rate of plant construction (V)	
			Months	Years	1,000 tons per month	Months per 1,000 tons
1	60	1,200	26.4	2.2	2.27	0.44
2	90	2,020	38.4	3.2	2.34	0.43
3	140	2,600	43.2	3.6	3.24	0.31

along with other provisions, it is important to consider the requirements of statistical theory about the homogeneity of the units in the aggregate in relation to the feature to be averaged, the presence of a goal for which the average is being determined, the economic sense of the formula for calculating it and their conformity to the determining property of the average.

Let us calculate the average duration of plant construction in years using the formula of the simple arithmetic average (see the designations in the table), that is,

$$\bar{T}_a = \frac{\Sigma T}{n},$$

where n--the number of plants (projects).

$$\bar{T}_a = \frac{2.2 + 3.2 + 3.6}{3} = \frac{9}{3} = 3 \text{ years.}$$

In this average, the determining property is expressed by the total calendar duration for erecting the three plants. This means that a simple arithmetic average can be employed for solving problems in which it is essential to establish the total duration of building the projects. In other words, it characterizes the average duration of construction from the technical and organizational aspects. This average will make sense only for an aggregate of projects (plants) which are uniform in terms of capacity, cost, composition and other features, since in the given instance the construction project itself and not its consumer property is the measurement of the aggregate.

The average duration of construction calculated for the formula of the arithmetic capacity-weighted average in the example equals:

$$\bar{T}_{ab} = \frac{\Sigma TN}{\Sigma N} = \frac{2.2 \cdot 60 + 3.2 \cdot 90 + 3.6 \cdot 140}{60 + 90 + 140} = \frac{924}{290} = 3.2 \text{ years.}$$

Calculating an average using this formula has the following economic sense: the numerator describes the conditional product output by the plants over all the years of their construction (if the duration is expressed in months and not in years, then capacity and duration will be measured by different units of time), while the denominator gives the total annual capacity of the plants. After dividing this produces an average duration of plant construction. In contrast to the simple arithmetic average, this calculated average is oriented at a different determining property, that is, at the total product output by all plants during the years of their construction. For this reason the given average can be employed in economic calculations where it is essential to determine product losses or its additional output as a consequence of the extending or reducing of construction times. This method for calculating the average duration of construction is frequently applied in planning.

If in the formula for the weighted arithmetic average the estimated cost of the enterprises is used as the "weights," then the formula for the average is difficult to interpret economically. Its numerator ΣTQ_p does not directly express any economic concept, as is not the case in the previous instances. The absence of a clear economic sense does not make it possible to formulate the conditions of the problem in the solution to which the arithmetic average weighted for estimated cost could be applied. However, what has been stated does not completely exclude the use of this average.

The average duration of construction using a formula for a simple harmonic average in our example equals:

$$\overline{T}_h = \frac{n}{\sum \frac{1}{T}} = \frac{1+1+1}{\frac{1}{2.2}+\frac{1}{3.2}+\frac{1}{3.6}} = 2.87 \text{ years.}$$

This average will make sense if all the projects in the aggregate are of the same type. Under the conditions of our example, like a simple arithmetic average, its use is not applicable due to the heterogeneity (in terms of capacity) in the studied aggregate of new construction sites. It is oriented at a number of simultaneously erected projects and, consequently, is applicable in problems which take this condition into account.

The harmonic average for the duration of construction when weighted for plant capacity in the example equals:

$$\overline{T}_{hw} = \frac{\Sigma N}{\sum \frac{N}{T}} = \frac{60+90+140}{\frac{60}{2.2}+\frac{90}{3.2}+\frac{140}{3.6}} = \frac{290}{94.3} = 3.1 \text{ years.}$$

The economic sense of calculating the average using this formula is obvious. This average is related to the total amount of plant production capacity put into operation and this is also its determining property and, consequently, the chief condition for the economic problems solved with its aid. The designated method for calculating the average duration of construction has been adopted in the practice of the USSR TsSU.

For calculating the weighted harmonic average, it is possible to proceed from the estimated cost of the projects (enterprises). In the example, such an average will equal:

$$\bar{T}_{hw} = \frac{\Sigma Q_p}{\sum \frac{Q_p}{T}} = \frac{1\,200 + 2\,020 + 2\,600}{\frac{1\,200}{2.2} + \frac{2\,020}{3.2} + \frac{2\,600}{3.6}} = \frac{5\,820}{1899.9} = 3.06 \text{ years.}$$

In contrast to the previous one, the obtained average is oriented at the total volume of capital investments for building all the enterprises. This is also its determining property which is the main condition of the problems solved by the given average. In the practices of the USSR TsSU, this average is calculated in instances when it is necessary to determine the average duration for projects having a different unit of measurement for capacity. The use of various methods for calculating the average duration of construction in planning and statistical practices complicates a comparative evaluation of the construction results. For this reason an important conditions for the comparability of the average actual construction times with the design, planned and normed ones is a uniform methodology for determining the averages. A clear formulation of the conditions for the economic problem must be considered an essential prerequisite for correctly choosing the type of average.

In analyzing the duration of construction it is advisable to compare individual projects, starting-up complexes, enterprises as well as their various groups for this indicator. For this the actual length of construction is ordinarily compared with that approved by the plan and the normed and in addition the last two indicators are compared between each other. In this manner the absolute and relative deviations are calculated as is shown in Table III.5 using the example of three chemical fiber plants.

Table III.5

Plant number	Full capacity actually put into operation, 1,000 tons of fiber per month	Length of construction, months		Deviation of actual length of construction from planned	
		Planned	Actual	Months	%
1	10	36	41	5	114
2	15	42	45	3	107
3	20	48	50	2	104
Average		43.3	46.3	3	107

Information on the length of construction for enterprises and their production capacity can be used for determining the amount of conditional losses in product output as a consequence of exceeding the construction times of the plants. The solution to this problem is provided by the capacity-weighted arithmetic average which is calculated in the table. As is seen from the calculations, the average actual duration of plant construction (46.3 months) was increased in comparison with the average planned length (43.3 months) by 3 months or 7 percent. The amount of losses as a consequence of extending the construction times is obtained by multiplying the total volume of production capacity for the enterprises under construction (calculated per unit of time as adopted for expressing the duration of construction) by the deviation of the average length of construction, that is,

$Q = N\Delta\overline{T}_{ab}$. In the example this is $3 \cdot 45 = 135{,}000$ tons of chemical fiber. The same amount can be obtained by a direct calculation ($10 \cdot 5 + 15 \cdot 3 + 20 \cdot 2 = 135$).

To a certain degree the duration of construction is a synthetic indicator the amount of which is influenced by numerous factors related to construction work, the organization and designing of enterprises, the area of their construction and so forth. The use of statistical groupings in factor analysis for the duration of project and enterprise construction makes it possible to establish in a general form the nature of its dependence upon the individual factors, for example, upon the amount of production capacity (Table III.6), its composition by projects, technical and design features of the projects, territorial placement and so forth. A more thorough study of the duration of construction can be carried out on the basis of correlation regression analysis making it possible to measure the closeness of the link of the resulting and factor features as well as to obtain multifactor models for the construction duration of the projects.

Table III.6

Plant groups by production volume	Capacity actually put into operation, 1,000 tons of product per year		Total length of construction, months		Rate of construction, capacity in 1,000 tons per month		Growth rate for speed of construction
	a	b	a	b	a	b	
Small	50	55	41	37	1.22	1.49	1.22
Medium	75	85	45	42	1.67	2.02	1.21
Large	100	120	50	48	2.00	2.50	1.25
Total	225	260	136	127	1.65	2.05	1.24

Key: a--Previous five-year plan; b--Current five-year plan

In a statistical study of the duration of construction, the characteristics of the intensity or speed of carrying out this process are of importance. The indicator for the rate of construction is expressed by the amount of capacity put into operation per unit of time (the direct value of the speed or rate), that is, $v = N/T$. These indicators can be calculated not only for individual projects but also for groups of projects which are similar in terms of the features of purpose or amount of capacity, design and production solutions and so forth (see Table III.6).

The methodology for calculating the average speed of construction for projects does not differ from the one examined for individual projects. The table gives an example of building bakeries in a republic during the current (report) and previous (base) five-year plans.

Information on the duration of project construction is contained in the builder's accounting documents (the statement of the state acceptance commission) as well as in a number of statistical reports (forms No 8-ks, 1-ef and others) and in the planning documents (title lists of the projects and the intrasite title lists).

§6. The Relationship of the Basic Indicators in Capital Construction Statistics

In a statistical study of capital construction, various indicators are employed which reflect the process of fixed capital reproduction. From the viewpoint of importance there stands out the group of basic indicators which most fully describe the results of this sector's operations in fixed capital reproduction. These include: the putting of capacity and fixed capital into operation, capital investments and incomplete construction. An isolated evaluation of capital construction results from the basic indicators at the present level of statistical economics analysis is insufficient and a comprehensive and systematic approach to solving this problem is required. An elucidation of the relationships between the basic capital construction indicators also creates a theoretical premise for employing a statistical methodology in an integrated analysis of the processes occurring in the use of capital investments, their distribution and concentration, and in ensuring the fulfillment of quotas related to the putting of fixed capital and production capacity into operation.

The relationship between the basic capital construction indicators is expressed in various forms. Under present-day conditions, the balance relation and the ratios of the basic indicators have assumed the greatest importance. On the basis of the balance method it is possible to construct several schemes for the relationship of the indicators using data in physical and cost terms. In the first instance this will be a balance for the number of construction sites the simplest scheme of which is shown in Table III.7.

Table III.7

Resources	a	b	Distribution	a	b
1. Construction sites on hand at year's start ($r_{a/s}$)	372	695.2	1. Sites put into operation in report year (r_o)	151	241.6
including starting-up	123	196.8	including starting-up	138	224.6
2. Newly commenced sites in report year (r_{new})	164	262.4	2. Sites on hand at year's end ($r_{a/e}$)	385	716.0
including starting-up	37	59.2	including starting-up of report year	22	34.4
Total	536	957.6	Total	536	957.6

Key: a--Number of construction sites; b--Full estimated cost of sites, million rubles

The relationship of the indicators in this balance can be represented by the expression $r_{a/s} + r_{new} = r_o + r_{a/e}$. For the purposes of analysis, the positions of the balance can be differentiated. For example, the total number of construction sites at the beginning of the period is represented by groups formed in terms of the features of the state of the construction sites, the dates of their beginning and completion, purpose, cost and so forth. From the data of a multiposition balance it is possible to determine the indicators for the structure of the total number of sites in the report period in the aim, for example, of disclosing the dispersion or concentration of capital construction and other tasks. In the example the share of the number of starting-up projects in the total number of those in operation during the year was 29.9% $\left(\frac{123+37}{536}\cdot 100\right)$, while the share actually put into operation was -25.7% $\left(\frac{138}{536}\cdot 100\right)$, that is, it declined. In turn, the share of the number of projects not complete at the year's end rose in comparison with their number at the beginning of the year, respectively, from 69.4 to 71.8 percent. The nonfulfillment of the quotas for putting starting-up projects into operation and the increase in the absolute and relative expression of incomplete construction show a dispersion of capital investments.

On the basis of this same scheme, it is possible to construct a balance for the sites in terms of the full estimated cost. Its difference from the balance in physical terms consists solely in the cost orientation of the same balance positions and this makes it possible to unite them in one table (see Table III.7). This balance solves analogous problems but now in a cost aspect. This makes it more homogeneous and eliminates the conditionalities related to the numerous different features of the projects and sites. The structure indicators worked out from the data of the cost balance more accurately reflect the existing conditions in the capital construction proportions. Thus, in the example, the proportional amount of sites at the year's start according to the estimated cost is 72.6 percent and this is higher than the proportional amount of the number of construction sites (69.4 percent). This shows the presence of larger sites in the composition of incomplete construction at the year's start than in the composition of the newly commenced ones.

The capital investment balance[4] is of independent significance and it can be constructed both in terms of the estimated cost (Table III.8) as well as in terms of the actual. The relationship of the cost indicators for capital construction in it is characterized by the expression $U_s + K_c = V_c + C + U_e$. The scheme for the capital investment balance can be modified on the basis of the previously examined groupings and this will make it possible to study the structure of incomplete construction, capital investments and putting of capacity into operation as well as obtain ratios for these indicators reflecting the particular features of the capital construction process.

The second form for a quantitative expression of the relationship for the basic capital construction indicators is characterized by their ratios in the form of relative units of plan fulfillment, intensity and so forth. Under the actually existing conditions of deviation from the plan, each basic indicators can have a varying direction and value and this creates a number of variations each of which leads to certain economic conclusions. Here, as a consequence of the balance link between the indicators, the levels of fulfillment and the directions of their deviations from the plan cannot develop arbitrarily and this must be considered in

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[4] In the given case it is a question of a statistical balance and not a bookkeeping one.

Table III.8

Resources	million rubles	Distribution	million rubles
1. Incomplete construction at year's start (U_s)	326	1. Fixed capital put into operation over year (V_c)	278
2. Volume of capital investments carried out over year (K_c)	284	2. Written off by established procedure (C)	14
		3. Incomplete construction at year's end (U_e)	318
Total	610	Total	610

analyzing the fulfillment of the capital construction plan. For example, if the capital investment plan in the report year has not been fulfilled, then under no conditions is it possible to fulfill or overfulfill the plan for putting fixed capital into operation or the plan for the incomplete construction on hand at the year's end simultaneously.[5]

On the basis of the examined capital construction cost indicators it is possible to calculate intensity indicators and in particular to construct three pairs (direct and inverse) of relative values:

$$\frac{K}{V} \text{ and } \frac{V}{K}\ ; \quad \frac{V}{U_c} \text{ and } \frac{U_c}{V}\ ; \quad \frac{U_c}{K} \text{ and } \frac{K}{U_c}\ ,$$

where V--the volume of fixed capital put into operation over the report period;
K--the volume of capital investments over the report period;
U_c--incomplete construction at the end of the report period.

Since each pair of relative values (direct and inverse) in essence reflects the same relationship of economic phenomena, in the system of indicators it is enough to examine one indicator of each pair. One of the properties of this sysyem of indicators is that the product of the three relative values for intensity equals one, that is:

$$\frac{K}{V}\cdot\frac{V}{U_c}\cdot\frac{U_c}{K} = 1 \quad (1), \quad \text{or} \quad \frac{V}{K}\cdot\frac{U_c}{V}\cdot\frac{K}{U_c} = 1. \quad (2)$$

This property makes it possible to use it primarily for control purposes in checking the correct calculation of the indicators.[6] Each of the three indicators in this system has a specific economic sense and at the same time can be viewed as the normed amount of one basic capital construction indicator in relation to the second.

[5]It is assumed that the plan and its actual fulfillment have been determined in accord with the planning and statistical principles.

[6]Below we will use formula (1).

As a consequence of the balance relation in the basic capital construction indicators, the relative values of intensity cannot assume arbitrary values and this makes it possible to use them in elaborating norms, in particular for incomplete construction.

The relative indicator expressed by the value $\frac{K}{V}$ characterizes the ratio of the value of all material, labor and financial expenditures going to the reproduction of fixed capital during the given period and the amount (value) of fixed capital which has completed construction in this period and gone into operation. Under the conditions of simple and even fixed capital reproduction this amount equals one. However, in actuality, these conditions do not occur as socialist production is expanded production and the projects being created differ in terms of the duration and cost of construction and for other features. Here one group of factors, for example, technical progress and industrialization of construction, tend to reduce this indicator, while another, for example an increase in the capital investment rate or a greater number of large projects with a long completion date, leads to the growth of this indicator. For this reason the amount of the ratio will be greater or less than one depending upon what production conditions have been dominant in the report period.

The relative indicator expressed by the value $\frac{V}{U_c}$ characterizes the ratio of the amount of assets circulating in the national economy in the form of fixed capital and the amount of assets tied up by the end of the given period in forming the capital construction backlog. An increase in this indicator or the maintaining of it on the previous level, in following the planned conditions and growth rates for the capital investment volume, means successful capital construction activities.

The relative indicator expressed by the amount $\frac{U_c}{K}$ characterizes the ratio of assets diverted for fixed capital reproduction at the end of the period and the amount of capital investments used in the given period. This indicator which is calculated for an annual period can be conditionally interpreted as the average duration of utilizing the assets (in years) as embodied in incomplete construction at the year's end. In practice this same indicator is adopted as the normed value in planning calculations.

The above-examined relationships can be employed in factor index analysis and in regression correlation analysis of capital construction activities.

CHAPTER IV: THE STATISTICAL STUDY OF CAPITAL INVESTMENT ECONOMIC EFFECTIVENESS

§1. Basic Areas in the Statistical Study of Economic Effectiveness

The enormous scope of capital construction being carried out in our nation puts in the forefront the problem of increasing capital investment effectiveness. The decisions of the 25th CPSU Congress state that "in capital construction the basic task is to increase capital investment effectiveness and to ensure the further growth and quality improvement of the fixed capital, the rapid completion and development of new productive capital in all the national economic sectors by improving planning, designing and the organization of construction work, shortening the time and lowering the cost of construction.[1]

Statistics has been confronted with the important task of working out a system and methodology for the indicators characterizing the levels of the actual economic effectiveness of capital investments into national economic fixed capital. The importance and timeliness of this task are determined by the need of monitoring the achieving of the efficiency levels set in the designs and plans, by the need for a scientific basis for the normed and planned effectiveness indicators and by the importance and the analysis of the disclosure of reserves for raising capital investment effectiveness. The task of statistics is also to improve the observation of the actual capital investment effectiveness, in particular sampling surveys of individual enterprises and production complexes.

In the statistical study of capital investment effectiveness it is advisable to differentiate two areas which have independent systems of indicators and various evaluation criteria. One area encompasses the aggregate of indicators reflecting the effectiveness of the reproduction cycle in which capital investments operate as an element of society's expenditures in the expanded reproduction process and expresses the national economic aspect of their effectiveness. For this reason in the given instance the increase in national income (net product) as well as the product or profit created as a result of applying the fixed productive capital into which the funds were invested is adopted as the economic effect from the capital investments.

The other area unites the indicators which characterize capital investment effectiveness as expenditures in a specific national economic sector, that is, construction, and thereby reflects the sectorial aspect of effectiveness. In this instance the

[1]"Materialy XXV s"yezda KPSS," p 211.

end result of production activities in the given sector, that is, the completion of construction and the putting of fixed capital into operation, is the economic effect from the capital investments made in capital construction. A study of the effectiveness of construction work and design-research activities comprises independent component parts of this area.

§2. A Statistical Study of the Economic Effectiveness of Capital Investments in the National Economic Aspect

The economic effectiveness of capital investments, in being viewed within expanded socialist reproduction, reflects the national economic approach to solving the given problem. For this reason, the indicators and methodology in a statistical study of actual capital investment effectiveness are based upon the common theoretical principles given in the Standard Procerdure[2] and which are required in the calculations and establishing of capital investment effectiveness in all national economic sectors. Let us examine these indicators and the methodology of calculating them.

Capital investment effectiveness is expressed by the ratio of effect and expenditures. Here a distinction is drawn between the indicators for the overall (absolute) and comparative capital investment effectiveness. The indicators for overall capital investment effectiveness for the national economy, its sectors and the Union republics are calculated using the formulas:

$$Z_{ca} = \frac{\Delta D}{K} \quad \text{or} \quad T_{ca} = \frac{K}{\Delta D},$$

where Z_{ca}--the coefficient for the overall (absolute) capital investment effectiveness;
T_{ca}--the capital intensiveness or capital-output ratio of national income;
ΔD--the increase in the annual volume of national income (net product);
K--capital investments causing an increase in national income (net product).

For the individual sectors and types of production in industry, transportation, agriculture and so forth as well as for the ministries and departments, if net product is not calculated for them, the economic effectiveness of capital investments can be determined on the basis of profit using the formulas:

$$Z_{cp} = \frac{\Delta P}{K} \quad \text{or} \quad T_{cp} = \frac{K}{\Delta P},$$

where Z_{cp}--effectiveness coefficient;
T_{cp}--the repayment time of capital investments;
ΔP--the increase in annual profit;

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[2]See: "Tipovaya metodika opredeleniya ekonomicheskoy effektivnosti kapital'nykh vlozheniy, utverzhdennaya 8 sentyabrya 1969 g. Gosplanom SSSR, Gostroyem SSSR i AN SSSR" [Standard Procedure for Determining Economic Effectiveness of Caiptal Investments as Approved on 8 September 1969 by the USSR Gosplan, the USSR Gosstroy and the USSR Academy of Sciences], Moscow, Ekonomika, 1969.

K--capital investments into building production-end projects causing an increase in profit.

The overall economic effectiveness of capital investments into the construction of individual enterprises as well as for individual measures is determined on the basis of profits using the formulas:

$$Z_{cp} = \frac{W-C}{K} \quad \text{or} \quad T_{cp} = \frac{K}{W-C},$$

where Z_{cp}--effectiveness coefficient;
T_{cp}--repayment time for capital investments;
W--the value of annual product output according to the plans (in enterprise wholesale prices);
C--the costs of annual product output.

In instances when the enterprises operate at a planned loss, the effect is characterized by the savings established as a result of reducing product costs as a consequence of employing the given capital investments.

The comparative economic effectiveness of capital investments is characterized by a comparison of different variations of new construction and reconstruction of existing enterprises. The minimum adjusted expenditures is the indicator for the highest comparative effectiveness for capital investments into different construction variations. The latter expressed the total current expenditures and capital investments adjusted for the same unit. In terms of the production volume per year the adjusted expenditures are determined using the formula $P_e = C + E_n K$ and for the capital investment repayment time using the formula $P_r = K + T_n C$,

where E_n--the normed effectiveness coefficient;
T_n--the normed repayment time. For the national economy these are equal, respectively, to 0.12 and 8.3 years.

In the formulas for the adjusted expenditures, the costs of the product and capital investments for projects which are equal in capacity are set in the full amounts and for different-capacity projects in the form of proportional expenditures per unit of product. In instances when the compared variations differ not only in terms of construction times but also in the distribution of the share of capital investments over the years and current expenditures change over time, the need arises of adjusting these expenditures made at different times to the initial moment of time by multiplying them by the reduction factor $B = \frac{1}{(1+E_n)^t}$, equal to 0.08 for the national economy as a whole, where t--the period of the reduction time in years.

The designated indicators of the Standard Procedure for Determining Economic Effectiveness have been well worked out for the stages of construction designing and planning. However, the direct application of these same indicators in studying actual captial investment effectiveness encounters difficulties related to obtaining the initial data and mainly to observing the demands of their statistical comparability, for example, in terms of the object of observation (the aggregate of enterprises, measures and so forth), in terms of the time of making the capital investments and obtaining an effect, in terms of the methodology of prices and calculating the cost indicators and so forth. At present these difficulties have been partially overcome and statistical theory and practice possess a methodology for measuring the level of actual economic effectiveness for capital investments.

In 1973, the Capital Construction Administration of the USSR TsSU and the USSR TsSU Scientific Research Institute for the first time worked out a "Procedure for the Statistical Study of Capital Investment Economic Effectiveness." Since 1974, the USSR TsSU using this procedure has begun each year to make one-shot samplings of the actual economic effectiveness of capital investments into industrial production capacity which has been put into operation. Subsequently the system of indicators employed by the statistical bodies like the work itself of conducting the samplings have been improved and enlarged.

The repayment (recoverage) time and the effectiveness coefficient of capital investments are among the basic indicators reflecting the level of actual capital investment effectiveness. The former indicator characterizes the length of the period during which the total actually earned profit reaches the amount of the actually made capital investments. The latter indicator expresses a relative amount characterizing that portion of the actually used capital investments which on an annual average has been repaid out of profit. This amount is inverse to the length of time for capital investment repayment. Thus, in determining actual effectiveness one considers the actually obtained profit and not its fixed amount as is done in design and planning calculations.

The economic sense of the actual effectiveness indicators predetermines the area of their application and the particular features of the methodology involved in calculating them. The actual repayment time of capital investments is directly determined for the individual enterprises and production capacity which have already been paid off in the operating period. In the instances when the capital investments have not been repaid, it is possible to determine only the anticipated date of their repayment. The methodology for calculating the actual repayment date differs also depending upon the nature of construction and the procedure for putting the capacity and projects into operation. The least conditionality is permitted in calculating the indicators for the actual effectiveness of new construction sites while the greatest is permitted for reconstruction and expansion of existing enterprises with their partial putting into operation. Let us take up the individual fundamentally important provisions of the methodology.[3]

It is recommended that the capital investment repayment time be expressed in years but shorter units of time are also possible. The overall formula for calculating this indicator is as follows:

$$T_i^f = T_i' + T_i + T_i'' ,$$

[3]"Metodika statisticheskogo izucheniya ekonomicheskoy effektivnosti kapital'nykh vlozheniy" [Procedure for a Statistical Study of Capital Investment Economic Effectiveness], Moscow, NII TsSU SSSR, 1973.

where T_i'--the duration of the enterprise's operation during the year it was put into operation (in years);
T_i--the number of the enterprise's complete operating years during the period of repaying the capital investments;
T_i''--the duration of the repayment period during the year this is completed (in years).

The amounts of time T_i' and T_i'' are insignificant and as a total they comprise not more than 2 years. However, the determining of them provides the greatest difficulty in calculating the recovery time. One of the existing methods for establishing these component parts consists in the following. The amount T_i', as a portion of the first operating year, is obtained by dividing the number of months the enterprise operates during this year (T') by 12, that is, T':12. The second component part of the recovery time (T_i'') is also expressed in years and is determined proportionately to the profit during the year the recovery is complete, that is, according to the formula:

$$T_i'' = \frac{K - \Sigma P_t}{P_r},$$

where ΣP_t--total profit (including losses) over the period from the putting of the enterprise into operation to the year of recovery;
P_r--profit during the year of recovery.

In the aim of eliminating the influence of prices in calculating the repayment time, the initial data, that is, the capital investment volume and the profit, are expressed in fixed prices, namely: capital investments, including unfinished work, according to the estimated cost, and profit according to data on commodity product and its costs in prices in effect during the survey year. For this, for recalculating commodity product and costs into comparable prices, the chain price indexes for each year of recovering the capital investments are employed.

The expected time for the recovery of capital investments (T_i^0) is calculated from the formula:

$$T_i^0 = T_i' + T_i^n + T_{rem},$$

where T_i^n--the number of complete years during the enterprise's operation to the critical moment of the survey, that is, the date at which the survey was made;
T_{rem}--the conditional duration of the period after the critical moment of the survey to the end of the recovery period.

Since the amount of T_{rem} is calculated on the basis of a fixed profit level usually for the last year of the enterprise's operation, the expected time for recovering the capital investments assumes a certain conditionality. The greater the value of T_{rem} the greater the indicator's conditionality. This part of the recovery time can be calculated by the formula

$$T_{rem} = \frac{K - \Sigma P}{P_s},$$

where ΣP--total profit over enterprise operating period after being put into operation (including losses);
P_S--profit in survey year.

Let us give an example which illustrates the calculating of the designated indicators. Let us assume that for an administration in the woodworking industry we know data on the construction and operation of three sawmills (Table IV.1):

Table IV.1

	Завод 1: сметная стоимость 5200 тыс. руб., годовой выпуск 115 тыс. м³, ввод в действие 28 апр. 1973 г. (a)		Завод 2: сметная стоимость 4600 тыс. руб., годовой выпуск 110 тыс. м³, ввод в действие 1 окт. 1973 г. (b)		Завод 3: сметная стоимость 3400 тыс. руб., годовой выпуск 87 тыс. м³, ввод в действие 26 авг. 1973 г. (c)	
	(d) Прибыль в сопоставимых ценах, тыс. руб.					
	за год (e)	нарастающим итогом (f)	за год (e)	нарастающим итогом (f)	за год (e)	нарастающим итогом (f)
1973	530	530	670	670	—170	—170
1974	840	1 374	1 102	1 772	452	282
1975	1 120	2 486	1 748	3 520	763	1 045
1976	1 960	4 450	2 110	5 630	824	1 869
1977	2 370	6 820	2 356	7 986	906	2 775

Key: a--Plant 1: Estimated cost of 5.2 million rubles, annual output 115,000 m^3, put into operation on 28 April 1973; b--Plant 2: Estimated cost of 4.6 million rubles, annual output 110,000 m^3, put into operation 1 October 1973; c--Plant 3: Estimated cost 3.4 million rubles, annual output 87,000 m^3, put into operation 26 August 1973; d--Profit in comparable prices, 1,000 rubles; e--For year; f--In running total

The capital investment repayment time was:

for Plant 1

$$T_i^f = \frac{8}{12} + 3 + \frac{5,200-4,450}{2,370} = 0.67 + 3 + 0.32 = 4.0 \text{ years;}$$

for Plant 2

$$T_i^f = \frac{3}{12} + 2 + \frac{4,600-3,520}{2,110} = 0.25 + 2 + 0.51 = 2.8 \text{ years.}$$

For Plant 3 the expected capital investment repayment time is determined since over the years of its operation the capital investments have not been repaid. We have:

$$T_i^0 = \frac{4}{12} + 4 + \frac{3,400-2,775}{906} = 0.33 + 4 + 0.69 = 5.0 \text{ years.}$$

Correspondingly, the coefficients for actual capital investment effectiveness equal: for Plant 1 $\frac{1}{4} = 0.25$, or 25 percent; for Plant 2 $\frac{1}{2.8} = 0.357$, or 35.7 percent; for Plant 3 $\frac{1}{5} = 0.2$ or 20.0 percent.

Let us compare the calculated indicators between themselves and with the equivalent normed (design) indicators of capital investment effectiveness. In the example, for Plant 2 the capital investments are recovered the most rapidly of all and, consequently, they have been most effectively used.

The above-examined indicators are directly employed for expressing actual capital investment effectiveness for individual enterprises. However, statistics is confronted with the equally important task of obtaining general indicators which characterize expenditure effectiveness for the aggregate of enterprises and capacity. This problem can be solved by various methods. First of all the sought answer is provided by the coefficient for the overall (absolute) capital investment effectiveness as recommended by the Standard Procedure. However, in practice its computation is very difficult due to the impossibility of determining net product for the groups of enterprises and production projects the capital investment effectiveness of which has been determined as well as due to the complexity of realizing the principle of comparability of effect and expenditures. The actual coefficient for absolute capital investment effectiveness can be determined only for the national economy as a whole by comparing the increase in national income over the year with the capital investments of the report or another previous year. In an analogous manner it is possible to calculate the actual effectiveness coefficient on a basis of the annual increase in profit for the national economy as a whole and for its sectors. These two indicators with great conditionality characterize the level of actual capital investment effectiveness since the capital investments of neither the report year nor any other year adopted as the basis of comparison in practical terms are used in fixed capital projects completed during the report year. At the same time these factors are not an obstacle in studying the dynamics of capital investment effectiveness on the basis of the same indicators.

A general description can be provided on a basis of the average actual capital investment repayment time (the actual effectiveness coefficient) calculated by the formula:

$$\overline{T}_i^n = \frac{\Sigma T_i N}{\Sigma N},$$

where T_i--the recovery time of capital investments at an individual enterprise;
N--production capacity of an individual enterprise.

From the data of the example, the average capital investment recovery time for the three enterprises will be:

$$\overline{T}_i^n = \frac{4 \cdot 115 + 2.8 \cdot 110 + 5 \cdot 87}{115 + 110 + 87} = \frac{1,203}{312} = 3.9 \text{ years}.$$

A general indicator for actual capital investment effectiveness can also be determined using the formula of the weighted harmonic average, that is,

$$\overline{T}_i^K = \frac{\Sigma K}{\Sigma \frac{K}{T_i}} = \frac{\Sigma K}{\Sigma \overline{P}},$$

where $\underline{K}$--capital investments into enterprise;
$\overline{P}$--average annual profit over period of recovering capital investments for enterprise.

The actual average recovery time for this formula for the three plants as a whole will be:

$$\overline{T}_i^K = \frac{5,200 + 4,600 + 3,400}{\frac{5,200}{4} + \frac{4,600}{2.8} + \frac{3,400}{5}} = \frac{13,200}{3,667} = 3.6.$$

The average repayment time calculated in this manner differs from the indicator obtained using the formula for the arithmetic average. But this does not mean that either indicator describes the phenomenon incorrectly. Both the first and second indicators make economic sense. The first indicator is oriented at the overall volume of product output over the capital investment repayment period while the second is focused on the total capital investment volume for the three enterprises as a whole. From the economic content of the averages derive also the conditions for applying one or another indicator. For example, if the first indicator (the arithmetic average) can be calculated only for a group of similar enterprises, the second indicator (the harmonic average) theoretically can be applied to any economically analyzable aggregate of enterprises since the average is oriented to a cost indicator. In instances when the analysis and conclusions are linked to product output, the repayment time must be calculated as the weighted arithmetic average, but if the study of effectiveness is linked to the capital investment volume, then the harmonic average must be calculated.

As a general indicator it is possible to determine the level of capital investment recovery describing in percent the portion of capital investments recovered by profits in the total amount of investments, that is:

$$L = \frac{\Sigma P_i \cdot 100}{\Sigma K},$$

where P_i--enterprise profit over the repayment period in percent of capital investments used for its construction.

In the example the capital investment recovery level for the enterprises as a whole was:

$$L = \frac{5,200 + 4,600 + 2,775}{13,200} = \frac{12,575}{13,200} = 0.953, \quad \text{or} \quad 95.3 \text{ percent.}$$

In the indicator's numerator, the profit obtained over the years of operation has been added up as follows: for Plants 1 and 2 within the limits of their estimated cost (as already repaid) and for Plant 3, fully, since its repayment time is not over. This indicator has a limit of 100 percent which means the full recovery of the capital investments. This can be calculated for any aggregate of enterprises and projects, for example, for a sector's enterprises which have been put into operation in individual years, in a five-year plan and so forth.

The rate of capital investment recovery can serve as a description which complements an assessment of actual capital investment effectiveness. This is expressed by the indicators:

$$v_k = \frac{\Sigma K}{\Sigma T_i} \quad \text{or} \quad \ell_k = \frac{\Sigma T_i}{\Sigma K}.$$

The first of them describes the average total capital investments recovered in a unit of time (in a year) while the second reflects the time required as an average for recovering a cost unit of capital investments. These can be calculated both for individual enterprises and also for their aggregate. In the example the rate of capital investment recovery for the three enterprises as a whole was:

$$\ell_k = \frac{4+2.8+5}{5.2+4.6+3.4} = \frac{11.8}{13.2} = 0.89 \text{ year per million rubles put into operation;}$$

$$v_k = \frac{13.2}{11.8} = 1.12 \text{ million rubles put into operation per year.}$$

The indicators for the rate of capital investment recovery can also be used in factor index analysis of actual effectiveness. For example, if the actual capital investment recovery time is viewed as the product of the rate of recovery (ℓ) and the volume of capital investments, that is, $T_i^f = \ell K$, then the influence of each of the two factors on the change in the basic indicator (Δ) in an absolute expression can be determined respectively from the formulas $\Delta_\ell = K_1(\ell_1 - \ell_0)$ and $\Delta_k = \ell_0(K_1 - K_0)$, where $\Delta = \Delta_\ell + \Delta_k$.

By this method it is possible to study the influence of the factors on the change in the basic indicator both in comparing individual enterprises as well as for an aggregate of enterprises as a whole which have been put into operation in different periods (years, five-year plans) as well as separately for new construction sites and existing enterprises which are being reconstructed and expanded. Here in the latter instance the total length of capital investment recovery of all the enterprises in the aggregate is used as the general index.

§3. A Statistical Study of the Economic Effectiveness of Capital Investments in Construction

A study of economic effectiveness in the process of utilizing capital investments in the investment sphere is a general description of the result of production activities in capital construction as a national economic sector. The indicators of capital investment effectiveness in this sector in terms of their economic content differ from the analogous indicators of the national economic aspect (see §2), but their constructive form remains in the form of the relationship of effect and expenditures.

The economic goal of capital construction consists in the creation and putting into operation of production capacity and other fixed capital projects. This is the end product of the sector, its economic effect which undoubtedly can be adopted in measuring the capital investment effectiveness level in construction.

The general indicator which expresses the end effect of the sector is the volume of fixed capital put into operation (in terms of the estimated or actual cost) and which has been created solely in the construction sphere. The cost of acquired production equipment and supplies outside the construction estimates should not be included in this indicator. The expenditures allocated for the creation of fixed capital, depending upon what aspects of effectiveness are being studied, can be represented by the capital investment volume over the period, by the incomplete construction, by the amount of all advanced funds or by other indicators. The actual capital investment effectiveness in construction is characterized by a series of indicators among which the most essential are the proportional capital investments, the rate of their turnover, the construction lag, the coefficient for the output of end construction product and certain others.

Proportional capital investments are a widespread indicator in designing, planning and statistical practices. These describe the average amount of expenditures (capital investments) for creating a unit of production capacity at new enterprises or an increase in capacity at an existing enterprise which is being reconstructed or expanded, or per unit of size (capacity, length) of a fixed capital project. The economic sense of the indicator predetermines its purpose. It can be applied not only in evaluating sectorial effectiveness but also in the national economic effectiveness of capital investments.

Proportional capital investments are calculated using the formula

$$K_{pr} = \frac{K}{N},$$

where K--the capital investments for creating the given fixed capital complex (project);

N--production capacity, volumetric capacity, length and so forth of the given complex (project).

In practice a distinction is made between the normed, design, plan and actual proportional capital investments. In terms of principles the methodology of calculating them differs only little. The differences are only in the initial data for calculating the proportional capital investments. Let us examine the particular features of calculating the actual indicator. The numerator in the formula for this indicator is the volume of capital investments according to actual cost for the builder considering expenditures on incomplete work for the fixed capital complex (project) put into operation. The denominator of the indicator's formula expresses the amount of production capacity actually put into operation or the amount of a certain consumer value of the project. Actual product output cannot be used as the denominator as this changes the economic content of the indicator. The indicator's economic sense allows its computation only for instances when the construction site has been completed and full designed capacity reached.

The sense of the indicator will change somewhat depending upon the method for expressing completion. If the production capacity put into operation is expressed by product output over a stipulated period (ordinarily for a year), then the proportional capital investments, along with the construction conditions, will also reflect the enterprise's operating conditions figured in the plans (the number of shifts and so forth). When the fixed capital complex put into operation is characterized not by product output but rather by capacity (a school), by length (a canal or road) or by power (a power plant), then the proportional capital investments will reflect the effectiveness of the design solution and construction work as well as the production equipment manufactured by industry. For these reasons the indicator calculated as the ratio of the value of fixed capital and the product actually produced over the period describes the effective use of fixed capital (its operation) and not the capital investments into the investment sphere.

Proportional capital investments are determined both as an individual indicator for a project, capacity, enterprise and so forth as well as a general indicator for their aggregate formed for types of production, sectors and so forth. As a general one this indicator is calculated by dividing the actual cost of the fixed capital put into operation by the total capacity (volumetric capacity, length and so forth) of the same type of projects for this capital. For planning purposes norms have been worked out for proportional capital investments for the building of individual projects and new enterprises, for the reconstruction and expansion of existing enterprises as well as consolidated standards for types of production and sectors as a whole. These norms are applied not only in capital investment planning but also in the analysis of their effectiveness.

In practice, along with the designated indicators, on the sectorial level proportional capital investments are also determined per ruble of product increase over an established period (usually a year). Thus, this indicator for machine building and metalworking as a whole has declined from 1.2 rubles in 1966-1970 to 1.17 rubles in 1971-1975 while for electric power over this five-year plan it increased from 3.8 rubles up to 4.08 rubles.[4] However, it must be remembered that the given indicator expresses not only capital investment effectiveness in construction but also the degree of fixed capital utilization during the period of its operation.

As an illustration of the methodology for calculating proportional capital investments and certain analysis procedures let us examine the example of enterprises in the building materials industry. Table IV.2 gives the initial data and a calculation of proportional capital investments for the individual plants. The actual proportional capital investments per ruble of annual product output for the sector's enterprises as a whole will be:

$$K^{f}_{pr} = \frac{64,650}{28,873} = 2.24 \text{ rubles};$$

according to the plan the proportional capital investments equal:

$$K^{p}_{pr} = \frac{200\cdot 68 + 90\cdot 263 + 24\cdot 235 + 5\cdot 4,050}{28,873} = \frac{63,160}{28,873} = 2.19 \text{ rubles}.$$

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[4]See: A. Belyakov, "Capital Construction in the Tenth Five-Year Plan and the Tasks of Statistics," VESTNIK STATISTIKI, No 7, 1976.

Table IV.2

Plants	Annual production capacity: 1,000 tons of product	Annual production capacity: In wholesale prices, 1,000 rubles	Capital investments, 1,000 rubles	Proportional capital investments, rubles: Actual (col. 3: col. 1)	Proportional capital investments, rubles: Plan	Deviation, rubles
	1	2	3	4	5	6
Prefabricated reinforced concrete	200	11,600	14,200	71	68	3
Building materials	90	5,046	24,600	273	263	10
Installation stock	24	2,982	5,800	242	235	7
Aluminum structural elements	5	9,245	20,050	4,010	4,050	-40
Total	--	28,873	64,650	--	--	--

The actual and planned proportional capital investments are always intercomparable. In the example for the three plants there is an exceeding of the design standards and this shows a decline in capital investment effectiveness. As a whole for the four plants there has been an overexpenditure of funds in building new enterprises and this has reduced their effectiveness for the sector by 0.05 ruble per ruble of product (2.24-2.19).

The proportional capital investments can be calculated as particular indicators for individual consolidated types in the technological composition of the capital investments corresponding to the specific stages of the investment process. For example, proportional capital investments into design and research activities, into construction work and into manufacturing production equipment. Since the plans (norms) give analogous data, there is an opportunity by a comparison with the actual particular indicators to analyze capital investment effectiveness.

The deviation of the actual average sectorial proportional capital investments from the planned (normed), like the dynamics of these indicators, depend upon changes in the individual indicators (K_{pr}) and the capacity structure for the enterprises or their groups $d_N = N/\Sigma N$. The influence of one or another factor can be determined, respectively, by indices for proportional capital investments of a fixed composition and the influence of structural shifts, that is:

$$\frac{\Sigma K_{pr_1} d_{N_1}}{\Sigma K_{pr_0} d_{N_0}} = \frac{\Sigma K_{pr_1} d_{N_0}}{\Sigma K_{pr_0} d_{N_0}} \cdot \frac{\Sigma K_{pr_1} d_{N_1}}{\Sigma K_{pr_1} d_{N_0}} .$$

Of significant interest for practice is an elucidation of the influence of a change in the proportional capital investments on the overall amount of capital investments the relationship of which can be expressed by the product of the capacity of the enterprise under construction (N) and the proportional capital investments, that is, $K = K_{pr}N$. Hence, on the basis of index calculations it is easy to determine the influence of each individual factor, namely: due to a change in the proportional capital investments this amount equals: $\Delta K_{pr} = N_1(K_{pr_1} - K_{pr_0})$ and due to changes in production capacity or $\Delta N = (N_1 - N_0)K_{pr_0}$. The absolute amount of the change in capital investments with the "-" sign describes a savings and with a "+" sign an overexpenditure. In the example, the influence of an increase in the actual proportional capital investments in comparison with the planned led to an increase in their total volume by 1,443,700 rubles, 28,873(2.24-2.19).

Capital investment effectiveness in construction can also be characterized by the turnover of the investments in the investment sphere by which one understands the rate of "converting" the capital investments into projects that are fully completed and ready for normal operation. The number of turnovers of capital investments in a given period and the average length of one capital investment turnover can serve as indicators describing capital investment turnover.

The number of capital investment turnovers over a studied period (n) is determined by the ratio of the value of the fixed capital put into operation during this period (V) to the average balance of incomplete construction over the given period ($\overline{U}$), that is, $n = V/\overline{U}$. The numerator of the formula shows the fixed capital put into operation and which has been produced solely in the capital construction sphere as well as considering the expenditures written off in the report period in the established procedure (abandoned work and so forth). The average carryover of incomplete construction is determined according to the formula of the chronological average. Either indicator should be expressed in the same prices: either at the estimated cost or at the actual cost for the builder.

Let us give an example. Let us assume that in the rayon during the report area ore mining fixed capital was put into operation valued at 14,240,000 rubles while the carryover of incomplete construction during the year was as follows: 15,620,000 rubles on 1 January, 13,836,000 rubles on 1 April, 14,110,000 rubles on 1 July, 15,247,000 rubles on 1 October and 15,118,000 rubles on 1 January of the following year.

The average balance of incomplete construction for the report year is:

$$\overline{U} = \frac{\frac{15,620}{2} + 13,836 + 14,110 + 15,247 + \frac{15,118}{2}}{5-1} = \frac{15,562}{4} = 14,640,000 \text{ rubles.}$$

The number of capital investment turnovers during the year equaled:

$$n = \frac{14,240}{14,640} = 0.97.$$

A particular feature of the designated indicator is its dependence upon the length of the period for which it is calculated. The longer this period the greater the number of capital investment turnovers. Consequently, in comparing this indicator over time it is essential to proceed from a uniform length of the compared periods.

In order to eliminate this shortcoming, in studying capital investment effectiveness, it is advisable to determine an average period of their turnover ($\overline{T}_t$) by dividing the calendar length of the studied period (T_c) by the number of capital investment turnovers, that is:

$$\overline{T}_t = T_c : n = \frac{T_u \overline{U}}{V} .$$

Depending upon the time unit adopted for measuring the length of the calendar period, the sought indicator is expressed in days, weeks, months and years. In the example the duration of a capital investment turnover will be:

in months $\frac{12 \ 14,640}{14,240} = 12.33$ and in years 14,640:14,240 = 1.03. Consequently, one capital investment turnover as an average equals a period of a little more than a year.

Proceeding from the content and the procedure for calculating the obtained indicator, it can be interpreted as the average length the assets remain in incomplete construction. Under this name this indicator figures frequently in economic calculations.

The average length of a capital investment turnover can also be defined as a particular indicator for various stages of the investment process, that is, separately for the design-research, construction-installation and even industrial activities involving the manufacture of production equipment. For calculating such indicators the initial data are to be found in the statistical reporting (Form No 2-ks) while the method of calculating them is analogous to the examined one, that is:

$$\overline{T}_p = \frac{T_c \overline{U}_p}{Q_w} ,$$

where U_p--the average balance of incomplete construction for the given type of activity;

Q_w--the value of the design-research or construction-installation work turned over to the builder or the value of installed equipment at projects put into operation.

Since the cost of all the amounts of work and equipment turned over to the builder, considering the other capital outlays, equals the cost of the fixed capital put into operation, that is, $\Sigma Q_w = V$, then an opportunity appears to analyze the effect of the rate of capital investment turnover for each stage of the investment process on the overall capital investment effectiveness expressed by the average length of capital investment turnover as a whole. In an absolute expression, the influence of the particular turnover indicator on the overall one is determined from the formula:

$$\overline{T}_{t/p} = \frac{\overline{T}_p Q_w}{V} .$$

The final relationship of these indicators with the general one will assume the form $\Sigma \overline{T}_{t/p} = \overline{T}_t$ and this makes it possible to employ the designated methodology in analyzing the average duration of capital investment turnover. A calculation of the particular indicators for capital investment turnover and their impact on the overall indicator can be illustrated using the example of putting ore mining capacity into operation during the report year (Table IV.3). Information for col. 2 is taken directly from Form No 2-ks and for col. 1 is calculated from the data of the same form. Here for balancing the volume of fixed capital put into operation with the component parts of the capital investments it is essential to add to this indicator the total expenditures written off in the established procedure as well as gratis financing.

Table IV.3

Capital investments by type	Average balance of incomplete construction, 1,000 rubles	Fixed capital put into operation, 1,000 rubles	Duration of capital investment turnover $\left(\frac{\text{col } 1\times 12}{\text{col } 2}\right)$, months	Influence on total length of capital investment turnover $\left(\frac{\text{col } 3 \quad \text{col } 2}{\text{total of col } 2}\right)$
	1	2	3	4
Construction-installation work	8,422	8,400	12.03	7.09
Production equipment	4,685	4,272	13.16	3.95
Design-research work	440	356	14.83	0.37
Other capital investments	1,093	1,212	10.82	0.92
Total	14,640	14,240	12.33	12.33

From the table it follows that the stages of construction work and industry have the greatest importance in shaping the length of capital investment turnover. In carrying out such calculations for a number of years for the ministries, departments and the sector as a whole, it is possible to obtain a notion of the dynamics of capital investment effectiveness in the various stages of the investment process and their roll in changing the overall indicator.

The rate of capital investment turnover, as an indicator of investment effectiveness, has a direct impact upon the amount of the funds advanced to create fixed capital. For this reason, in analyzing effectiveness, the need arises to establish the amount of this impact, that is, the savings or additional expenditure of financing. A solution to this problem can be obtained by the index method. Here the average balance of incomplete construction (the advanced funds) is viewed as the result of multiplying the amount inverse to the number of capital investment turnovers (A) by the volume of fixed capital put into operation over the studied period, that is, $\bar{U} = AV$.

The influence of the change in the rate of capital investment turnover on the total amount of investments advanced is determined by the formula $\Delta_A = (A_0-A_1)V_1$, while the influence of a change in the volume of fixed capital put into operation is determined by the formula $\Delta_V = A_0(V_1-V_0)$. In either instance the amount obtained with a minus sign means a savings in funds in capital investment turnover and leading to a declinein incomplete construction. A plus sign means the additional involvement of funds in turnover and this leads to a growth of incomplete construction. Let us assume that in the above-given example, the fixed capital put into operation in the previous year was 13.1 million rubles and the number of capital investment turnovers was 0.92. Hence, as a consequence of the acceleration in capital investment turnover, the amount of assets advanced for construction declined by $\Delta_A = \left(\frac{1}{0.97} - \frac{1}{0.92}\right)14{,}240 = -797{,}800$ rubles. However, as a consequence of the increased amount of fixed capital put into operation, it was necessary to increase the funds advanced for construction by 1,239,100 rubles, that is, $\Delta_V = \frac{1}{0.92}(14{,}240 - 13{,}100)$. Under the effect of the two factors, the average balance of assets in incomplete construction increased by $(-797.8) + (1{,}239.1) = 441{,}300$ rubles.

The construction lag is an indicator that is close to the economic content of the one examined above. This is the period that capital investments are diverted from the accumulation fund from the start of their use until the obtaining of an effect from these assets. The construction lag differs from the length of construction in its economic content and in terms of amount it is significantly shorter (approximately 2-fold). The amount of the lag depends upon the length of construction, the volume of capital investments and their allocation over the years of the construction period. The influence of the latter factor is determined by the fact that the expenditures of the first year are tied up for the entire construction period while in the last year they are virtually not diverted from the accumulation fund. Considering what has been said, the construction lag of an individual enterprise can be defined from the formula for a weighted arithmetic average, that is:

$$\bar{T}_\ell = \frac{K_1(T_1-0.5) + K_2(T_2-0.5) + \ldots}{K_1 + K_2 + \ldots},$$

where K_1, K_2, ...--the capital investment volume, respectively, for the first, second and subsequent years of construction;

T_1, T_2, ...--the length of tieing up capital investments of the first, second and subsequent years of construction.

A reduction in the number of years the capital investments are tied up by a half a year reflects the condition of the even use of capital investments during the year of their making as employed in calculating the indicator.

For an aggregate of projects, the average construction lag can be determined from the formula of a weighted harmonic average using the estimated cost of the fixed capital put into operation, that is:

$$\bar{T}_\ell = \sum V : \sum \frac{V}{T_{\ell_1}} = \frac{\Sigma F}{\Sigma \bar{K}}.$$

From the transformed formula it follows that the average construction lag can be calculated as the quotient of dividing the total volume of actually utilized capital investments for the aggregate of enterprises (projects) put into operation by the average annual amount of funds diverted to the given construction ($\bar{K}$). The lag is employed in determining the amount of losses for the savings of assets (the affect) related to an increase or decline in construction times. This effect is determined by the formula

$$Z = K \cdot E_n (T\ell_1 - T\ell_0),$$

where $T\ell_1$ and $T\ell_0$--the lag under the conditions of a reduced or lengthened construction time.

The lag can also be employed to describe the level of capital investment concentration.

Capital investment effectiveness can be described by an indicator which reflects the amount of fixed capital put into operation per cost unit of capital investments advanced in the report period. This indicator which in practice is termed the coefficient for the output of end construction product is determined by the formula:

$$K_o = \frac{V}{U_s + K_p},$$

where K_p--the volume of capital investments used during the given period;
U_s--incomplete construction at the start of the given period.

The denominator of the fraction $(U_s + K_p)$ describes the full amount of the consumed resources (capital expenditures) for construction and the projects and sites fixed in the given period. For this reason the ratio of the volume of fixed capital put into operation in the given period to this amount reflects the relationship of effect and expenditures, and consequently, capital investment effectiveness. The numerical value of this indicator fluctuates within the limits from 0 to 1, that is, $0 < K_o < 1$, describing, respectively, the intensity of the output of projects and starting-up complexes completed and ready to go into normal operation.

Under the conditions of the even reproduction of fixed capital and the use of capital investments, the coefficient for the output of end product in a sector equals 0.5. A systematic increase in capital investments and an acceleration of construction have an opposite impact on the change in the coefficient. At present, for the Soviet national economy as a whole its value is somewhat greater than 0.5.

CHAPTER V: THE STATISTICS OF CONSTRUCTION PRODUCT

§1. The Tasks of Construction Product Statistics

The production of a product is the aim of construction like any other sector of the production sphere. For precisely this reason the product indicators hold a central place in the system of construction statistics indicators and the study of the production activities of the sector's organization and enterprises starts with them.

The result of production activity in construction is the production capacity, technical complexes, buildings, installations and other projects designed to function as fixed capital in various national economic sectors.

In studying construction product, statistics solves a number of problems, including:

1) Determining in physical and cost terms the volume of product produced at each construction organization, association, department and the sector as a whole;

2) Assessing the fulfillment of current and long-range plans for putting capacity and fixed capital projects into operation as well as plans for commodity construction product;

3) Studying the dynamics of the construction product volume;

4) Characterizing the rhythmicalness of construction work;

5) Studying the quality of construction product and the work quality of the contracting organizations;

6) Comparing the volume and growth rate of construction product in the USSR and in foreign countries.

The Decree of the CPSU Central Committee and the USSR Council of Ministers "On Improving Planning and Strengthening the Effect of the Economic Mechanism on Raising Production Efficiency and Work Quality" has outlined a system of measures to complete the economic reform in construction. This important decision confronts construction produ[illegible] statistics with additional tasks. Among them an important place is held by improving the system of indicators for construction product and the methodology of calculating this so as to ensure economic incentives for construction work and a rise in its efficiency.

§2. Construction Product as an Object of Statistical Study

The product of construction, as a national economic sector, represents a portion of social product created by the labor of workers and with the aid of the means of production in the given sector. Regardless of the apparent simplicity in describing construction product and determining the volume of production, this statistical task as been very complex and does not have a uniform solution. Under the conditions of the diversity of consumer values created in construction and their vividly expressed individual differences, construction statistics should find the most advisable methods for measuring product volume. This can be carried out if consideration of the product, as is said, will be statistically organized, that is, the very object of statistical study, the sector and its result of activity (product) will be defined with maximum clarity and the accounting units for construction product correctly set.

Since construction is an aggregate of design-research and construction-installation organizations as well as other enterprises included in the sector's system, all the sector's product can be viewed as the aggregate result of their production activities. Relying on such an understanding of the sector and its product, it is possible to form a system of general indicators for construction product which reflects their relationship with social product and national income as well as the intrasectorial structure of construction as an object of statistical study (Fig. V.1). This also determines the content of the general indicators of the sector's product, the methodology for calculating them and the sources of statistical information on the product.

The end product of construction is the production capacity and technical complexes which have been put into operation and duly accepted, for example, new, expanded and reconstructed plants, factories, oil and gas lines, railroads and highways as well as housing and other different-purpose projects which serve the production and nonproduction spheres of the national economy. Also among the general indicators of the sector's product as a whole are the net and gross product of construction as component parts of aggregate social product and national income.

The sector's system of indicators includes physical and cost indicators for the product of design-research activities and construction work. The product from the individual types of production activities in the sector assumes a varying physical form. In research this is the aggregate of engineering and technical data on the terrain, the state of the ground and so forth for construction, in designing it is the plans worked out in drawings and mark-ups for the future projects and technical complexes of fixed capital and, finally, in construction work this is the erected projects such as building, installations and so forth.

An important feature in the above-given product cost indicators is that their amount does not contain the cost of production equipment installed or assembled at the project. This is due to the fact that installed and preassembled production equipment does not participate in the economic circulation of the organizations comprising the sector and expenditures for its acquisition and delivery to the construction site are not accounted for on the balance sheet of basic operations for the organizations. Consequently, the cost indicators for the sector's product should not and in practice do not include equipment costs.

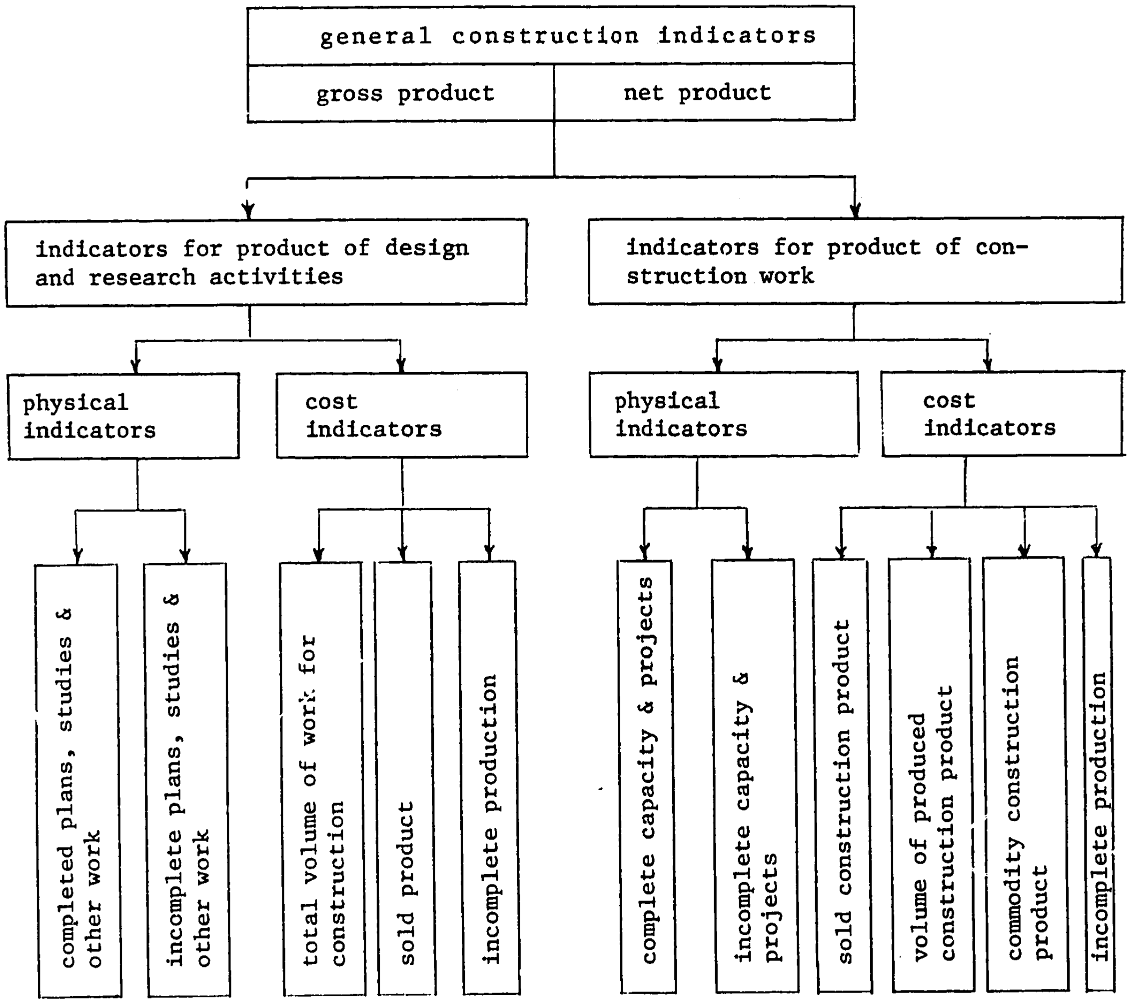

Fig. V.1. System of general indicators for construction product

Along with the above-given notion there is also another understanding of the product of construction as a national economic sector. Construction is the concluding stage in the process of fixed capital reproduction. In this stage the construction workers, on the basis of their own product created, bring together the end product of other national economic sectors, and primarily heavy industry, into unified technical complexes. Here capital investments are expended on fixed capital reproduction and a significant portion of them is used as a result of construction. Consequently, here construction acts as an investment sector which completes the reproduction of fixed capital in the form of technical complexes which bring together the active (equipment) and passive means of labor (buildings and installations). In this instance a monetary indicator of the sector's end product volume is the full cost of the fixed capital put into operation created in construction as a national economic investment sector. An important feature of this indicator is in the full conformity of its cost form to the physical form of expression. The cost of the equipment to be installed and preassembled according to the plans and estimate is a component part of the cost of the fixed capital put into operation but this does not occur in the system of general product indicators adopted in the practice of the construction organizations.

The builder is the primary economic unit in which end construction product is accounted for in physical and cost terms. In the given instance the builder operates as the report unit for capital investment statistics (see Chapter I, §5). In the contracting construction organizations, the fixed capital put into operation is not determined. The possibility and necessity of accounting for the fixed capital put into operation appear only on the level of the builder who, along with the functions of the client, exercises managerial and economic functions in construction.

From what has been stated above there follows the conclusion that in calculating the general cost indicators for the product, it is essential to distinguish the dual notion of construction as a national economic sector. In the broad sense of the word it is an investment sector of the economy which completes the process of fixed capital production and for this reason includes in its product costs all the expenditures (cost) including installed and preassembled equipment. In the narrow sense of the word, it is an aggregate of organizations comprising the sector while the overall result of its production activity is seen as the aggregate product of all these organizations. The most significant in terms of the volume and proportional amount in the sector is the product of construction work, that is, the construction product which comprises a predominant portion in the construction industry. For this reason in the following sections of the chapter basic attention will be given to a statistical study of construction product.

§3. The Concept of Construction Product

The construction industry is the production basis for construction as a national economic sector. It is comprised of the state contracting organizations and installation organizations as well as the interkolkhoz construction organizations. The production activities of the contracting organizations as a whole and its result have an intersectorial nature. The goal and basic result of these activities are to create a construction product expressed by erected buildings, installations and its other types. But, in addition, a contracting organization can create a product which is related to other national economic sectors such as industry, transportation, agriculture and so forth. In this product the largest proportional amount is taken up by industrial product manufactured in the so-called subsidiary types of production, for example, the production of sand, stone, clay and the manufacturing of structural and other prefabricated elements.

For the accounting for construction product it is essential to delimit it from the product of the other sectors created by contracting organizations. In order to meet this condition, statistics should have a clear definition of what must be considered as construction product.

Construction product is created chiefly by the contracting organizations which comprise the construction industry per se as well as by the internal forces of industrial and other enterprises (OKS or UKS), that is, by the so-called direct-labor method of construction. The contracting organizations perform over 91 percent of the construction-installation work and the remaining 9 percent of the work is done by the direct-labor method. The product created by the contracting and direct-labor methods as a total forms the product of construction work and this, in turn, is a component part of the aggregate product of construction as a national economic sector. In 1978, the share of the sector's product reached 10 percent of the total gross social product of the nation.

From the economic viewpoint, the direct useful result from the basic production activities of construction organizations must be considered the construction product.[1]

The given definition contains four specific features which indicate what must be considered as construction product. If the result of the work done by a construction organization has all the features of the given definition, then it can indisputably be considered as construction product. A product which lacks even one of the four features of the definition is not a construction product. Let us take up the essence of each feature individually.

In the first place, the product of a construction organization includes the result of only its production activities, that is, the materials created by the labor of the employees and by this organization's means of production. According to this feature of the definition, the materials acquired by the organization but not used by it in production or sold outside cannot be considered as the product of the construction organization. Of course, the result of the activities of the nonproduction units of the contracting organization, for example, the housing and utility systems and so forth, are not a product.

Secondly, construction product includes the result of not all the organization's production activities but only the basic one, that is, the construction activity as a result of which the construction and installation work has been carried out. The product from the various production but not construction subdivisions of a contracting organization is not a construction product. for example, the output of stone, clay and sand, the manufacturing of structural elements in subsidiary production lines, the result of the work of transport systems, subsidiary farms, telephone exchanges, dining rooms and so forth.

Thirdly, the construction product includes only the direct result of the basic activity, that is, the construction-installation work aimed at erecting buildings and installations, the installation and assembly of equipment as envisaged by the plans and estimate. The assembly and disassembly of construction machinery (power cranes, overhead cableways and so forth), the erecting of temporary (nontitle) structures, for example, sheds and other objects at a construction site paid from the overhead and expenditures accounted for in the estimate unit rates are not the direct result of construction work and are not considered as a construction product

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[1] See: D. V. Savinskiy, "Kurs promyshlennoy statistiki" [A Course on Industrial Statistics], Moscow, Gosstatizdat, 1960, p 36.

although the work done here does have a construction nature. All sorts of wastes from construction work, even when sold outside (used lumber, broken brick and so forth), are not considered as construction product.

Fourthly, the construction product includes only the useful result of construction work, that is, that which corresponds to the purpose of the given product and meets the demands made by the Construction Standards and Rules on the quality of construction-installation work. All work carried out with deviations which exceed the accepted tolerances are not considered as product but rather are considered rejected work and must be redone.

The construction product is embodied either in a physical form or in the form of production services (work). The most widely spread physical form of construction product is the objects which have a material form and permit the description of them by physical measurements of length, height, area, volume, capacity, power and so forth. Buildings and installations are specific types of construction product (see Chapter III, §2).

In order to erect a building or structure it is essential to carry out construction work. Among the most widely found types of them are the forming of the walls of buildings or the installation of buildings and structures from prefabricated pieces, assemblies and modules, the building of foundations and support elements under equipment; the lining of boilers and furnaces; sanitary-technical work and others. This work directly expresses the characteristics of construction work. However the term construction work is much more frequently employed not to designate actions but rather their result, that is, the construction product.

The construction product which assumes the form of production services includes the work leading to an increase in the previously created consumer value or to the restoring of a lost consumer value. In the first instance it is a question of work to install production equipment and in the second a major overhaul on projects of construction origin.

The work of installing equipment represents a range of jobs to install production, power and other equipment at the place of its operation. This includes the assembly of the equipment, the fastening of it to the supports, the connecting of pipelines and other utilities, painting and insulating, the setting up of assembly areas and ladders which are design-related to the equipment. From what has been stated it follows that the installation of equipment in terms of the nature of the jobs performed comes close to work of an industrial nature. A number of economists have rightly felt that with great justification the installation of equipment could be considered among industrial product rather than construction product, viewing it as the completion of the production cycle involved in manufacturing the equipment.[2] In statistical practices equipment installation is considered among the construction product if it is done by specialized installation organizations which are part of the system of contracting construction organizations. If the equipment is installed at the site of its operation by the manufacturing plant and the

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[2]See: M. F. D;yachkov, "Statistika kapital'nogo stroitel'stva" [Capital Construction Statistics], 3d Edition, Moscow, Statistika, 1977, p 89.

cost of installation has been considered in the product's wholesale price, then this work is considered among industrial product.

Major overhaul, as a type of construction product, represents a range of construction jobs to replace individual worn out structural elements of buildings and installations with new ones, their internal and external finishing, as well as other jobs to rebuild fixed capital projects of construction origin. For example, a major overhaul on the building of a weaving shop would be considered among construction product while a major overhaul of the looms would be considered among industrial-type jobs, that is, as an industrial product. As a consequence of the specific nature and purpose of major overhaul and the sources of financing it, the accounting for major overhauls is distinct from the remaining types of construction product.

§4. The Stages of Construction Product in Terms of the Degree of Its Completeness

In construction work, at each given moment the product is in varying stages of completeness depending upon the volume and composition of the work performed since the start of erecting the projects. In order to correctly determine the volume of construction product under these conditions, it is essential to account for it at each stage of completeness. For this purpose in statistics and accounting only individual stages of completeness are selected which meet the demands of organizing construction product accounting, control over the result of production activities, the current procedure for paying for construction product and cost accounting.

The formation of product stages in construction is much more complicated than in industry and this is caused by the duration of the production cycle, by the individualism of the created product, by the shopless organization of production and by other particular features of construction. The completion of production for all work for the project as a whole, for stages or work complexes and so forth has been adopted as the basis for dividing construction product into stages according to the degree of completeness. In addition, the interests of the construction industry as a whole and the individual construction organization are taken into account.

Considering what has been said above, all product of construction work (the construction industry) can be represented by the following stages of completeness: a finished project (groups of projects), incomplete product of construction work, a work stage, a complex of special construction and installation work and incomplete construction work.

The completed projects (groups of projects) are the end product of construction work and represent the fully complete projects which can perform the fixed capital functions envisaged in the plans. A completed project acquires social recognition only after it has been accepted by the state acceptance commission and put into operation. For precisely this reason the given stage of completeness is reflected in the accounting for the putting of capacity and fixed capital projects into operation of the general contractor and builder (see Chapter III).

From the viewpoint of the individual construction organization, and in particular from the position of its cost accounting, the concept of a completed project can also be viewed in the narrow sense. In this instance, the buildings and installations as such are considered as the completed projects of construction work and not the production capacity of which they are a part as a passive portion of the fixed capital. Here it makes no difference whether the project has received the planned equipment or not. However, regardless of such a narrow understanding of a completed project, its specific representatives, the buildings and installations, do not lose their importance of consumer values for the construction organizations inside the sector and beyond it.

The incomplete product of construction work encompasses all projects which have been commenced but not completed. The distinction between an incomplete product of construction work and its end product, in essence, is the full completion of construction and installation work in the amount and composition envisaged by the plans for the given project. The statement of the state acceptance commission is the accounting feature which designates the transition of an incomplete product to a completed project. The incomplete product of construction work in terms of volume is the most significant component of incomplete construction, that is, the volume of capital investments estimated or a certain date.

Under the conditions of an extended production cycle or the specialization of the contracting organizations in performing individual types of work, the accounting for product solely by the above-examined stages of completeness would put the organizations in a difficult position in terms of carrying out cost accounting and operational control over the fulfillment of the production program. For surmounting these difficulties and solving the problems of product accounting, the construction organizations must account for the product not only in the concluding stage but also in intermediate stages of a protracted production cycle in order to reflect the result of the work over a relatively short interval of time (10-day period or month) or for small sections (a brigade or project) and thereby carry out payments with the client for a fulfilled product.

At present these stages of construction product include the completed project, work stage, complex of installation and special construction work, incomplete construction work as well as structural elements and consolidated types of work. Let us examine these stages of product completeness with the exception of the completed project which was spoken about above.

The work stage in construction is a technologically complete complex of construction-installation work, as a result of which a design-distinct portion of a building or installation is created and which has been assigned an independent position in the plans and estimate for the construction of the given project. For example, in building housing using standard plans, two stages are established: stage I--preparatory work, the foundation stage, with the work of building the utility leads as well as the water, sewage, heating, gas and electrical networks and so forth; stage II--the above-ground portion of the building including the internal sanitary-technical installations, electrical wiring, the installation of low-voltage networks and other work not included in the foundation work.

The stage is considered fulfilled if the entire complex of construction-installation work has been carried out in the composition and volume envisaged in the plans for the given stage. The completeness and the meeting of the set requirements should be approved by the statement of the Form No 2a.

A complex of installation and special construction work is considered to be a portion of a stage created as a result of the performing of an aggregate of special construction and installation work by a subcontracting organization for the general contracting organization through subcontracting ties. At times this can also be the portions of a construction project which has not been divided in the plans into work stages. The inside sanitary-technical facilities, the installation of production and other equipment, finishing work at the project and so forth could serve as examples of these complexes. A complex of installation and special construction work is considered completed if the subcontracting organization has performed the entire aggregate of jobs in the volume and composition envisaged in the contract and its acceptance by the contracting organization has been confirmed by the statement of Form No 2a.

Incomplete construction work includes the incomplete stages and complexes of installation and special construction work, that is, those parts of buildings and installations or parts of stages for which not all the work has been performed (in terms of volume and composition) as stipulated in the plans or in the subcontract. For example, if the upper slab or roof has not been installed in erecting the shell of a residential building (a work stage), then the created work stage is considered incomplete. Work which has not been turned over or accepted by formalized statements is also considered to be incomplete stages and complexes of installation and special construction work.

For determining the volume of produced construction product, as yet it remains essential to account for it in terms of complete and incomplete structural elements and consolidated types of work and these represent the smallest parts of construction product. By a structural element (KE) in accounting one has come to understand the parts of a building or installation the creation of which requires the execution of a range of simple operations stipulated by the Construction Standards and Rules. Among the structural elements of a building are, for example, the foundation, walls, interfloor slabs, internal partitions and so forth. By consolidated types of work (UVR) in construction product accounting one understands a range of simple jobs and operations as a result of which the structural element assumes new qualities or a portion of the work involved in creating it is simply completed. For example, the excavation for a foundation, the digging of ditches for laying pipes, the work of installing equipment and so forth. Such structural elements and consolidated types of work or parts of them are considered complete when all the operations envisaged by the technology (estimate standard) have been performed. The acceptance of this work is formalized by the statements of Form No 2b and 2c and by the monthly information of Form No 3.

The designated stages of construction product are represented in Fig. V.2 which describes their place and relationships.

§5. Accounting for Construction Product in Physical Units

In construction the product volume is measured by two ways: in physical and monetary units. Each of the methods of product measurement is of independent significance in solving the economic problems of construction statistics. Accounting for construction product in physical terms makes it possible to determine the production scope of the most important types of construction work in the USSR and to compare

<table>
<tr><td colspan="5">Product of construction work</td></tr>
<tr><td colspan="4">Incomplete product of construction work</td><td>Completed projects</td></tr>
<tr><td colspan="3">Incomplete construction work</td><td>Completed stages and work complexes</td><td></td></tr>
<tr><td>Completed KE and UVR</td><td>Completed parts of KE and UVR</td><td>Incomplete parts of KE and UVR</td><td></td><td></td></tr>
</table>

Fig. V.2. Stages in the completeness of construction product

this with analogous indicators in the capitalist nations. Accounting for products in physical units holds an important place in the organization, planning and control of construction work. It makes it possible to obtain an evaluation of plan fulfillment in the individual units, worker brigades, in the foreman sections and so forth. The volume of construction product in physical terms is the basis for accounting for construction product in monetary or cost terms.

Accounting for construction product in physical terms is essential for calculating worker wages in accord with the quantity and quality of labor expended by them and for figuring the various quality indicators which describe, for example, labor productivity for the employees, the level of mechanization of construction-installation work, the degree of utilizing construction machinery and so forth.

Accounting for product in physical units consists in determining the construction product volume in units which describe its basic consumer property. Construction product is accounted for in physical units during all stages of its completeness, starting from simple work and ending with the completed projects. Individual simple construction or installation jobs, structural elements and types of work are accounted for in ordinary physical units. We can find information on such types of work in the work orders, work logs, the cumulative journals and so forth.

In calculating the volume of work performed in physical units it is essential to bear in mind that in these indicators the data have been generalized for far from always uniform products. In particular, such differences occur not only in labor expenditures but also in the composition of construction work and operations for a given type of structural element. For example, the same volume of a foundation can be erected from various preassembled structural elements and pieces requiring various operations and labor expenditures for their installation. However, in generalizing the volume of the same types of work in physical units for the aggregate of construction organizations, these differences in practical terms are disregarded.

Finally, physical units are employed to determine the volume of end construction product, that is, the completed projects or, in other words, the putting of them into operation and this holds an important place in the system of construction product indicators. Chapter III or the textbook described in detail the methods for measuring the volume of completed projects put into operation.

§6. Accounting for Construction Product in Cost Units

The cost can serve as the sole measurement for construction products of different quality. For this reason, a general description of the result of construction work presumes the presence of accounting for the product in monetary or cost terms. The general importance of accounting for product in cost terms consists in the fact that on this basis control can be exercised over production and the measure of consumption. In construction, this makes it possible to bring together in a single summary indicator the diverse results of production activities and this, in turn, provides an opportunity for all the construction organizations to plan the volume of construction-installation work in cost terms for any period and to monitor its fulfillment. Accounting for product in cost terms makes it possible to study the dynamics of its production volume on any level of the organization and management of construction.

In construction a product can be estimated by its costs or by using the estimated prices. But only by using prices which reflect the full amounts of the expenditures of socially necessary labor is it possible to correctly express the volume of construction product. However, in construction it is extremely difficult to establish ex-factory prices for the product and, in particular, for completed projects in an analogous manner as is done in industry. This is prevented by the specific features of construction product and its production expressed in the individual nature of the projects created and, in particular, in the unique conditions of construction work. For precisely this reason product costs in construction are determined on the basis of the expenditure estimate which, along with the plans, is drawn up for each construction project or group of projects (site) and is termed the estimated cost.

The estimated cost of construction-installation work is the basic type of monetary expression for the volume of construction product and consists of three parts: direct expenditures, overhead and planned accumulation. The methodology for determining the estimated cost of the work comes down to establishing the listed component parts for the specific types of construction and installation work. For this normative and estimate manuals have been worked out and put into effect in construction and the most important of these for determining estimated cost are the following: the estimated standards of expenditures for carrying out construction work or Part IV of the Construction Standards and Rules (SNiP), the regional unified unit rates (YeRYeR), the price lists for the installation of equipment, and the listed prices per unit of completed construction product.

The methodology for calculating the estimated cost of construction and installation work varies. Thus, for calculating the estimated cost of just construction work, the unified rates are employed which have been brought together and published in the collections for the types of general construction and special construction work (YeRYeR).

The rates given in the YeRYeR are averaged amounts of direct expenditures (the cost of materials, expenditures on operating construction machinery and basic wages of workers employed in basic and ancillary production) per unit of structural element and consolidated types of work, for example, per m^3 of brickwork, per m^2 of flooring and so forth. The unit estimates are based upon sector-wide estimated standards for the consumption of materials, labor expenditures and operating time of construction machinery as well as calculated wage rates of employees for the various natural regions, the ex-factory wholesale prices for materials and the rates for transporting them. The estimated norms are given in Part IV of the SNiP, and this is the basic document which controls estimate calculations in construction. They were first put into effect in 1955. Since 1 January 1969, revised estimate standards for the expenditure of production resources have been employed for the unit rates. As prices for materials ordinarily fixed wholesale prices as of a certain date are employed and these are termed estimated prices. At present (from 1 January 1969), these are the ex-factory prices as of 1 July 1967 with certain supplements and amendments made after 1 January 1969, in particular in line with the introduction of new wholesale prices on 1 January 1975.

Prior to 1969, for compiling the estimates the prices of various years were employed. Thus, in the 1937-1945 period, 1936 prices were in effect, 1945 prices in 1946-1949, 1950 prices in 1950-1955 and 1955 prices in 1955-1969.

The YeRYeR have been differentiated into 19 groups for territorial regions (zones) with approximately equal construction conditions. This means that the level of estimated prices, strictly speaking, is not uniform for the entire nation but rather reflects the actual difference of expenditures for performing the same type of jobs under different construction conditions. This important feature of estimated prices should be considered in comparing the construction product volumes in different economic regions of the nation. In the instances when the construction conditions go beyond the limits adopted by the YeRYeR norms, corrections are made in the unit rates or, as they say, the unit rates are "tied" to the local construction conditions. Such corrections are made for wages, for the cost of buildings materials and for other expenditures.

The estimated cost of construction work is determined in the following manner. For each project, the volume of construction work to be carried out is determined in physical units and using the YeRYeR the rates are found for each type of structural element or type of work. By multiplying the volume of work in physical units by the corresponding unit rates, the amount of direct expenditures for the given work is determined. Then the total overhead is figured using the established norms in percent of the direct expenditures. The current rates for overhead were introduced as of January 1969 within limits from 12.5 to 19.0 percent for construction work and from 70 to 144 percent for installation work, depending upon the departmental affiliation of the contracting organizations. The total of planned accumulation, in other words, the planned profit, for all construction organizations was set on 1 January 1969 on the same level, namely 6 percent of the total of the direct expenditures and overhead.

Having added up the direct expenditures, the overhead and planned accumulation, we will obtain the full estimated cost of construction work. Let us assume that for the construction of a shop building the external walls were erected from sawdust concrete with a volume of 700 m^3. For the given construction organization, the overhead rate is 14 percent. According to the YeRYeR collection the cost of erecting 1 m^3 of such walls is 18 rubles. Hence:

Direct expenditures for erecting walls $700 \cdot 18 = 12,600$ rubles;
Overhead $12,600 \cdot 0.14 = 1,764$ rubles;

Planned accumulation (12,600 + 1,764) 0.06 = 862 rubles;
The estimated cost of erecting the exterior walls equals: 12,600 + 1,764 + 862 = 15,226 rubles.

For determining the estimated cost of work related to equipment installation, price lists for these jobs have been compiled in the USSR. The presently employed price lists for equipment installation were put into effect on 1 January 1969. These documents contain the rates for installing various types of production and other-purpose stationary equipment. The rates for equipment installation, in contrast to the YeRYeR, give the full estimated cost of installation work for each calculation unit of equipment or individual units of large-size equipment. For calculating the estimated cost of the performed installation work, one has merely to multiply the number of units of installed equipment or the installed assemblies of a unit by the corresponding rates found in the approved installation lists.

At present, more advanced price lists are being worked out for equipment installation and these will be based upon consolidated units for the measurement of installation work and their estimated cost, for example, the installation of individual types of equipment per unit or per unit of capacity at the given shop or starting-up complex.

Under the conditions of the complete transition to payments for a completed project as well as the continuing industrialization of construction and the use of standard plans, the optimum methodology for determining the estimated cost of construction product will be the one which is based upon listed prices for completed projects or a unit of their capacity, volume capacity and so forth. In construction they have begun elaborating and employing such prices starting in 1959, simultaneously with the introduction of payment for the fully completed project where these are most effective. In practice listed prices are used for the construction of mass-built housing per m^2 of total area; for school buildings, hospitals, movie theaters and other cultural and service projects the unit is per place; in individual production buildings and installations it is for the project as a whole, a unit of capacity or other consolidated unit of measurement for the completed project.

§7. Indicators for the Volume of Produced Construction Product

For studying and assessing the results of production activities carried out by contracting organizations, statistics employs a system of construction product indicators in which the construction activities of the contracting organizations are viewed as a single process of producing and selling the construction product. For this reason the result of the work carried out by the contracting organizations is primarily characterized by two interrelated indicators: by the volume of the produced construction product and by the volume of the commodity construction product. These have different purposes and a differing methodology of calculation. Information on the volume of produced construction product is required to describe the volume of construction work, for planning calculations for the need of the contracting organizations for labor resources and means of production and, consequently, for planning and managing the construction industry.

The volume of produced construction product can be represented in physical or cost terms. In the former instance the physical and material composition of the product produced by the organization will be described in the form of an aggregate of indicators expressing the number, capacity or volume of the completed projects and the amount of construction-installation work performed. In the latter instance a single general indicator will be obtained for the result of construction work in cost terms and this makes it possible to correlate the volume of produced product with other indicators in the system.

In accounting and statistics, the volume of the construction-installation work performed by the organization over the report period according to the estimated cost is used as the cost indicator for the produced construction product. The economic sense of this cost indicator is that it describes the entire result of construction production activities by the organization and only for the given period regardless of the degree of completeness which the product has achieved by the end of the period. As a consequence of the fact that the construction cycle, for example, in building the foundation of a house or the erecting of a building as a whole, is very extended and may not coincide with the report period or may go beyong its limit, a portion of the construction and installation work for the projects and construction stages can be performed prior to the report period and, consequently, will not be considered among the amount of construction product produced over the report period.

The volume of produced construction product (the volume of performed construction and installation work) over the report period can be calculated either by totaling its component elements or by the balance method. The composition of the volume of produced construction product includes the estimated cost of the work performed in the report period: 1) for projects, work stages and complexes commenced and completed in the report period; 2) for projects, work stages and complexes commenced in the report period but incomplete; 3) for projects, work stages and complexes commenced in the previous period and completed in the report period; 4) for projects, work stages and complexes commenced in the previous period and not complete in the report period.

Let us examine an example illustrating the methods of calculating the indicator of produced construction product in a construction administration during the third quarter (Table V.1). The table gives information on the work performed by the construction administration at projects having different periods for the start and completion of their construction. In calculating the indicators let us assume that all the work has been done in full accord with the plans and the estimate. If in the accounting there are direct data on the work performed over the third quarter, then the volume of produced construction product over this period will correspond to the total of col. 6.

Information on the estimated cost of the work for the first and second components can be found in the acceptance and delivery statements as well as in the construction estimates. It is more difficult to determine the amount of work for the third and fourth components of the produced construction product as the accounting may not include the corresponding direct data. In such instances it is advisable to determine the work carried out over the report period by selecting the data from primary accounting documents for small stages of product completeness, for example, a structural element or consolidated type of work. This information is to be found in the acceptance and delivery statements, the accounting logs for the performed work and the cumulative ledgers. These show the amount of work for each construction project, work stage or complex in both physical units and estimated cost.

Table V.1

Номер объекта a	b Число и месяц фактического начала и окончания строительства	c Полная сметная стоимость работ, тыс. руб.	d Незавершенное строительное производство на начало III квартала	e Объем работ, выполненных		h Незавершенное строительное производство на конец III квартала
				с начала строительства f	за III квартал g	
1	2	3	4	5	6	7
1	17.03—15.08	456	364	456	92	—
2	12.08—20.12	408	—	103	103	103
3	1.07—30.09	117	—	117	117	—
4	6.01—4.11	641	479	510	31	510
	total	1 622	843	1 186	343	613

Key: a--Project number; b--Date and month of actual start and completion of construction; c--Full estimated cost of work, 1,000 rubles; d--Incomplete construction work at start of third quarter; e--Volume of work carried out; f--Since start of construction; g--Over third quarter; h--Incomplete construction work at end of third quarter

The estimated cost of the work performed in the report period for projects, work stages and complexes started in the previous period and completed in the report period (the third component) can be obtained if one subtracts the estimated cost of the work performed on these projects, stages and complexes in the previous period from the estimated cost of them (the incomplete construction work at the start of the period). In the example an analogous case is shown for project 1 for which the volume of work performed is 92,000 rubles (456 - 364).

The last component, the estimated cost of the work carried out in the report period on projects, work stages and complexes commenced in the previous period and incomplete in the report one, is determined either directly from the primary accounting data or as the difference in the incomplete construction work on such projects at the end and beginning of the report period. In the example this case occurs in project 4 for which the volume of work performed over the third quarter equaled 31,000 rubles (510 - 479).

Since a contracting organization accounts for the volume of incomplete construction work at the end of each report period, the method of calculating the volume of produced construction product is simplified. It can be based on a balance scheme for the relationship of produced and completed construction product and from which the volume of product produced over the report period is the total volume of work on the projects, work stages and complexes completed in the report period and the change in the balance of incomplete construction work at the beginning and end of the report period (U), that is:

$$Q^r_{ci} = Q_c + (Q^e_u - Q^s_u) = Q_c + U,$$

where Q^r_{ci}--estimated cost of the work performed in the report period;
Q_c--estimated cost of the projects, work stages and complexes completed in report period;

Q_u^s and Q_u^e--the estimated cost of incomplete construction work at the beginning and end of the report period.

The volume of construction-installation work completed in the third quarter as calculated by this method will be: $(456 + 117) + (613 - 843) = 343{,}000$ rubles.

An important methodological feature of the designated indicator which determines the area of its use is the absence of double counting of the construction product within the entire sector. However, the cost of the raw products and materials produced in industry and consumed in construction, in determining the cost of produced construction product, is double counted. Such double counting of the product is completely justified since it is a consequence of the social division of labor and cooperation among the national economic sectors. In this regard the volume of work carried out over the given period is applicable for calculating a number of derivative indicators which describe the degree of utilization for the labor resources and means of production, for example, the output level of the employees, the output-capital ratio, materials utilization and so forth.

Information on the volume of produced construction product is given in the statistical reporting in Form No 3-t in the section on employee output where this indicator is termed the volume of construction-installation work considering changes in the balances of incomplete construction work, as well as in Form No 2-s.

Along with the volume of produced construction product, an indicator describing the overall volume of contracting work is calculated in the practices of the contracting organizations and in statistics. In contrast to the one examined above, the volume of contracting work, in addition to the produced construction product (the volume of construction-installation work) includes the so-called other contracting work. In the latter are the work carried out using the funds for the basic activities of the contracting organizations but the results of this work are not of the nature of a construction product. For example, such would be the manufacturing of boiler and other nonstandard equipment at the construction site, landscaping on the grounds, the creation of forest belts and so forth. The volume of contracting work is set by the superior organizations as a calculated indicator in the plans of the contracting organizations under the ministries and departments. Form 1-ks gives the data on the carrying out of the contracting work plan.

§8. Indicators for the Fulfillment of the Construction Product Plan

In the various stages of national economic development, for assessing the operation of the construction organizations a system of construction product indicators linked to specific economic conditions has been employed. Prior to the economic reform, the results of the production activities at construction organizations was assessed according to the production capacity and projects put into operation as well as in terms of the volume of performed construction-installation work. After the carrying out of the economic reform in construction (1969), the following were adopted as the indicators to be approved in the plan: the putting of capacity and projects into operation and the volume of sold construction product.

In the contracting organizations the putting of production capacity and projects into operation is planned and accounted for in physical units. The importance of this indicator consists in the fact that it describes the amount of construction product the utility of which has been given social (national economic) recognition.

The quota for the putting of capacity and projects into operation and the accounting for it in physical units are envisaged only for the general contracting organization which bears full responsibility for the construction and the putting of the starting-up complex into operation. In individual instances this is also established for specialized organizations which install basic production equipment as a subcontractor. In all remaining instances the putting of capacity into operation is not planned for the specialized and general construction organizations operating as a subcontractor since the production activities of these organizations do not terminate with the creation of the completed projects.

At the same time, for a general assessment of the results of production activities by a contracting organization, the need arises to supplement the designated indicator by employing a unified cost indicator of the type of sold or commodity construction product. Prior to the economic reform, such an indicator was the volume of construction-installation work completed and turned over to the client using the estimated cost, that is, an indicator analogous in its content to the volume of the produced product. The difference of these indicators was merely that the former expressed the amount of work turned over to the client while the latter was an indicator for the entire volume of work carried out in the given period, including the incomplete parts of structural elements and consolidated type of work which were not presented for submission to the client according to the previous financing rules. Such an evaluation indicator was divorced from the quotas relating to the putting of fixed capital projects into operation and did not encourage the contracting organizations to carry out these quotas. After the economic reform, the sold construction product was adopted as a general cost indicator and this was expressed by the estimated cost of construction-installation work on the projects, stages and complexes of the special construction and installation work completed and turned over to the clients in the report year. However, the indicator of sold construction product has not assumed its proper place in assessing the work results of the contracting organizations and the need has arisen to further improve it.

The Decree of the CPSU Central Committee and the USSR Council of Ministers "On Improving Planning and Strengthening the Effect of the Economic Mechanism on Raising Production Effectiveness and Work Quality" for assessing the results of economic activities by construction organizations has adopted the following as among the basic indicators: the putting into operation of production capacity and projects prepared to produce product and render services and the volume of commodity construction product. The putting of capacity and projects into operation as well as the volume of commodity construction product are approved in the five-year and annual plans of the ministries and the construction-installation organizations. The evaluating of the work of the organizations using these indicators creates a greater incentive than before for the employees to first carry out the work at the starting-up projects and, consequently, to best ensure the prompt putting of fixed capital into operation.

Commodity construction product is the estimated cost of the construction and installation work at enterprises, starting-up complexes, stages and projects which have completed construction and have been turned over in the report year in the established procedure for operation and ready to turn out product and provide services. The commodity construction product also includes work on completed stages and complexes of special construction and installation work to be turned over to the general contractor (to the basic subcontractors) and performed by the given organization under subcontracting arrangements. Moreover, the commodity construction product includes the so-called "other contracting work" as well as work the volume and methods of execution of which are clarified only in the course of construction, for example, dredging and mine-sinking work. The incorporation of work stages and complexes on incomplete projects as part of the commodity construction product, along with the end product of the sector, is a certain divergence from the basic payment principle adopted in the decree (that is, for the end product). At the same time, this exception makes it possible to solve the problem of accounting for commodity construction product not only for the general contracting organizations but also for the specialized and general construction organizations performing work under subcontracting arrangements.

In the payments of the construction organizations for the completed project, the estimated cost of the work on the project is included in the commodity construction product after the full completion of its construction in the volume and composition of work envisaged by the plans and estimates and after being turned over to the client. The turning over and acceptance of the completed project are carried out depending upon its significance by state or worker acceptance commissions and are formalized by statements in the established procedure. The value of work on stages of construction and work complexes is included in the commodity construction product of the organization after they are fully complete in the volume and composition envisaged by the estimate and after they have been turned over to the general contractors under the statements of Form No 2a. The "other contracting work" is considered as commodity construction product under the condition that it has been carried out in accord with the plan and the turning over to the client has been formalized by the statements of Form No 2b and 2c. The above-mentioned documents (statements) confirm the completeness of the construction product required for turning over and at the same time serve as the basis for the client to pay for the accepted product. However, payment for the turned over product is not considered as an essential condition in determining commodity construction product.

The volume of commodity construction product includes the full estimated cost of the work carried out on the completed projects, starting-up complexes and so forth, regardless of when they were started, and not just the cost of the work carried out in the report period. Here the volume of work on a project turned over to the client with unfinished work is included in the commodity construction product in the actual amounts, that is, for the full estimated cost of the work on the project minus the value of the unfinished work. Consequently, commodity construction product reflects not only the result of the work carried out in the report period but also to a significant degree the result of the work carried out in previous periods. This particular feature of the indicator makes it practically applicable in calculating the indicators for labor productivity, the output-capital ratio and so forth.

In the plans of the ministries and organizations, the overall volume of commodity construction product is set along with the volume to be carried out by their own forces. In assessing plan fulfillment for commodity construction product, the volume of work on completed sites, starting-up complexes and projects will be considered in the plan fulfillment if they are a component part of the plan approved by the superior organization. In instances when the construction organizations carry out work on projects not envisaged in the approved plans, their value is not considered in estimating plan fulfillment, with the exception of projects put into operation ahead of time. In the latter instance, the plan for commodity construction product is not changed and this serves as an additional condition for encouraging the organizations to shorten the construction time.

Let us give an example of determining the volume and degree of fulfillment for the plan of commodity construction product according to the data of a trust for the report year (see Table V.2). In calculating the indicators, we will assume that the construction-installation work has been carried out and assessed in accord with the plans and estimate. The total volume of work turned over to the client during the report year was 2,754,000 rubles, including 2,574,000 rubles for the volume of commodity construction product (the total of the last colume). The commodity construction product did not include the work which, although completed (and even turned over to the client) did not satisfy the procedural requirements for the sought indicator, that is: the volume of work on a coal storage facility which was incomplete and not turned over to the client and the amount of work on the foundation of an apartment building which was turned over to the general contractor under a subcontracting arrangement (not provided in the plan of the report year). The percentage of plan fulfillment for commodity construction product by the trust during the report year was: $\frac{2,574}{2,464} \cdot 100 = 104.5\%$.

Table V.2

Name of starting-up complexes, projects and work stages	Commodity construction product by plan for year, 1,000 rubles	Actually performed work, 1,000 rubles		
		Total	Including	
			Accepted by statements	Included in plan fulfillment
Heating plant (by subcontracting)	1,340	1,340	1,340	1,340
Coal storage facility	210	146	--	--
Cooling tower	684	684	684	684
Club building (finished ahead of time)	--	320	320	320
Other contracting work	230	230	230	230
Foundation of apartment building (by subcontracting)	--	180	180	--
Total	2,464	2,900	2,754	2,574

In individual periods, when the plans of the construction organizations do not envisage quotas for putting projects into operation and for commodity construction product, as an exception the evaluation of the result of production activities is made in terms of the fulfillment of the contractor- and client-approved schedules for carrying out construction-installation work on individual projects and installations.

The introduction of payments between the clients and contractors for enterprises, starting-up complexes, stages and projects which have completed construction, been put into production and are ready to produce products and provide services as well as for commodity construction product is planned for the start of the 11th Five-Year Plan.

§9. Indicators for the Volume of Construction Product Under the Conditions of Specialization and Cooperation of Contracting Organizations

Under the currently existing construction conditions the indicators for produced and commodity product are determined in accord with the established forms of specialization and cooperation among the contracting organizations. Thus, considering the different types of contracts reflecting the production ties of the contracting organizations and the builders, in planning and statistics the volume of construction product is calculated broken down for the general, direct and subcontracting contracts.

The first two indicators describe the volume of construction product which has been turned over to the builder and, consequently, is eliminated from the sphere of construction work. In totaling the volume of work carried out for all the general and direct contracts, we will obtain the total amount of contracting work for the sector. The third indicator describes the volume of construction product realized within the sphere of construction work, that is, between the construction organizations.

In erecting large, industrial transport and other complexes through production cooperation, scores of subcontracting organizations are involved. Here the subcontractors bear responsibility only for the work assigned to them while the general contractor is responsible for all the work on the project and site, that is, for the work carried out both by its own forces as well as by the subcontracting organizations. The particular features of the production ties between the construction organizations and the nature of the functions performed by them in joint construction are expressed in the system of construction product indicators. Thus, the plan of the general contractor approves the following two indicators for commodity construction product: the overall volume of commodity construction product and that done by the organization's own forces; in addition, the volume of commodity construction product carried out by other involved organizations is determined. Analogous indicators are also calculated for contracting work.

The volume of construction product carried out by the contracting organization's own forces over a given period describes the result of the production operations of just the given organization. This indicator in no degree repeats the production result of the other construction organizations which cooperate with the given one and, consequently, in calculating an analogous summary indicator for a trust, glavk [main administration], ministry and sector there is no product double counting. The designated feature is very crucial and it distinguishes this indicator from the cost indicators of industrial product (gross, commodity and so forth) in the summarizing of which product double counting within the enterprises and the sector is inevitable.

Table V.3

	Total volume of turned over work, 1,000 rubles	Volume of work carried out by own forces, 1,000 rubles	Volume of work carried out by outside organizations, 1,000 rubles		
			of own trust	other trusts of own glavk	of other glavks of own ministry
	1	2	3	4	5
SU-5 [construction administration]	3,200	2,500	100	320	280
SU-6	3,140	2,000	600	320	220
Total for Trust No 1	6,340	4,500	700	640	500
SU-7	2,620	2,000	420	150	50
SU-8	2,220	1,500	360	240	120
Total for Trust No 2	4,840	3,500	780	390	170
Total for glavk	11,180	8,000	1,480	1,030	670

For an illustration of calculating the product indicators, Table V.3 gives a simplified example for an aggregate of contracting organizations from a glavk over the report year. From the data of the example the volume of the work performed by the organizations' own forces equaled 8 million rubles for the glavk.

The volume of work performed by associated organizations characterizes that portion of the construction product which has been produced by contracting organizations for the general one due to the responsibility of the general contracting organization for all the work related to erecting the project, it must consider that portion of the construction product which is included in the overall program of contracting work as approved by the superior organization. Construction-installation work under subcontracting arrangements is usually performed by specialized contracting organizations. A characteristic feature of the construction product produced by these organizations is that as a rule it assumes the form of not a completed project but rather a work stage or complex at the project.

The amount of work carried out by the associated organizations for the given aggregate of construction organizations is an amount which depends upon the scale and structure of the construction organization assuming the role of the head one and in terms of which all remaining organizations may be considered associated. Here the summary indicator for the aggregate of organizations, the volume of construction product of the associated organizations, will be reduced as one moves from a small-scale organization to a larger one recognized as the head one, for example, from the administration to the trust, from the trust to the glavk and so forth. Such a pattern is caused by the fact that in moving to the larger scale organization, a number of organizations previously considered associated ones are dropped out of the calculation. In a general form this pattern can be represented by the following inequality:

$$Q_{administration} \geqslant Q_{trust} \geqslant Q_{glavk} \geqslant Q_{ministry} \geqslant Q_{sector},$$

where Q--the volume of construction work performed by associated organizations for the entire aggregate of contracting organizations while the subscript word designates the type of construction organization adopted as the head one and on the level of which the given indicator has been calculated.

The designated pattern of the indicator can easily be traced from the data of our example. Namely: the volume of work performed by associated organizations equals: on the administration level--1,400 + 1,030 + 670 = 3.18 million rubles; on the trust level--1,030 + 670 = 1.7 million rubles; on the glavk level--670,000 rubles.

From the given calculations it is not difficult to see that the numerical difference between these indicators is characterized by the amount of work carried out within the structural subdivisions of the construction organization accepted as the head one. In practice this value is usually termed the internal production turnover. Thus, the total volume of work delivered (the total of col. 2) contains the "internal trust turnover" totaling 1.48 million rubles (the total of col. 3) and the "internal glavk turnover" totaling 1.03 million rubles (the total of col. 4).

The total volume of construction-installation work is determined as the total of the first two indicators, that is, the volume of work performed by the general contractor's own forces and the volume of work performed by the associated organizations. This describes the aggregate volume of work turned over by the general contractor to the builders. In the example this is the total of col. 1, that is, 11.18 million rubles.

The examined methodological features in the system of construction product indicators are of importance in their statistical summarizing for the aggregate of contracting organizations. All the above-examined indicators for construction product are given in the statistical reporting under Form No 1-ks.

§10. The Relationships of the Indicators for the Construction Product Volume

The indicators examined in the preceding paragraphs for produced and commodity construction product are interrelated and comprise a system of indicators. This system's indicators and their relationships can be studied by various statistical methods.

The balance method provides the fullest understanding of the diversity of the relationships between the construction product indicators and primarily in the stage of its production and sales. The balance of product production and sales (the turning over of the work) is comprised of two parts, each of which is assigned to one stage of the organization's production activity. Each part of the balance represent the basic construction product indicators which reflect its differences in terms of degree of completeness, the production ties of the organizations, the types of contractual relations between them and other features. Depending upon the nature of the tasks of economic research, in constructing the balance it is possible to use a greater or lesser number of indicators. A simplified scheme of a balance for construction product is shown in Table V.4.

Table V.4

Production of construction product	a	Allocation of construction product	a
1. Incomplete construction work at year's start, total	2,436	1. Work turned over to clients in report year, total	6,772
Including:		Including:	
a) For projects turned over in report year	1,684	a) For projects put into operation	4,870
b) For projects carried over to following year	752	b) For work stages and complexes	1,902
2. Production of work over year, total	6,367	2. Incomplete construction work at year's end, total	2,031
Including:		a) For projects to be turned over in following year	1,486
a) For projects turned over in report year	3,758	b) For projects carried over to following years	545
b) For carryover projects	2,609		
Total	8,803	Total	8,803

Key: a--Estimated cost of work, 1,000 rubles

The balance can be constructed for the purposes of analyzing plan fulfillment or for studying the dynamics of the construction product volume. In this instance, in addition to the initial data on product volume, in its predicate it is advisable to give the deviations from the plan or the previous period in absolute and relative terms. Schematically the produced (Q_{pr} and commodity Q_c) construction product can be represented by the following equation:

$$Q_u^s + Q_{pr} = Q_c + Q_u^e ,$$

where Q_u^s and Q_u^e--estimated cost of incomplete production of work at beginning and end of report period (year).

The relationship of the product indicators within each portion of the balance is expressed in the form of the components of the construction product. For example, the total volume of produced construction-installation work over the report year according to the data of the second section on the lefthand side of the balance can be represented by the total volume of work for the two positions of this section, that is, 3,758 + 2,609 = 6,376,000 rubles.

The relationship of produced and commodity construction product and the role of the individual factors can be established if one proceeds from other forms of the relation, in particular when the system's indicators can be depicted in the form of the product of comultipliers. The index method in the given instance is the theoretical basis for studying the impact of the factors on the overall result. Let us take up the method of the interrelated study of the impact of the factors and for illustrating this we will use the basic indicators of produced and commodity construction product the relationship of which can be presented in the following manner (Fig. 5.3).

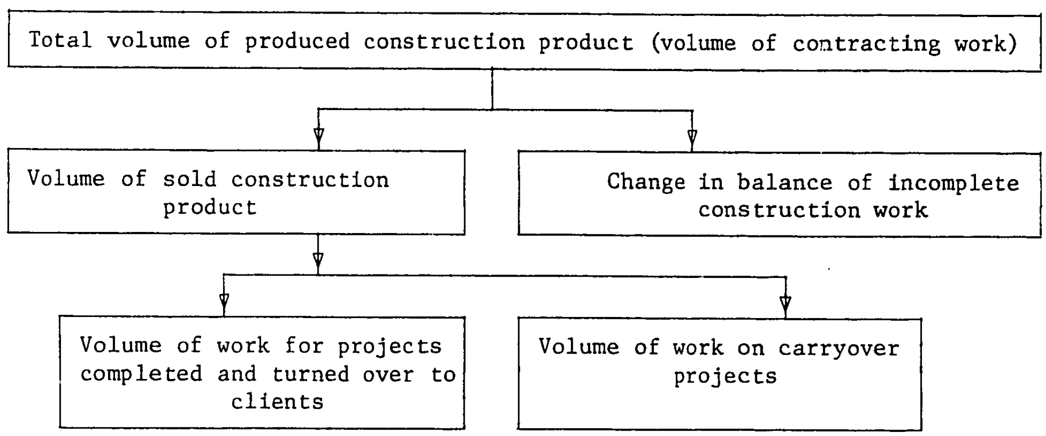

Fig. V.3. Relationship of cost indicators for construction product

In order to form a system of product indicators, we will establish two coefficients or comultipliers by which it is possible mathematically to move from one indicator to the other. The first is the coefficient for the work turned over and this is the ratio of the volume of sold construction product to the volume of the produced over the given period. This indicator characterizes the amount of the sold construction product per ruble of work carried out in the report period. With other conditions being equal, an increase in the volume of work in the projects, work stages and complexes sold to the clients leads to an increase in this coefficient. The second is the coefficient of the output of end construction product. This is the ratio of the volume of commodity product (work on projects put into operation) to the volume of sold product. A rise in the amount of work on the projects put into operation, in comparison with the plan or the previous period, with other conditions being equal is accompanied by an increase in this coefficient.

In applying the designations for the indicators introduced in Table V.5, it is possible to present the volume of work on the projects put into operation in the form of the following product of the comultipliers: $Q_o = Q K_d K_o$. Consequently, depending upon what volume of work the contracting organization carries out and whether attention is focused on the nearly-completed or carryover projects, the fulfillment of the plan for the amount of work on projects put into operation will be respectively more or less. Let us examine the influence of these factors from the example of a construction administration (Table V.5).

Table V.5

	Symbol	By plan for year	Actual for year	Absolute change
1. Volume of produced construction product, 1,000 rubles	Q	6,202	6,820	618
2. Volume of sold construction product, 1,000 rubles	Q_d	6,510	6,510	0
3. Including for projects put into operation, 1,000 rubles	Q_o	4,650	3,720	930
4. Coefficient of work turned over (line 2:line 1)	K_d	1.05	0.954	-0.1
5. Coefficient for output of end construction product (line 3:line 2)	K_o	0.71	0.57	-0.14

The basic factor influencing a change in the volume of work on the completed projects is the total volume of construction-installation work carried out over the period and to some degree this reflects the volume of construction work. The influence of a change in this volume factor can be determined under the condition that all the remaining factors or quality indicators remain on the level of the base period, that is, according to the formula $\Delta_Q = (Q_1 - Q_0)K_{d_0}K_{o_0}$. In the example, the influence of this factor will be: $\Delta_Q = 618 \cdot 1.05 \cdot 0.71 = 461{,}000$ rubles. In figuring the influence of the subsequent factors, we may proceed from the assumption that a change in the preceding factors occurred and for this reason they should be taken on a level of the report period. Thus, the influence of a change in the coefficient for turned-over work can be determined from the formula $\Delta_{K_d} = Q_1(K_{d_1} - K_{d_0})K_o$; the influence of the change in the coefficient for the output of end construction product can be determined from the formula $\Delta_{K_o} = Q_1 K_{d_1}(K_{o_1} - K_{o_0})$. In the example, the influence of the corresponding factors will equal: $\Delta_{K_d} = 6{,}820(-0.1) \cdot 0.71 = -484{,}200$ rubles, while $\Delta_{K_o} = 6{,}820 \cdot 0.95 \cdot (-0.14) = -907{,}100$ rubles.

An assessment of the influence of these factors can also be given in a relative expression, having divided for this the result of the influence of each factor by the planned volume of work on projects completed in the report year. In the example we have: for the Q factor $\frac{461 \cdot 100\%}{4{,}650} = +9.9\%$, for the K_d factor $\frac{(484.2) \cdot 100\%}{4{,}650} = -10.4\%$, and for the K_o factor $\frac{(907.1) \cdot 100\%}{4{,}650} = -19.5\%$. Thus, the overfulfillment of the plan for the volume of work on projects completed and put into operation during the report year is formed under the influence of the designated factors in the following manner: in absolute terms $461 + (-484.2) + (-907.1) = -930{,}300$ rubles; in relative terms $919 + (10.4) + (-19.5) = -20\%$.

On the basis of the relationships between the construction product indicators it is possible to carry out analytical calculations for the influence of a larger number of factors, that is, the indicators which reflect different conditions of construction work.

§11. Indicators for the Volume of Construction Work

The cost indicators for the produced and sold construction product are employed in solving many planning, accounting and statistical problems. However, the use of the product volume in cost terms for solving these problems is not always unconditionally applicable since the cost of construction product reflects the influence of factors which have no bearing on the product volume. For example, the estimated cost of the construction product and its change over time depend, with other conditions being equal, upon the change in the ratio of live and embodied labor in product cost. The result of previous labor is embodied chiefly in the materials consumed in construction work.

For example, if in laying parquet flooring, oak or yew is used instead of the ordinary (maple or ash) wood, then the estimated cost of a unit of such parquet flooring will be much greater than the cost of flooring made from maple. Thus, the use of the estimated cost of the work to describe the dynamics of the physical volume of construction product, the changed level and dynamics of labor productivity, the output-capital ratio and other indicators can produce a distorted notion of the dimensions and dynamics of product volume. All of this has led to the search for and practical experimental testing of production volume indicators.

The volume of production is an indicator characterizing in cost or labor terms the amount of involvement in producing a certain product for the labor of workers from a given organization (live labor) and the labor embodied in the organization's implements of production and material expenditures needed for the functioning of these means of labor in production. Thus, by concept the production volume should reflect the amount of participation of each enterprise, construction organization or its individual sections in creating the product.

For expressing the production volume in construction practices several indicators have been employed of which the best known were the following: the production volume for the normed cost of the work (NSR), for the normed labor intensiveness (NT), for the estimated normed labor intensiveness (SNT), the conditionally net product and others.

Of the above-listed indicators the features of the given definition are best met by the production volume according to the normed cost of the work as this is an indicator in which all types of the performed construction and installation work are correlated to the normed cost of their production. The component elements of this norm are the estimated expenditures on the wages for the workers in basic production, expenditures on operating construction machinery and overhead. In contrast to the estimated cost, the NSR does not include expenditures on raw products, materials and other subjects of labor as well as the profit incorporated in the estimated cost, being, in essence, the incomplete normed production costs. For precisely this reason the NSR to a certain degree makes it possible to smooth over the influence of certain factors which are not directly related to producing the given product and chiefly the influence of the material intensiveness and profitability of the work. Consequently, the NSR can be employed for assessing the work results of the organizations and for calculating output, the output-capital ratio and the other indicators for the effectiveness of construction work, and in particular labor-intensive work. Here it is essential to bear in mind that the NSR does not eliminate all the shortcomings of a cost indicator caused, in particular, by price formation features.

The conditional net product of construction organizations is an indicator close in content to the production volume but not equal to it. The sense of this indicator is that in addition to the newly created value, the total amortization on fixed capital is also included in it. In order to determine this indicator, it is essential to deduct from the estimated cost of construction-installation work the cost of the fixed and auxiliary materials, fuel, electric power and other material expenditures consumed in production with the exception of fixed capital amortization.

Conditional net product does not fully describe the volume of construction work since the profit of the contracting organization does not always correspond to the results of its operations.

Recently, normed net product has begun to be used as an indicator for evaluating the operation of the organizations. This includes all types of wages and deductions for social security. The net product norm or rate for each type of work can be determined as the difference between the estimated cost and the cost of material expenditures for producing a unit of work. An experimental verification of this indicator has shown its advantages over the other product indicators.

The production volume in terms of normed labor intensiveness is determined by multiplying the amount of work (Q) by the normed labor intensiveness (t_n). The total labor intensiveness of all the work carried out will be obtained by totaling these products, that is, Σqt_n and expressed in units of normed working time (man-days, man-hours and so forth). In contrast to the NSR, the designated indicator reflects the participation of just live labor in the given production and as a consequence of this it is also termed the volume of production work. This indicator is widely employed in the practices of planning construction work at individual organizations to figure output, to assess the fulfillment of the output standards and for other purposes. The calculation of the normed labor intensiveness of work can be carried out on a basis of estimated labor intensiveness norms which are uniform for all construction organizations as well as the planned norms worked out in the individual organizations. However, the latter are not uniform for the sector and cannot be employed to obtain a general indicator of the production volume for an aggregate of organizations as well as for comparison in other organizations.

As a variety of the normed labor intensiveness of the work, the contracting organizations as an experiment have employed the production volume according to the estimated normed labor intensiveness of the work (SNT) and this describes the volume of construction-installation work according to the estimated cost given in the normed labor intensiveness.[3] It is calculated in the following manner: the normed labor intensiveness of construction-installation work is determined in man-days and the obtained amount is multiplied by the average output for the estimated cost of one norm-day in the base period, that is:

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[3] See: A. M. Gol'dberg, V. S. Kozlov and D. G. Dolgushevskiy, "Proizvoditel'nost' truda v stroitel'stve" [Labor Productivity in Construction], Moscow, Statistika, 1970, pp 30-32.

$$\sum q_1 t_n \cdot \frac{\Sigma q_0 p_{cm}}{\Sigma q_0 t_n} = \sum q_1 t_n \overline{p}_{cm} .$$

The estimated normed labor intensiveness, like normed labor intensiveness of the work, does not consider the complexity and quality of the labor and responds poorly to a change in the work volume caused by an increased degree of work mechanization.

The above-examined indicators for the production volume are particular and conditional. They help in solving the problems of economic analysis, planning and operational leadership over the work of a given organization. A number of construction ministries are continuing to experiment with different measurements for the volume of construction work for the purpose of improving the indicators to assess the results of activities at the contracting organizations.

§12. Gross and Net Construction Product

Along with the examined indicators for construction product, on the sectorial scale statistics determines gross product as a portion of the aggregate social product in the nation and net construction product as a part of national income. In the individual contracting organizations these indicators are not calculated or employed. Sometimes the volume of produced construction product or contracting work is equated to the gross product of a contracting organizations. However, the term "gross product" has not become established in the accounting of an individual contracting organization.

Gross construction product is the total volume of product created by the basic activities of the research, design and construction organizations in the sector and by the population in individual construction. In accord with this notion, gross construction product includes the following components: 1) the product of design and research activities paid for out of capital investment funds, 2) geological prospecting paid for out of capital construction funds, 3) the product of construction work, 4) individual construction by the public.

However, the statistical reporting of contracting construction and design-research organizations does not provide for the full breaking down of gross product both for the nation as a whole as well as for the economic and administrative regions, the sectors and forms of ownership. The volume of gross construction product can be most fully calculated only on a basis of comprehensive information obtained from the reports on capital investments, construction and other sectors as well as from the materials of specially organized statistical surveys.

Information on the volume of construction product produced by the contracting organizations and by the direct labor method, the product of the design-research organizations as well as the work on deep exploratory and operational drilling for oil and gas are to be found in the reporting on capital investments submitted by the builder enterprises and organizations (Form No 2-ks). Since the builder participates in construction work (the concluding of contracts, the accepting of equipment, technical supervision and so forth), the result of this participation is a component part of the gross product of the sector in the form of the expenditures on technical supervision, the support of the administration and so forth. These data are found in the report of Form No 2-ks in the line "Other Capital Work and Expenditures." Data on major overhauls carried out both by the contracting and the direct-labor method as a whole are taken from the summary reporting of the ministries and departments. For the individual construction of the public, the data needed to calculate gross product are obtained from the annually conducted one-shot counts of individual housing and other construction by the public and from samplings of the cost of this construction.

Under the conditions of payments for a completed project and work stage, in the construction, design and research organizations large amounts of incomplete construction work are formed and this is not fully reflected in the accounting of the builders but should be included in the gross product. Information on incomplete construction work is submitted by the appropriate construction and design-research organizations to the builders in the statement of Form No 3 at the end of each month.

Along with gross product, in statistical practice the net product is also determined for construction as a national economic sector. For this the cost of material expenditures is subtracted from gross construction product. In this calculation the main difficulty is related to determining the amount of material expenditures in the sector's gross product. The problem is that the accounting of the builders contains no information on the expenditures for carrying out construction-installation and design-research work. The contracting and design-research organizations do account for the expenditures but only in terms of comprehensive items and not in terms of expenditure elements as is done in industry. As a consequence of this, in statistical practices the material expenditures in gross construction product are determined indirectly on the basis of data from the reporting of the contracting and design-research organizations on the costs of their product as well as by sampling surveys for production expenditures in these organizations as carried out by the USSR TsSU.

Gross and net construction product are calculated in current and fixed prices. For studying the dynamics of these indicators, their amounts are expressed in fixed (comparable) prices. At present these are 1973 prices. Gross and net construction product is recalculated using price indexes which reflect the ratio of the actual and estimated cost of the work performed.

§13. Methods of Studying the Dynamics of the Construction Product Volume

A study of the volume of construction product over time is a traditional and important task for statistics. In carrying out this task, statistics constructs time series and calculates the product volume indexes for the sector as a whole and for the types of its activities. The relative dynamic indicators calculated on the basis of a physical product count, the so-called individual indexes, are more often used to describe changes in end construction product, that is, the putting of capacity and fixed capital projects into operation. For example, in the Ninth Five-Year Plan, the state and cooperative enterprises built 407.3 million m^3 of total housing area and this was 115.5 percent of the housing construction volume in the Eighth Five-Year Plan.

For a general description of product dynamics in construction, the product cost indicators are employed, that is: gross and net construction product, the volume of construction-installation work, the volume of design-research work and others. The construction product volume used as the level for the time series is expressed by the estimated cost making it possible to measure the physical product volume and its change. The index for the construction product volume is determined by the formula:

$$I = \frac{\Sigma q_1 p_{cm}}{\Sigma q_0 p_{cm}},$$

where q_1, q_0--volume of the work carried out by the sector's organizations in physical units, respectively, in the report and base periods;

p_{cm}--fixed estimated prices.

In the index for the product volume, the prices for obtaining its cost expression should be uniform for the compared periods. Ordinarily in practice, for the comparison estimated prices in effect during the report period are employed. It is possible to calculate the index for the volume of construction product directly using the above-given formula without any corrections and limitations solely in the period the same estimated prices were in effect. However, during the time fixed estimated prices are in effect there often are particular changes in the price formation elements. For example, after the introduction of the new estimated prices on 1 January 1969, changes were made in the prices for individual types of materials and the overhead rates for individual types of construction; the wages of the medium-paid employee categories were increased. Such changes did not involve the general price formation base in construction and did not entail a change in the estimated prices, but at the same time they led to adjustments in the estimated cost of the work, that is, to a recalculating of the work volumes.

For recalculating the work volumes in statistical practices price indexes (conversion factors) are used in employing the following formula:

$$Q_n = \sum Q_o \cdot I_p,$$

where Q_n and Q_o--the work volumes, respectively, in the new and old estimated prices.

In addition to the indicators for the work volume dynamics, statistics also calculates territorial indexes for the physical work volume, that is, statistical indicators. The methodology of calculating these indicators is analogous to the calculating of the product volume indexes under the conditions of applying different prices. Since the nation has estimated prices which are differentiated by regions (zones), the same physical volume of construction-installation work expressed by the estimated cost can have a differing amount for the various geographical areas of the nation. For example, the volume of work carried out in the Far East (the fifth territorial zone) comprising 2.5 million rubles in the estimated prices of this region would be only 2.12 million rubles in the estimated prices of the first territorial zone.

For calculating a territorial index for the volume of construction-installation work, it is essential first to recalculate the compared work volumes in the estimated prices of the same territorial zone used for the comparison. Most often the estimated prices of the first territorial zone are used as the comparisons. The work volume in the prices of the first territorial zone is recalculated by dividing the work volume in the estimated prices current for the given territorial zone by the deviation ratio for the estimated prices in the given territorial zone from the estimated prices of zone one. For calculating the territorial indexes one should clarify the boundaries of the compared areas and the range of construction organizations the products of which should be considered in calculating the index. Both questions are settled considering the specific aim of the economic research.

§14. A Statistical Study of the Steady Output of Construction Product and Its Quality

The carrying out of construction-installation work over each segment of time in the report period in accord with the established plan is one of the most important conditions for completing the construction of each project on time and also for achieving high economic indicators for construction work. The steady pace of construction is studied by statistics in two areas: in the first place, in terms of carrying out the construction-installation work in accord with the established plan (schedule) for the volume and composition of work over equal time intervals; secondly, the evenness and steadiness of completing construction of the projects and their putting into operation are assessed.

For measuring the steadiness of producing construction product the product cost indicators are most often employed. However, an assessment of the steady operation of the primary production sections of a construction organization is possible by physical product measurements, for example, for the individual types of construction and installation work. Only physical measurements are employed in assessing the steadiness of putting projects into operation.

The most widespread method of observing the steadiness of pace in construction is the calculating of the proportional amount of the work volume carried out over each time segment of the overall period. For example, if the volume of construction-installation work is carried out over a year, it can be represented as the total of the component work volumes over the four quarters or 12 months. By dividing the completed work volume for each quarter (month) by the annual work volume we will obtain the sought relative indicator, that is, the proportional amount of work in the quarters (months). Table V.6 gives an example of calculating these indicators for a construction administration during a report year. From a comparison of the actual and planned indicators for the proportional amount in each quarter it is possible to obtain an idea of the disruption in the steady pace of the given organization.

Table V.6

Indicators	Volume of construction work by quarters				
	I	II	III	IV	Year
By plan in % of annual volume	24	25	26	25	100
Actual:					
1,000 rubles	1,015	1,297	1,805	1,523	5,640
% of annual volume	18	23	32	27	100

Precisely this method can provide a description of the influence of the seasonal factor of climatic conditions on the scale and dynamics of construction work and its steadiness. The industrialization of construction which has developed in recent years which has made it possible to overcome the seasonality in this area. But this does not mean that in individual periods of the year the influence of the seasons on the work volume has been oompletely eliminated. Ordinarily the seasonality index (I_s) is figured to disclose and numerically describe seasonal fluctuations. In the given instance this is the percentage of the actually completed amount of work over each month (quarter) of the year (Q_m) to the average monthly (or quarterly) work volume ($\bar{Q}_m$), that is, $I_s = Q_m : \bar{Q}_m$. In the example the seasonality indexes are for the first quarter $\left(1{,}015 : \frac{5{,}640}{4} \cdot 100\right) = 72\%$, for the second quarter 92%, for the third quarter 128% and for the fourth quarter 108%. A graphic depiction of the results of producing construction product provides a visual idea of the steadiness and seasonality of carrying out the work over adjacent segments of time.

For a general description of the steady execution of work, statistics calculates indicators based upon a direct comparison of report and plan data on construction product output. Here the information on the fulfilled amount of work is best taken for short time intervals such as months, 10-day periods, days or even hours. The shorter the unit of measurement the fuller the evaluation will be for production steadiness. The indicators of this group are termed steadiness factors. For calculating them, methods have been proposed based upon absolute indicators for the work volume or on relative amounts of plan fulfillment.

Such an indicator is the steadiness coefficient calculated by the formula:

$$K_r = \frac{\Sigma q_f}{\Sigma q_{p\ell}},$$

where q_f--the volume of actually completed work in the individual time intervals within not more than the plan;

$q_{p\ell}$--the amount of work according to the plan for these same time intervals.

The formula of the steadiness coefficient for relative data provides virtually the same result but the conditions for its use are different as only equal intervals of a period are used:

$$K_r = \frac{\Sigma p}{100 \cdot n},$$

where p--the percentage of plan fulfillment over an individual period but not more than 100 percent;

n--the number of individual periods for which the relative indicators of plan fulfillment have been calculated.

The basic principle for calculating the given coefficient is the assumption that the amount of steadiness cannot be more than one (or 100 percent). For this reason in determining this indicator the volume of work within the plan is figured in the fulfillment of the plan for steadiness. Let us show the calculating of this indicator from an example. We will assume that the following data are known on the fulfillment of the work plan by a construction organization for the individual months of a year (Table V.7). With the fulfillment of the work plan over the year by 100.17 % $\left(\frac{20,475}{20,440} \cdot 100\right)$, the steadiness coefficient will be: $K_r = \frac{19,905}{20,440} \cdot 100 =$ 0.974 or 97.4%.

Table V.7

Месяцы 1	Производство работ в тыс. руб. сметной стоимости 2		5 Процент выполнения плана	6 Засчитывается в выполнение плана по ритмичности	Отклонения от плана в долях единиц 7	
	по плану 3	фактически 4			положительные 8	отрицательные 9
Jan	1 150	1 020	88,70	1 020		0,1130
Feb	1 100	1 000	90,91	1 000		0,0909
Mar	1 280	1 240	96,88	1 240		0,0312
Apr	1 400	1 360	97,14	1 360		0,0286
May	1 600	1 530	95,62	1 530		0,0438
Jun	1 800	1 890	105,00	1 800	0,0500	
Jul	2 000	1 900	95,00	1 900		0,0500
Aug	2 010	2 005	99,75	2 005		0,0025
Sep	2 100	2 260	107,62	2 100	0,0762	
Oct	2 000	1 950	97,50	1 950		0,0250
Nov	2 000	2 160	108,00	2 000	0,0800	
Dec	2 000	2 160	108,00	2 000	0,0800	
year total	20 440	20 475	100,17	19 905	0,2862	0,3625

Key: 1--Months; 2--Production of work in 1,000 rubles of estimated cost; 3--Planned; 4--Actual; 5--Percentage of plan fulfillment; 6--Figure in fulfillment of plan for steadiness; 7--Deviations from plan in fractions of a unit; 8--Positive; 9--Negative

The unsteadiness of producing construction product is described much more completely by the unsteadiness number recommended by Prof V. Ye. Adamov for studying the steadiness of industrial production.[4] In order to calculate these indicators, one determines the relative deviations in the volume of the actually completed work from the work volume according to the plan in fractions separately for the instances of the fulfillment and overfulfillment of the plan and for the nonfulfillment of the plan. The total deviations of the first type provide positive numbers for unsteadiness while the total deviations of the second type produce the negative unsteadiness numbers. The result of adding the negative and positive numbers provides the overall unsteadiness number. In the example the calculating of the unsteadiness numbers has been given in the last two columns of the table. For the report year the overall unsteadiness number will be: 0.2862 + 0.3625 = 0.649. If, for example, in the previous year the overall unsteadiness number (calculated for the monthly data) equaled 0.684, then one can conclude that the steadiness level has

[4] See: V. Ye. Adamov, "Statisticheskoye izucheniye ritmichnosti promyshlennogo proizvodstva" [A Statistical Study of the Steadiness of Industrial Production], Moscow, Statistika, 1965.

declined by 5.1 percent (0.649:0.684). In construction, an assessment of steadiness using an hourly schedule has still not been widely used due to certain features of the given sector. However the rapidly developing industrialization of construction has raised the task of carefully observing the steady operation of an organization not only by quarters and months but also in terms of daily and hourly schedules. The use of the "off the truck" installation method by housing construction combines and the assembly-line construction method have posed the compulsory demand of strictly observing the hourly work schedule not only in terms of volume but also in terms of the quality, composition and sequence of construction-installation work.

An important task for statistics is to study the quality of construction product. The importance of improved product quality for the national economy is very great as this leads ultimately to a decline in the labor and material expenditures and to the growth of production efficiency. At present, in all the national economic sectors and, in particular, in construction, a struggle has started to improve product quality. In this movement a special place is held by increasing reliability and raising durability of the product. The latter are becoming important indicators characterizing the quality of the construction product.

The construction product quality indicators should numerically describe the ability of the created fixed capital projects to satisfy the consumer properties envisaged in the plans and give an overall assessment of product quality. Statistics should also bring out the degree to which various factors influence the change in product quality.

The basic consumer properties of construction product and their conformity to the technical conditions are disclosed in the process of technical control or inspection and the forms and methods of these in construction are diverse. In accord with the organization of technical inspection and the particular features of construction work, the quality of construction product is determined in the process of the construction work and for the completed fixed capital projects in the process of their operation as well.

It must be pointed out that the product quality indicators and the methods of calculating them in construction have not yet emerged from the development stage and are only separate indicators which have not been linked into a system.

A point assessment of the quality of construction-installation work is one of the widespread product quality indicators. On the basis of this system, statistical reporting has been worked out and is employed by the contracting organizations for the quality of construction on the projects accepted for operation (the Appendix to Form No 1-ks and 2-ks). The quality of the projects turned over and the work performed in this reporting is described by three estimates: excellent, good and satisfactory, and here data are given on the number of projects, their estimated cost, and for production projects, on the value of the work performed. Having assigned an appropriate number of points to each assessment, it is possible to obtain a general description of construction product quality in the form of an average number of points calculated from the formula for the arithmetic average weighted for the number of projects and their estimated cost.

Another indicator which is employed in the practice of the construction organizations describes the volume of construction-installation work which does not meet the requirements of the technical conditions and must undergo redoing. Information on such work can be obtained both in physical measurements as well as in cost units (according to the estimated cost). The volume of such work when related to the total volume will show the relative amount of work produced which does not satisfy the required consumer properties.

The quality of the work performed can be described by the estimated cost of the uncompleted work on projects which have been put into operation and this in practice is termed "unfinished work." Such an indicator is given in the statistical reporting on the construction quality of projects. The designated indicators, strictly speaking, describe the work quality of a construction organization for the unfinished work and work to be done are not products.

In this same group of indicators is the amount of losses from the redoing of work both in an absolute form (in terms of cost) and in a relative one. The latter indicator is calculated by dividing the total losses (at the estimated cost) related to the redoing of work by the estimated cost of all the construction-installation work over the given period.

A description of the quality of end construction product can also be given using the above-examined indicators. Moreover, for studying the durability of buildings and installations, the scientific research institutes in practice calculate the average lives of construction projects using a formula for the arithmetic average weighted for the number of projects. Certainly such indicators are determined for uniform construction projects grouped by different features (purpose, design, size, wall materials and so forth).

For a study of reliability which is a second important quality feature of construction product, indicators are calculated which describe the average lives of a construction project without major and medium overhauls. In the process of the description it is important to estimate the total additional monetary expenditures to eliminate any sort of flaws in the performed work, to reinforce structural elements and so forth, as well as to determine the relative amount of these expenditures in the estimated cost of the given project. In construction the methods of statistical product quality control for the purpose of preventing defective products have been little worked out.

CHAPTER VI: LABOR AND WAGE STATISTICS

§1. The Tasks of the Statistical Study of Labor and Wages in Construction

Labor is the basic factor in the production process. The correct placement of workers in the construction sections and their rational utilization have a substantial impact upon the successful fulfillment of the construction plans in terms of volume and quality. At present, the following are set as approved indicators in the construction plan: the growth of labor productivity, the limit on the number of employees and the total wage fund. A statistical study of labor encompasses the statistics of labor resources, labor productivity and wages.

The labor resources of construction are formed by the aggregate of workers employed in the construction, installation, design-research and other organizations comprising the sector. The tasks of statistics in studying labor resources are to describe the number and composition of workers, to determine the supply of workers for construction, to study the movement of the number of workers and to determine the amounts of the actual labor expenditures and the utilization of work time.

Increased effectiveness of the employed labor, that is, higher labor productivity, is an important condition for increasing the construction volume. In studying labor productivity, statistics poses and solves the following problems: measuring the level of labor productivity, describing the fulfillment of the plan and dynamics of labor productivity in the various production areas, assessing the fulfillment of the output norms by workers, analyzing the influence of factors on a change in labor productivity and elucidating reserves for its further rise.

The concluding section of labor statistics takes up the questions of wages for construction workers. Among the tasks of wage statistics are the following: Studying the amounts, composition and use of the wage fund, a description of the average wage levels and their dynamics, a study of the ratio of the growth rates of labor productivity and average wages and a description of the distribution of wage forms and systems in construction.

§2. A Statistical Study of the Size, Composition and Movement of the Workers

Depending upon the economic tasks, the composition of workers at construction organizations is studied in different ways. The most important of these is a study of the composition of workers by areas of their work and by the production functions performed by them. By production areas all personnel at an organization is distributed into the workers engaged in basic production, in subsidiary production and in service systems.

The first group includes all the workers employed directly or indirectly in basic, that is, construction, work. Here are the workers who carry out construction and installation work in erecting the buildings and installations, the workers from the personnel of the construction organizations, the OKS and UKS, the workers of service systems but employed in running construction machines and so forth. The se^ nd group includes the workers from subsidiary production which is organizational] .istinct but does not have an independent balance sheet and produces industrial-type products (quarries, concrete and cement centers, sawmills, construction yards, power plants and so forth). The third group includes the workers from the numerous production-end service systems (transport offices, assembly supply administrations, design-estimate groups and so forth) and of a nonproduction nature (the housing and utility system, polyclinics, clubs, nurseries, creches and so forth).

In terms of the production functions performed, all personnel of the organizations is divided into the following categories: workers or persons employed in manufacturing the product, students or persons learning worker professions, engineer and technical personnel (ITR) or persons employed in preparing and supervising the production process, directing production and carrying out other functions requiring special technical and economic knowledge, white collar personnel or persons performing office, accounting, supply and other functions, junior service personnel (MOP) or persons employed in cleaning or heating the rooms and so forth, and security workers or persons employed in guard and fire security for the construction sites.

Statistics pays particular attention to the most numerous and important personnel category in terms of their role in production, that is, the workers. The proportional amount of worker in 1978 was around 80 percent of all construction employees. The composition of workers is studied by sex, age, length of employment, professions, skills and many other features. The initial data for such worker groupings are usually obtained as a result of one-shot surveys which are periodically conducted by the statistical bodies (twice every 5 years).

A notion of the general skill level of the workers can be gained on the basis of the average worker rate categories as a whole, for the work areas, professions and so forth. These are calculated by the formula:

$$\overline{R} = \frac{\Sigma Rn}{\Sigma n},$$

where R--the rate category;
n--the number of workers with the given category.

Here the degree of skill homogeneity in the composition of the workers can be judged from the variation indicators.

In the analysis of manpower, of interest is the result of comparing worker skill levels in different construction areas and professions and the work performed by them. Here the compared average worker rate categories and the work performed by them must be calculated by the same method, that is, weighted with the number of workers from the given aggregate. A more complete notion is provided by a combination table or a matrix for the distribution of the workers in terms of their skill level and the performed job, as has been done in the example of surveying 284 workers from a trust (Table VI.1) and the conformity indicators calculated on its basis.

Table VI.1

worker category	work category						total
	1	2	3	4	5	6	
1	18						18
2	3	17	11				31
3		10	64	12	1		87
4			8	58	9		75
5			1	13	24		38
6					13	22	35
total	21	27	84	83	47	22	284

According to the data of the table, $R_{worker} = \frac{1\cdot18+2\cdot31+3\cdot87+4\cdot75+5\cdot38+6\cdot35}{284} =$ 3.67, while $R_{work} = \frac{1\cdot21+2\cdot27+3\cdot84+4\cdot83+5\cdot47+6\cdot22}{284} = 3.61$, that is, the average skill level of the workers is higher than the average difficulty level of the work performed by them. The proportional amount of the number of workers performing a job of a higher category than their skill will be: $\frac{(11+12+1+9)}{284}\,100 = \frac{33\cdot100}{284}\,100 =$ 11.6%, the proportional amount of workers performing a job under their category equals: $\frac{3+10+8+1+13+13}{284} = 16.9\%$, while the total proportional amount of the number of workers performing a job not conforming to their skill is $\frac{33+48}{284}\cdot100 =$ 28.5%. The coefficient of rank correlation or the concordance coefficient can serve as an overall measure of the conformity of the workers and their jobs, since the values of the features are given in a natural series of numbers, that is, they are ranked. In the example, the coefficient of rank correlation calculated by Spearman's formula is:

$$\rho = 1 - \frac{6\Sigma d^2}{n(n^2-1)}\text{, and equals } 0.916,$$

where d--the difference in the skill levels of the worker and his job;
n--the number of feature pairs.

This points to a high level of the conformity of worker skill and his job.

A study of the composition of employees is closely related to the determining of their number. In statistics and accounting a distinction is made in the following categories of the number of employees: the listed number, the present number and the number of persons who actually worked. The listed number of workers (listed composition) encompasses the aggregate of all the permanent, seasonal and temporary employees hired for work for one day and more. The including of the employees in the listed composition does not depend upon whether or not the person has reported for work or begun it or not. Employees hired by an organization in the capacity of a second job are not included in the listed personnel and this makes it possible to prevent double counting in a summarizing of the number of workers. The present number characterizes the number of workers who have appeared for work. The number of persons who have actually worked indicates the number who have appeared and gone to work. The inequality of the last two categories for the number of employees is caused by the presence of entire-day stoppages. The accounting for employees by number categories is carried out daily on the basis of a table or time board and on holidays and days off the listed number of employees is considered equal to the number of employees on the previous work day.

For describing the number of employees over a period, the average listed number is determined (for a month, quarter or year). For a month this indicator is obtained from the formula:

$$\bar{C} = \frac{\Sigma C_i}{T_c},$$

where C_i--the number of listed employees for each day and
T_c--the calendar length of the month in days.

Since the listed number of employees over a day equals the number of those present C_p and those absent C_a on a given day, the formula for the average assumes the following form:

$$\bar{C} = \frac{\sum C_p + \sum C_a}{T_c}.$$

In calculating the average listed number of employees over an extended period (quarter, 6 months or year), it is possible to proceed from the averages calculated over the previous periods ($\bar{C}_i$), using for this the formula of the weighted arithmetic average, that is,

$$\bar{C} = \frac{\sum \bar{C}_i T_i}{T_i},$$

where T_i--the calendar length of the period (in days or months) for which the intermediate average ($\bar{C}_i$) was obtained.

In instances when there are average listed numbers for the same calendar periods, in practice a simple arithmetic average is calculated. According to the USSR TsSU instructions, in calculating the average listed number of employees, one should exclude from the count the persons who are on extended supplementary leaves (for example, women after completing pregnancy leaves during the period of caring for the child until it reaches the age of 1 year, employees who are studying in evening and correspondence higher and specialized secondary schools and who have been given additional unpaid leave and so forth).

Table VI.2

indicators	date								total
	24	25	26 (off)	27 (off)	28	29	30	31	
1) Состояло рабочих в списках	638	647	647	647	642	654	651	658	5 184
2) в том числе не учитываемых в расчете средней		2	2	2	3	3	4	6	22

Key: 1--Listed workers; 2--Including those not counted in figuring the average

Let us examine an example of calculating the average listed number of employees for a trust which began operating on 24 December with 2 days off a week (Table VI.2). The average listed number of employees at the trust in December will be: $\frac{5,184-22}{31} = \frac{5,162}{31} = 166.5$ persons (man-months), while the average listed number of workers for the fourth quarter will equal: $\frac{166.5 \cdot 1 + 0.2}{3} = 55.5$ persons (man-quarters), and the average listed number of workers per year is $\frac{166.5 \cdot 1 + 0.11}{12} =$ 13.9 persons (man-years). The difference in the average values is caused by the differing length of the periods for which they are figured. In other words, each average corresponds to the calendar time fund of the workers expressed, correspondingly, in man-month, man-quarters or man-years.

An important question in the study of labor resources is a description of the availability of employees for a construction organization in the necessary quantity and composition for carrying out the production program. For this, for each employee category, the actual average listed number of employees is compared with the planned and in terms of the workers this is compared with the planned number ($\bar{C}_{p\ell}$) corrected by the percentage of plan fulfillment for construction product ($I_{f/p\ell}$), that is, $\bar{C}_{p\ell/c} = \bar{C}_{p\ell} I_{f/p\ell}$. Let us assume that in September the trust fulfilled the work plan by 105 percent, having the following number of employees (Table VI.3, cols. 1 and 2). The table shows the calculation of the availability of workers for the trust not counting the fulfillment of the work plan. But considering the fulfillment of this plan, the absolute deviation in the actual number of workers from the plan (corrected) will be: $1,642 - \frac{1,600 \cdot 105}{100} = 1,642 - 1,680 = -38$ men. The discovered savings in manpower has been caused by the corresponding rise in labor productivity in comparison with the plan. Consequently, the total savings of employees for the trust will be 44 men (38 + 6).

The study of the change in the number of employees or the movement of their number is another task of labor resource statistics. It is possible to judge the movement of the number of employees from the growth rates and the absolute increase determined by comparing the data on individual dates of different periods. A fuller picture of the dynamics is provided by the indicators showing the movement of the number of workers and namely the manpower turnover as a consequence of hiring and firing. In

Table VI.3

Categories of trust personnel	Average listed number of employees		Absolute deviation (col. 2-col. 1)	Percentage of plan fulfillment (col. 2:col. 1)
	Planned	Report		
	1	2	3	4
Total personnel of trust	2,000	2,036	+36	101.8
Including:				
Workers	1,600	1,642	+42	102.6
Employees of other categories	400	394	-6	98.5

statistics a distinction is drawn between hiring turnover and firing turnover and these are expressed, correspondingly, by the number of persons hired and the number of persons let go over the period. Here the movement of the employees from one category to another is not taken into account.

The fullest notion of the movement of the number of employees is provided by the manpower balance which, on the one hand, shows the available employees at the start of the period and the number of employees hired with a distribution according to the sources, and on the other hand, the distribution of the number of workers let go for various reasons and their available number at the end of the period. From the balance scheme information are given on the number of workers and the changes in their number in the report for Form No 3-t (quarterly). On the basis of these data, the absolute amounts of the hiring and firing turnover are calculated as well as the relative indicators for turnover coefficients calculated, correspondingly, as the ratios of the absolute turnover amounts (T_u) for hiring and firing to the average listed number of employees over the given period, that is, $K_t = T_u:\bar{C}$.

The most detailed study is made of the reasons for the loss of employees. The dismissal of employees for reasons of a production or general state nature (completing the term of a contract, induction into the Soviet Army and so forth) as well as related to age and state of health comprises the necessary turnover while dismissal for reasons of a personal nature, for example, due to the failure to meet skills, leaving at own request and so forth, comprises the excess turnover or manpower turnover. The ratio of the number of persons let go for reasons causing personnel turnover to the average listed number of workers is termed the turnover coefficient. High personnel turnover points to serious shortcomings in the organization of labor, wages and so forth. The frequent change of personnel leads to a situation where unskilled or persons not having the needed specialty are hired and ultimately to a decline in labor productivity and work quality.

The labor reporting gives the number of workers who are part of the listed personnel for the entire year. This indicator characterizes manpower stability. The ratio of the number of workers on the lists for the entire year to the listed number of workers at the start of the year is termed the personnel constancy factor. In construction, depending upon the season, there are seasonal changes in the number of workers. Thus, at the Komsomol and other construction sites of the nation during the period of summer vacations large student detachments are employed. For establishing the numerical nature of the seasonal changes, seasonality indexes are calculated as the percentage ratio of the average listed number of employees for each month to the average monthly number of employees over the year (or equated to the annual levels).

§3. Accounting for Working Time and the Indicators of Its Use

Labor resource statistics is closely tied to the study of working time which describes the amounts of the available and actual expenditures of live labor. Working time is accounted for basically only for the worker category and chiefly in man-days and man-hours. The presence and absence of employees on the job are expressed primarily in man-days. Here each day of a worker's presence or absence is recorded as a corresponding man-day. Absent workers are accounted for in terms of the reasons for absence (regular leave, day off, sick leave and so forth). The day when the worker has reported and begun to work or has been on an official mission is considered to be a worked man-day. A worker who has reported for work but who has not worked during the day due to factors not depending upon him is considered in the reporting as a man-day of a whole-day stoppage.

On the basis of working time accounting in man-days, in accord with the work conditions and hours, different available working times are determined and their content and relationship with one another can be seen from the diagram. The total attendances and absences for all reasons comprises the worker available calendar time. Thus, for a worker who has been on the lists for a full month, it equals the calendar length of the month, and for all workers the total of the listed numbers for each day of the month. Using the data on the composition of available working time, indicators are figured for its use and these are expressed by indicators for the structure of the available calendar time and by the ratios of the various components of the available time (the available time use factors).

<table>
<tr><td colspan="5">Available calendar time</td></tr>
<tr><td colspan="4">Timesheet available time</td><td>Holidays and days off</td></tr>
<tr><td colspan="3">Maximum availalbe possible working time (MVF)</td><td>Regular leaves</td><td></td></tr>
<tr><td colspan="2">Reports for work</td><td>Absences from MVF</td><td colspan="2"></td></tr>
<tr><td>Worked man-days</td><td>Entire-day stoppages</td><td colspan="3"></td></tr>
</table>

Diagram VI.1. Composition of available worker calendar time

Let us assume that in a trust during the report quarter some 62,246 man-days were worked, absences during days off and holidays were 20,104 man-days, absences due to regular leaves were 4,683 man-days, other absences were 1,168 man-days and whole-day stoppages were 34 man-days. The available worker calendar time for the trust over the quarter was: $64{,}246 + 20{,}104 + 4{,}683 + 1{,}168 + 34 = 90{,}235$ man-days, while the use factor of this available time will be: $\frac{64{,}296}{90{,}235} = 0.712$. The maximum possible available working time over the quarter is: $90{,}235 - 20{,}104 - 4{,}683 = 65{,}448$ man-days and correspondingly the use factor of the MVF will be: $\frac{64{,}246}{65{,}448} = 0.98$.

More precise accounting for working time is kept in man-hours. One hour of actual work by a worker is considered a worked man-hour. However, in practice the worked man-hours also include brief breaks in the work. The worked man-hours are divided into regular, that is, those worked in a work shift, and overtime, that is, those worked above its limit. The time not worked during a shift (the intrashift breaks), in particular stoppages, are also accounted for in man-hours. In construction organizations, worker stoppages are studied in terms of the reasons of their occurrence, among which one must mention first of all the lack of a workfront, materials, electric power, malfunctioning machinery and others.

In accounting the intrashift stoppages are not always fully shown due to the difficulty of detecting them. For this reason, for a thorough study of working time, and in particular, its losses special studies are run, for example, the photographing and self-photographing of the workday, the essence of which consists in recording working time and work breaks by special observers or by the workers themselves. Recently, the statistical method of moment observations has become widespread. The essence of this sampling method is that the observers over certain intervals of time go around to the work areas and record the state of the work or the reasons for work breaks. The number of observations needed to obtain confident data can be determined from the formula of a random repeat sampling observation

$$n = \frac{t^2\omega(1-\omega)}{\Delta^2},$$

where t--the confidence coefficient which depends upon the probability that guarantees the maximum sampling error (Δ);
ω--the sampling fraction (working time use factor).

From the number of observations it is possible to determine the fraction of work and unworked time and them their absolute amounts.

For example, during a shift (8 hours or 480 minutes) a group of 70 workers made 900 observations and in 774 instances recorded "work" and in 126 instances intrashift stoppages. Hence the share of worked time was $\frac{744}{900} = 0.86$, and the share of stoppages $\frac{126}{900} = 0.14$. Consequently, the intrashift stoppages were: $70 \cdot 480 \cdot 0.14 = 4{,}704$ man-minutes or 78.4 man-hours while the actually worked time was $70 \cdot 480 \cdot 0.86 = 28{,}896$ man-minutes or 482 man-hours. An assessment of the representativeness of the sampling can be determined using the resampling formulas.

A most detailed notion of the amounts and composition of labor expenditures and their losses is provided by the working time balance. As the resources in the balance they ordinarily employ the maximum possible available working time expressed in man-hours and called the available time. This is determined by multiplying the maximum possible available time by the average established length of the work day. The distribution of the available time comprises the second and basic portion of the balance which contains three sections: 1) actually worked time, 2) working time not used for valid reasons (provided in the labor legislation) and 3) working time losses caused by whole-day and intrashift stoppages, by violations of labor discipline (absences without leave, tardiness and so forth). The overtime worked by the workers is shown off the balance. In the predicate of the balance, in addition to the absolute amounts of working time, the indicators of its structure and deviations from the plan are also given.

In analyzing the labor resources it is advisable to employ the interrelated indicators for working time utilization. Most often this is the coefficient for the utilization of the number of workdays of a worker, the coefficient for the utilization of the length of the workday and the integral coefficient (complete) of working time utilization. The initial data and the methodology for calculating the indicators for working time utilization are given in Table VI.4 using the example of the operation of a trust for 2 months. A diagram of the relationship between the indicators of working time utilization is: $T_s = \overline{T}_d \cdot \overline{T}_{wd} \cdot \overline{C}$; their coefficients are analogously related. In the example 1.048 = 1.044•0.986•1.018. The relationship of the indicators is used in factor index analysis of a change in working time expenditures over time or in comparison with the plan.

Table VI.4

Indicator	Symbol	September	October	Dynamics coefficient
1. Average listed number of workers	$\overline{C}$	486	495	1.018
2. Man-days worked by workers	T_d	9,866	10,494	1.064
3. Total man-hours worked by workers	T_h	71,053	74,498	1.048
4. Including overtime	T_{ot}	987	1,049	1.063
5. Average number of workdays per worker (line 2:line 1)	$\overline{T}_d$	20.3	21.2	1.044
6. Average full duration of workday (line 3:line 2)	$\overline{T}_{wd}$	7.2	7.1	0.986
7. Average regular duration of workday (line3 - line 4):line 2	$\overline{T}_r$	7.1	7.0	0.986
8. Average number of work hours of one worker (line 3:line 1)	$\overline{T}_h$	146.2	150.5	1.029

Construction organizations have different work schedules including one, two or three shifts. In this regard for planning and other purposes the need arises to study the load factor of the work areas over the shifts. The load factor for the work shifts is characterized by the shift factor or the shift utilization factor. The shift factor is figured by relating the worked man-days to the number of man-days worked on the biggest shift. The second indicator is obtained by dividing the shift factor by the number of work shifts established for the organization. Let us assume that in a trust operating on two shifts in September, 5,243 man-days were worked on the largest shift, and then the shift factor will be $\frac{9,866}{5,243} = 1.9$ while the shift utilization factor is $\frac{1.9}{2} = 0.95$. The first indicator describes the average load factor for each work area during the shifts while the second shows the evenness of shift loading. If the latter equals 1.0, then this means that there is an even distribution of the workers over the shifts. In the administrations of a trust, glavk or ministry, most often various shifts are the most filled and for this reason in the denominator of the shift factor it is essential to use the total of the worked man-days in the fullest shifts of each administration. Since there is no information in the statistical reporting for calculating the shift factors, these are determined from the data of accounting by the organizations or from special observations.

§4. The Statistical Methodology for Measuring Labor Productivity in Construction

Labor productivity is a most important quality description of the labor process expressing its efficiency and fruitfulness. A constant rise in labor productivity is an economic law of socialist production.

The labor productivity level is expressed by average product output per unit of working time (the direct amount) or by the labor intensiveness of a unit of product (the inverse amount). Having designated the volume of construction product by q and the working time expenditures on producing it by T, average product output per unit of working time can be determined as $w = q/T$, while the labor intensiveness of the product is expressed as $t = T/q$. Average output and labor intensiveness are reciprocal amounts, that is, $w = 1/t$. For this reason, in knowing how average output changes, it is possible to determine the dynamics of labor intensiveness. At the same time the coefficient for the dynamics of labor productivity will be calculated for output in terms of the ratio $i = w_1:w_0$ and for labor intensiveness $i = t_0:t_1$, that is, as the ratios of the base and report levels. This principle is maintained in constructing aggregate labor productivity indexes. Let us assume that over a month a worker brigade has carried out 750 m^2 of painting, having spent 150 man-hours on this. Average output per man-hour is 750/150 = 5 m^2, while the labor intensiveness of 1 m^2 is 150/750 = 0.2 man-hours. Let us assume that in the previous month average output per man-hour was 4 m^2 while labor intensiveness of 1 m^2 was 0.25 man-hours. Then the coefficient for labor productivity dynamics is $i = 5:4 = 1.25$, or $i = 0.25:0.2 = 1.25$.

In calculating labor productivity levels, the question arises of the categories of the worker aggregate and the working time units which are to be employed in the calculation as well as the question of the methods of measuring the product. Due to the fact that various worker groups and categories are involved in the creation of construction product, the question of the choice of the aggregate is determined depending upon the specific economic task of the research. Theoretically output can be defined both for the workers and for all the employees of the construction organizations engaged in basic production or in the basic and auxiliary production together and even for all the organization's production subdivisions. In planning and statistical practices it has become the rule to calculate output for the employees of basic and auxiliary production and in describing labor productivity this makes it possible to consider the role of all employee categories engaged both in basic and the closely related subsidiary production.

Worker labor productivity is studied in the greatest detail. Depending upon the scale of the unit of measurement for working time, a distinction is made between the average hourly, daily and monthly output of the workers and these have a varying content and purpose. Average hourly output (ω_h) is determined by the ratio of the volume of construction product to the worked man-hours. This describes the labor productivity level on which the worker worked without stoppages and intrashift losses of working time. The average daily output (ω_d) is obtained by dividing the volume of construction product by the worked man-days. This depends upon the hourly output and the utilization of the length of the working day. Average monthly output (ω_m) is determined by dividing the volume of construction product by the average listed number of workers. It reflects the influence of average daily output and the utilization of the work month. The larger the unit of working time the more factors and conditions reflected in output.

The designated types of average worker output are interrelated and can be represented in the form of the product of comultipliers or indicators, for example, the following ones: $\omega_m = \omega_h \overline{T}_{wd} \overline{T}_d = \omega_d \overline{T}_d$. The corresponding dynamic coefficients are interrelated in an analogous manner. Like the average monthly output, proceeding from the corresponding data, the average quarterly, semiannual and annual output of workers and employees can be calculated. The multiplicative form of the dependence of the indicators is the basis for carrying out factor analysis on labor productivity using the index method.

The volume of construction product can be expressed by different measurement units. Depending upon this, a distinction is made between the physical, labor and cost methods of measuring labor productivity. The labor productivity level in physical units is the simplest and least subject to distortion. This is described by the quantity of construction-installation work carried out in physical units per unit of work time, for example, by the amount of dirt moved in m^2 or tons of installed metal structural elements per worked man-day. On the basis of the labor productivity levels in physical units, indicators are calculated for its dynamics using the formula of the so-called average level index, that is, $I = \overline{\omega}_1 : \overline{\omega}_0$. Here it is essential to observe a number of conditions which ensure compatability of the levels. First of all, the construction product used in calculating the output levels should be uniform in terms of its consumer properties and this does not always happen in construction work. For example, earthmoving is considered all the same although in actuality the earth to be moved differs in terms of density. Moreover, the construction product should be uniform in terms of the composition of the work performed. For example, painting, in addition to spackling and priming, can include one, two or more coats on the surface of a building's walls. In a majority of instances, in the accounting for construction product consideration is not given to these differences in consumer values. To a certain degree this gives rise to conditionality in measuring labor productivity in physical units. The presence of specialized organizations which perform the same types of construction and installation work (mechanization, finishing and other trusts) creates the prerequisites for employing this method in construction.

Since the labor productivity levels are characterized by average output, a change in it over time depends upon a change in output in the individual areas (W) and in the structure of the aggregate for the areas (d) and can be expressed in the following manner:

$$\overline{w}_1 : \overline{w}_0 \frac{\sum w_1 T_1}{\sum T_1} : \frac{\sum w_0 T_0}{\sum T_0} = \frac{\sum w_1 d_{T_1}}{\sum w_0 d_{T_0}}, \quad \text{where } d_T = \frac{T}{\sum T}.$$

The obtained expression in statistical theory is called the natural index for labor productivity of varied composition. The dynamics of average output is analyzed by constructing a system of interrelated indexes.[1] Most often in textbook literature on statistics, a system of indexes is recommended constructed according to the chain method:

$$\frac{\sum w_1 d_{T_1}}{\sum w_0 d_{T_0}} = \frac{\sum w_1 d_{T_0}}{\sum w_0 d_{T_0}} \cdot \frac{\sum w_1 d_{T_1}}{\sum w_1 d_{T_0}}.$$

In this system, the first comultiplier is the index for the labor productivity of a fixed composition and it describes the average change in labor productivity in individual areas and reflects the effect of internal production factors (labor skills and the capital-to-labor ratio, the quality of the subjects of labor, working conditions and so forth). The second comultiplier is the index for the influence of structural shifts and it characterizes the change in average output as a consequence of a change in working time structure in the work areas considering the interrelated influence of two factors (covariance). The designated system can be applied under construction conditions as many specialized trusts have subsidiary administrations which perform uniform types of work.

For obtaining a general description of labor productivity the labor method for measuring this is employed. On the basis of the labor method, the fulfillment of the output standards and the indicators for labor productivity dynamics of the workers are determined. The fulfillment of the output standard can be determined by the direct and inverse labor productivity levels. In practice the latter method has become widespread, that is, in terms of labor intensiveness as it makes it possible to obtain general indicators. In the simplest instance, when one worker performs the same type of job, the percentage of fulfillment for an output standard is determined by the ratio of the average actual labor intensiveness (t_f) and the normed (t_n), that is, $i = t_n : t_f$. For instances when the percentage is determined for the fulfillment of an output standard for a group of workers employed in different jobs, the index is calculated by the formula:

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[1] See: "Obshchaya teoriya statistiki" [The General Theory of Statistics], by V. S. Kozlov, L. M. Erlikh, F. G. Dolgushevskiy and others, 3d Edition, Moscow, Statistika, 1975, Chapter X, §3, pp 382-387.

$$I_{f/n} = \frac{\Sigma q_f t_n}{\Sigma q_f t_f} = \frac{\Sigma q_f t_n}{\Sigma T_f},$$

where q_f--the volume of the given type of performed work;
T_f--actual working time expenditures.

From the data of the example (Table VI.5), the percentage of output standard fulfillment in the installation of columns will be in February $\left(0.25 : \frac{900}{4,300}\right) \cdot 100 =$ 108.6, in January $\left(0.25 : \frac{770}{3,200}\right) \cdot 100 = 103.9$. As a whole for the two types of work the fulfillment of the output standard in January is:

$$\frac{3,200 \cdot 0.25 + 4,600 \cdot 0.12}{770 + \%\%)} = \frac{1,352}{1,320} = 1.024, \text{ or } 102.4\%.$$

But in February $\frac{4,300 \cdot 0.25 + 3,800 \cdot 0.12}{990 + 420} = \frac{1,531}{1,410} = 108.6\%$.

Information on the fulfillment of the output standards is given in the statistical reporting in Form No 4-t.

Table VI.5

Type of work	Labor intensiveness by standard, man-hours per ton	January		February	
		Volume of work, tons	Worked man-hours	Volume of work, tons	Worked man-hours
Installation of columns	0.25	3,200	770	4,300	990
Installation of floor slabs	0.12	4,600	550	3,800	420

For studying labor productivity dynamics, an aggregate index for the actual labor intensiveness levels is calculated, that is,

$$I = \frac{\Sigma q_1 t_0}{\Sigma q_1 t_1} = \frac{\Sigma q_1 t_0}{\Sigma T_1},$$

where t_0 and t_1--labor intensiveness of the individual types of work in the base and report periods.

In the example, this index equals: $\frac{4,300 \cdot \frac{770}{3,200} + 3,800 \cdot \frac{550}{4,600}}{990 + 420} = \frac{1,489}{1,410} = 1.056$, or 105.6 percent.

The increased labor productivity caused a savings in working time of 79 man-hours (1,489-1,410). The use of this index in construction practice is limited as the composition of the work as a rule does not coincide in the base and report periods.

Labor productivity dynamics can be characterized by normed working time expenditures having calculated the index for the average level by the formula:

$$I = \frac{\Sigma q_1 t_n}{\Sigma T_1} : \frac{\Sigma q_0 t_n}{\Sigma T_0} = \frac{\Sigma q_1 t_n}{\Sigma q_1 t_1} : \frac{\Sigma q_0 t_n}{\Sigma q_0 t_0} .$$

The first index compares the average output expressed in norm-hours, while the second compares the fulfillment of the output standard in the report period with the base. In the example the labor productivity index for the workers equals: 1.086:1.024 = 1.06 or 106 percent.

Labor indexes are employed only for studying the labor productivity of piece workers. An essential feature of these indicators is their low sensitivity to work mechanization since the labor intensiveness of performing mechanized jobs is many times less than the labor intensiveness of manual work and for this reason its amount is less significant in calculating the index.

The most general evaluation of labor productivity dynamics for the workers of construction organizations can be provided only on a basis of a cost expression of the product. Average output in this instance is described by the volume of produced construction product in estimated prices per worker or per unit of work time. The labor productivity index according to the cost method is calculated as the result of comparing average output, that is, by the formula:

$$I = \frac{\Sigma q_1 p_{cm}}{\Sigma T_1} : \frac{\Sigma q_0 p_{cm}}{\Sigma T_0},$$

where q_0 and q_1--the volume of work carried out in physical units of the base and report periods;
T_0 and T_1--the average listed number of employees (or working time expenditures) of the base and report periods;
p_{cm}--estimated prices.

In calculating the cost index of labor productivity it is essential to proceed from the volume of produced construction product, that is, the volume of the construction and installation work carried out, considering the incomplete construction work. The value of the work carried out in the base and report periods is expressed in the same estimated prices. In planning and statistical practices, output in cost units is determined per worker of basic and auxiliary production. This indicator is given in the report of Form 3-t. In instances when construction employs persons not on the lists of the organization, their number must be considered in calculating average output. For this the average number of workers not on the lists is added to the average listed number of employees for the period of work.

The cost index of labor productivity, as an index of variable composition, reflects the influence of all the factors in construction work. In addition, this indicator is influenced by factors of a cost nature, that is, the change in the ratio of live and embodied labor related, as a rule, to a change in the work structure. For precisely this reason in a cost form the output of one worker from construction organizations having different purposes and specialization is not comparable. Even within one organization, labor productivity dynamics can be determined by the cost method only under the condition of a relative stability in the structure of the work done in different periods. This method provides a more or less reliable notion of a change in labor productivity in comparison with the plan, as in this instance the structure of the work, as a rule, is the same. The use of the cost index for labor productivity is methodologically justified for a larger aggregate of organizations, for example, for a glavk, ministry and sector as a whole where the work structure as a whole remains more or less stable over several years.

At present an experiment is being carried out in construction to apply normed net product (see Chapter V, §11) in the planning and accounting of labor productivity. This eliminates individual shortcomings in the methodology of measuring the labor productivity level and its change in comparison with the plan and over time.

§5. The Statistical Methodology of Analyzing Labor Productivity

The main task in analyzing labor productivity in construction is to make a maximum full disclosure of the internal production reserves for increasing labor productivity in all work areas for the purpose of increasing the construction volume, saving working time and expenditures and accelerating the time for erecting the buildings and structures. Important areas in the analysis of labor productivity are, in the first place, a comparative description of labor productivity levels for the individual construction organizations and their change in relationship to the plan and over time for the purpose of disclosing the better organizations and reserves for increasing labor productivity; secondly, determining the influence of a change in labor productivity on the fulfillment of the plan and the dynamics of the construction product volume, the savings (over expenditure) of working time expenditures, a reduction (rise) in product costs and other general indicators of construction; thirdly, a disclosure of the influence of production factors, its organization and so forth on the level and dynamics of labor productivity. The tasks of labor productivity analysis in these areas are carried out by various statistical methods and most often the index method, grouping and regression correlation analysis. The choice of one or another method is determined primarily by the content of the specific research task.

In an analysis of individual organizations and their groups it is essential to remember that the cost indicators of construction product cannot express labor productivity levels. They make it possible only with a varying degree of conditionality to judge plan fulfillment and dynamics of labor productivity. It is possible to measure the labor productivity levels of the individual construction organizations and compare them with one another only by the direct and inverse amounts in physical units. However, the use of the physical method of measuring labor productivity is limited to the conditions when the same construction or installation jobs are performed in the work areas, for example, in organizations specialized in finishing work or earth moving.

In a comparative analysis more often the inverse amounts of labor productivity are employed, that is, the labor intensiveness of a unit of the individual types of work and completed projects. Thus, in practice there is frequently a comparison of the production labor intensiveness of building the projects and its component elements by types of work. An example of this sort is given in Table VI.6 which shows the average actual labor expenditures per m^2 of effective area for various types of apartment buildings as a whole and for types of work. From the data of the table

Table VI.6

Type of apartment building	Number of stories	Man-days per m^2 of effective area: Total	Including for: erection of foundation	installation of above-ground part	finishing work	other work
I-605	9	1.48	0.17	0.54	0.37	0.4
IMG-601	16	2.45	0.22	0.69	0.72	0.82
Rolled panel	18	2.56	0.29	0.67	0.69	0.91

it follows that labor intensiveness per m^2 of area rises with an increase in the number of stories in the building.

In describing the role of labor productivity in carrying out the plan for construction product and its dynamics, it is advisable to employ the index method which reflects the functional dependence between the analyzed phenomena. For this purpose one utilizes the form of the relationship between labor productivity and product volume and this is expressed as follows:

$$Q_p = \overline{w} \cdot T,$$

where Q_p--the cost of construction product;
$\overline{w}$--average output per worker and
T--average listed number of employees.

Table VI.7

Indicator	Symbol	First 6 months	Second 6 months	Index
Volume of performed work, 1,000 rubles	Q_p	2,494.4	2,777.3	1.113
Average listed number of employees in basic and auxiliary production	T	468	458	0.979
Including workers	T_p	384	389	1.013
Average daily output, rubles	a	52	58	1.115
Average number of workdays per worker	b	125	123	0.984
Share of workers in total number of employees	c	0.82	0.85	1.037
Average 6-month output of one worker, rubles	$\overline{w}$	5,330	6,064	1.138

In relying on the known provisions of index theory, it is possible to carry out an arithmetic expansion of the entire increase in product volume due to the change in average output and the number of employees. From the data of the example of a construction trust (Table VI.7), the index for the volume of work performed in the second 6 months in comparison with the first was 111.3 percent while the absolute product increase was 282,900 rubles. The influence of the rise in average output per worker on the increase in product is: $\Delta_{w} = (\overline{w}_1 - \overline{w}_0)T_1 = (6{,}064\text{-}5{,}330) \cdot 458 =$ 336,200 rubles, while the influence of the reduction in the number of employees is:

$\Delta_T = \bar{w}_0(T_1 - T_0) = 5{,}330(458-468) = -53{,}300$ rubles. The total is $336.2 + (-53.3) =$ 282,900 rubles.

In an analogous manner it is possible to establish the influence of a change in labor productivity on the saving or overexpenditure of work time and for this a dependence of a different type is used: $T = Q_p \cdot \bar{t}$, where $\bar{t}$--average labor intensiveness of a cost unit of construction product.

The saving (overexpenditure) of work time under the influence of labor productivity will be shown by the formula $\Delta_t(\bar{t}_1 - \bar{t}_0)Q_p$ and for the volume of work $\Delta_Q = \bar{t}_0(Q_{p_0} - Q_{p_1})$.

The use of the grouping method in analyzing the impact of labor productivity on the resulting indicators of production is advisable only in the instance when there is no strict dependence between these indicators. For example, in studying the influence of the fulfillment of the output standards or the labor productivity plan for the aggregate of the construction organizations on the deviation of actual costs from the planned ones or the amount of expenditures per ruble of estimated cost of the work and so forth. In these instances the grouping feature is the output level in physical units or its relative value (index) for the construction organization.

The reserves for increasing labor productivity are disclosed by an analysis of its factors. In solving this problem an important role is played not only by the index method and the groupings but also by the regression correlation research method.

Analytical groupings make it possible to obtain only an approximate idea of the nature of the dependence of employee labor productivity on one or another factor without any numerical expression. For this reason it is advisable to employ them for studying the dependence of labor productivity upon factors which do not have a functional relationship to output when it is difficult or completely impossible to express them by a statistical indicator. For example, the factors characterizing the form of management organization, production, labor, technical progress and industrialization, equipping with the means of labor and so forth. In the studying of these factors, the number of workers and most often the aggregate of contracting organizations are grouped. Such factor features as, for example, the types of specialization of the organizations, methods of production, the form of payments for completed work and so forth are used as the grouping features.

In factor analysis the index method assumes great importance. As a consequence of the methodological features, its application is limited to the possibility of constructing multiplicative models for the indicator dependences. However, in practical terms those of them which reflect the objective economic dependence of the phenomena and not the formal mathematical one are suitable for index analysis. For precisely this reason the use of the index method in analyzing labor productivity to a significant degree involves the use of working time, the change in the structure of the number of organization employees and certain others. The choice of the system of interrelated indicators and their number is determined by the specific research task.[2]

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[2]A. G. Kazachenok and V. A. Tarlovskaya, "Analiz proizvoditel'nosti truda v stroitel'stva" [Analysis of Labor Productivity in Construction], Moscow, Stroyizdat, 1977.

Thus, in analyzing plan fulfillment and the dynamics of labor productivity in a construction trust or main administration for an annual period, of interest is the following system of factor indicators for annual output per worker in basic and auxiliary production:

$$w_a = w_h \bar{T}_{rd} \bar{T}_d d_p d_{bp},$$

where w_h--hourly output;

d_p--the share of workers in the total number of basic production employees;

d_{bp}--the share of employees in basic production in terms of basic and auxiliary production together.

In narrowing the task of analysis, it is possible to consolidate the factor indicators as has been done in the example (see Table VI.7). According to the symbols adopted in the table, the constructing of the system of interrelated indices is based on the following dependence: $\bar{w} = abc$. In accord with the order of fixation adopted in statistical theory (in terms of volume and quality indicators), we obtain the following system of interrelated indices:

$$\frac{\bar{w}_1}{\bar{w}_0} = \frac{a_1b_1c_1}{a_0b_0c_0} = \frac{a_1b_1c_1}{a_0b_0c_1} \cdot \frac{a_0b_1c_1}{a_0b_0c_1} \cdot \frac{a_0b_0c_1}{a_0b_0c_0}.$$

In the example, the intensity in the change of the annual 6-month output per employee as caused by the change in each factor is characterized by particular indexes which numerically are equal to the individual indexes of each factor (see the last column of Table VI.6). The influence of each factor on the change in the overall output average is determined by the difference in the numerator and denominator of each interrelated partial index, namely:

influence of the a factor $\Delta_a = (a_1-a_0)b_1c_1 = (58-52)\cdot123\cdot0.85 = 627.3$ rubles;
influence of the b factor $\Delta_b = a_0(b_1-b_0)c_1 = 52(123-125)0.83 = -88.4$ rubles;
influence of the c factor $\Delta_c = a_0b_0(c_1-c_0) = 52\cdot123(0.85-0.82) = 195.0$.

TOTAL increase in output 733.9 rubles

If the designated system of indicators is supplemented by the average number of employees in basic and auxiliary production (d), then it is possible to analyze plan fulfillment for the dynamics of the volume of construction product proceeding from the dependence $Q_p = abcd$.

Recently the regression correlation method has also become widespread in analyzing labor productivity factors. A number of economists have made successful attempts at constructing a multifactor linear regression model for labor productivity.[3] One of the important stages in elaborating such a model is the choice of the labor productivity factors and the equivalent statistical indicators which conform best to them. In leaving aside the statistical methodology for calculating regression

[3]See: V. A. Balan, "Ekonomiko-matematicheskiye modeli proizvoditel'nosti truda" [Mathematical Economics Models of Labor Productivity], Moscow, Nauka, 1979.

Table VI.8

Обозначение факторов в модели a	Значение факторов-показателей b		e Отклонение в значениях показателей (гр. 3 – гр. 2)	f Коэффициенты регрессии	g Изменение средней выработки, руб. (гр. 4 × гр. 5)
	средние по министерству c	d по тресту			
1	2	3	4	5	6
X_1	58.0	60.2	2.2	20.4	44.9
X_2	41.4	68.5	27.1	—13.0	—352.3
X_3	11.3	14.5	3.2	133.8	428.2
X_4	1.2	0.9	—0.3	83.3	—25.0
X_5	8206	8656	450	0.2	90.0

Key: a--Symbol of factors in model; b--Significance of factor indicators; c--Average for ministry; d--For trust; e--Deviation in indicator significance (col. 3-col. 2); f--Regression coefficients; g--Change in average output, rubles (col. 4 x col. 5)

equations,[4] we would point out that they make it possible to establish a measure of change in the resulting feature (the regression coefficients) depending upon a change in the feature factor by one. In using this particular feature, it is possible to construct a table for calculating reserves for increased labor productivity (average output) for each factor (see Table VI.8). For an illustration of what has been stated, let us use a simple linear multifactor regression model for labor productivity obtained for an aggregate of organizations in one ministry:

$$y_x = 1{,}708 + 20.4X_1 - 13X_2 + 133.8X_3 + 83.3X_4 + 0.2X_5,$$

where y_x--average annual output of work at estimated cost per employee of basic and auxiliary production;

X_1--material intensiveness of construction-installation work (%);

X_2--personnel turnover coefficient (%);

X_3--proportional amount of ITR in total number of workers (%);

X_4--proportional amount of worker bonuses in worker wage fund (%);

X_5--annual work volume (1,000 rubles).

The indicators for the second and third columns in the table have been taken from the statistical reporting, respectively, of a ministry and a trust. The last column shows the effectiveness of each factor. Here the sign "+" means the achieved result in increasing output per worker while the sign "-" is the possible reserve for increasing output for the given factor. As the comparison basis (col. 2) it is possible to use the indicators for a better trust in terms of operating results or better indicators achieved in various trusts over the previous year and so forth,

[4] See: I. G. Venetskiy and G. S. Kil'dishev, "Teoriya veroyatnostey i matematicheskaya statistika" [Probability Theory and Mathematical Statistics], 3d Edition, Moscow, Statistika, 1975.

depending upon the specific analysis task. In our example, the positive effect (the increase in output) from exceeding the base factors was: $44.9 + 428.2 + 90 = 563.1$ rubles. The reserve for increasing annual output per employee in achieving the best indicators of the ministry (for X_2 and X_4) equals: $(-352.3) + (-25.0) = -377.3$ rubles.

The use of regression models is possible only for organizations which are part of an aggregate for which the regression equation has been calculated.

§6. A Statistical Study of the Wage Fund

The wages of enterprise employees in the production sphere are the portion of national income expressed in a monetary form and figured in accord with the quantity and quality of the labor expended by the workers. Construction statistics studies wages primarily as an element of expenditures on creating a product as well as a level of the material well being of employees from construction organizations. In 1978, the share of wages for the employees of construction organizations was 32 percent of the total expenditures on construction-installation work. Under the conditions of the economic reform, the employees of construction organizations are materially interested in achieving high work indicators for the organization as a whole, in receiving remuneration from the material incentive fund formed from the organization's profit.

By the wage fund of construction organization employees one understands the total money provided for by the plan and actually paid as wages. In addition to the money the wage fund also includes the value of various gratis or reduced-cost services provided by the construction organization for its employees, for example, the providing of housing, utility services and so forth. All information on the wage fund is found in the bookkeeping office and labor and wage departments of the contracting organization.

Statistics studies the composition of the wage fund in terms of the production areas, worker categories and wage elements. In terms of the production areas, the wage fund for all the personnel of a construction organization is divided into the fund of the workers in basic, that is, construction-installation, production, the fund for the employees in subsidiary production and the fund for the employees of the service systems. Each of these funds is then divided in terms of employee categories. Information on the composition of the wage fund in terms of work areas and employee categories is given in an abbreviated form in the statistical reporting of the construction organizations (Form No 3-t).

The types of wages have been used as the basis of the element distribution of the wage fund. For the various employee categories, the types of wages (elements) will differ substantially. The composition of the wage fund has been studied in greatest detail for the workers and the ITR. Thus, for the worker category the elements include, for example, wages by piece rates, bonuses to piece workers, time wages by wage rates, additional payment for overtime and so forth. For the ITR the component elements will be the earnings for the basic salaries, bonuses, remuneration for the number of years worked and so forth. The element composition of the wage fund makes it possible to obtain a notion of the distribution of various forms and systems of wages and of the ratio of wages for basic salaries and wage rates and the remaining elements which make up wages, to disclose the absolute and relative amount of unproductive expenditures, for example, payment for stoppages, damaged products which are not the fault of the worker and so forth.

As was said above, in addition to the wage fund, the employees of construction organizations have an additional source of income, the material incentive fund, which is designed to encourage the employees for collective efforts in the work of the organizations. In studying the material incentive fund, statistics describes the amounts, composition and dynamics of this fund and the distribution of it over the production areas and employee categories as well as in terms of the types of material incentives. It determines the ratio of payments from the material incentive fund and from the wage fund.

In calculating the indicators for the structure of the material incentive fund [FMP], it is important to isolate such sources of its formation as profit deductions and the receiving of money from clients to pay bonuses to employees, for example, for completing projects on time and ahead of time. The indicator for the use of the FMP is the proportional amount of the funds paid to the employees during the report period in the total amount of money transferred in the given period to the FMP. For a comparative description in practice they calculate the ratio of the amounts paid from the FMP and the bonuses from the wage fund. For the same purposes the indicators for the bonus structure from these two funds in the total amount of bonuses are determined. The initial data for calculating the designated indicators are given in Form No 3-t and in the Appendix 2 to Form No 1 (contractor).

Under the conditions of the economic reform, the wage fund is among the plan indicators to be set for the construction organizations. This is determined by the importance of supervising the expenditure of the wage fund. The statistical methodology for assessing plan fulfillment in terms of the wage fund differs somewhat from that adopted in industry. For all employee categories, the conformity of the actual wage fund to the planned limits is set by a comparison (by dividing or subtracting) the actual fund with the planned (Table VI.9).

Table VI.9

	Wage fund, 1,000 rubles		Percentage of plan fulfillment	Absolute deviation
	Plan	Report		
All employees of basic and subsidiary production	248.2	250.6	101.0	2.4
Including:				
Workers	193.5	196.3	101.4	2.8
Employees of remaining categories	54.7	54.3	99.3	-0.4

The deviation of the actual wage fund from the planned one for all employee categories, with the exception of the workers, will be caused by changes in the number of employees and their wage level. For the workers this deviation is due primarily to the fulfillment of the plan for the volume of construction product as well as to a change in the number of workers and their wage level. For this reason in terms of the workers the methodology for assessing plan fulfillment for the wage fund is altered.

Instead of the established (calculated per 100 percent of plan fulfillment for construction product) wage fund according to the plan ($F_{p\ell}$) a new corrected planned fund ($F_{cp\ell}$) is calculated and the actual one is compared with this. Here in the instance of the overfulfillment of the plan for the volume of work, the corrected wage fund is determined by the formula:

$$F_{cp\ell} = F_{p\ell} + F_{p\ell}\frac{\Delta K}{100},$$

where Δ--the percentage of overfulfilling the plan for contracting work, and
K--the reduction factor for each percentage of overfulfilling the work plan equal to 0.93.

The use of the reduction factor is caused by the unproportional dependence between the increase in the cost of the work performed and the wages. Let us assume that in the example the plan for contracting work has been fulfilled over the year by 106.2 percent by the trust. Then the corrected annual planned wage fund for the workers will be: $193.5 + 193.5\,\frac{6.2 \cdot 0.93}{100} = 193.5 + 11.1 = 204{,}600$ rubles. Consequently, the percentage of plan fulfillment for the wage fund for the workers is $\frac{196.3}{204.6} \cdot 100 = 95.9$, or a savings of 8,300 rubles (196.3 - 204.6) and not an overexpenditure as was established without considering the percentage of overfulfilling the work plan. As a whole for the wage fund of all the employees there is also a savings of 8,700 rubles (8.3 + 0.4) and not an overexpenditure. In instances when the plan for construction product has not been fulfilled, the wage fund is adjusted without the reduction factor, that is:

$$F_{cp\ell} = \frac{F_{p\ell} I_{p\ell}}{100},$$

where $I_{p\ell}$--the percentage of fulfilling the work plan.

§7. The Study of Average Wages and Their Dynamics

From the viewpoint of studying the material prosperity of construction employees and analyzing expenditures on production, a description of the wage level expressed by average wages is of importance. Under the conditions of the economic reform, the average earnings of employees are determined, in the first place, considering the payments from the wage fund and the FMP and, secondly, as average earnings solely from the wage fund. The wage level in the latter instance is viewed as a factor in the formation of the wage fund as well as in analyzing expenditures on producing construction product. The wage level of the workers has been studied in most detail.

Depending upon the unit of measurement for working time, a distinction is made between average hourly, daily and monthly wages. The average hourly wage (f_h) is determined by dividing the hourly wage fund by the man-hours worked over the given period. The hourly wage fund (F_h) encompasses the wages for the actually worked man-hours or the direct work (without overtime) and the corresponding level describes wages under these conditions. The average daily wages (f_d) are obtained

Table VI.10

Indicator	June	July	Index
1. Hourly wage fund, 1,000 rubles	12,773	14,378	1.126
2. Daily wage fund, 1,000 rubles	13,440	15,075	1.222
3. Monthly wage fund, 1,000 rubles	17,115	18,537	1.083
4. Monthly wage fund, including payments from FMP, 1,000 rubles	17,544	18,870	0.076
5. Average listed number of workers	105	111	1.057
6. Man-days worked by workers	2,100	2,250	1.071
7. Man-hours worked by workers	16,375	7,750	1.084
8. Average hourly earnings (line 1:line 7), rubles	0.78	0.81	1.038
9. Average daily earnings (line 2:line 6), rubles	6.4	6.7	1.047
10. Average monthly earnings (line 3:line 5), rubles	163	167	1.024
11. Full average monthly earnings (line 4:line 5), rubles	172	170	0.988

by dividing the daily wage fund by the man-days worked. The daily wage fund (F_d) encompasses all types of payments for the worked man-days, including additional payments for unworked man-hours. The average monthly wage of a worker (f_m) is calculated by dividing the monthly wage fund (F_m) by the average listed number of workers for the month. The average quarterly, semiannual and annual earnings in terms of the content of the elements comprising them do not differ from the monthly. However, the full average earnings (f_f) from the wage fund and the material incentive fund (F_f) are best determined for the annual period, as payments from the incentive fund are not characteristic in construction for an individual month. Table VI.10 gives the initial data and the methodology for calculating the examined wage levels. The wage levels of the workers and the indicators for the use of working time are interrelated in a system which in an expanded form has the following appearance:

$$f_f = f_h \overline{T}_{wd} K_{dw} \overline{T}_d K_{mw} K_{fmp},$$

where $K_{dw} = F_d : F_h$--the coefficient for surpayments to the daily wage fund;
$K_{mw} = F_m : F_d$--the coefficient of surpayments to the monthly wage fund;
$K_{fmp} = F_f : F_m$--the coefficient of payments from the material incentive fund.

These interrelated indicators can lie at the basis of constructing a system of interrelated individual indexes and calculations for the impact of the corresponding factors on plan fulfillment and the dynamics of average wages. Here, depending upon the tasks of analysis, the indicator factors can be consolidated or represented by various complexes, for example:

$$f_m = f_d K_{dw} \overline{T}_{wd} K_{mw} \quad \text{or} \quad f_d = f_h \overline{T}_{wd} K_{dw}$$

and by other systems. The corresponding dynamic indicators are in an analogous dependence. From the data of the example, the index for the average daily wages will equal:

$$I = 1.038 \cdot \left(\frac{17,750}{2,250} : \frac{16,375}{2,100}\right) \cdot \left(\frac{15,075}{14,378} : \frac{13,440}{12,773}\right) = 1.038 \cdot 1.012 \cdot 0.996 = 1.046.$$

Average employee wages are studied for their categories, production areas and for worker wages also for professions, skill level, length of employment and other groups characterized by varying levels of the capital-labor ratio, its organization, industrialization of construction and so forth. On the basis of the distribution of employees by wage level and the share of payments from the various incentive funds, the degree of wage uniformity is studied for the various categories and groups of employees (the variance indicators), the particular features in the structure of the employee aggregate in terms of the wage level (the modulus is the ascertained wage level which is most often received by the employees and the median which is the wage level dividing the aggregate of employees into equal parts, the series asymmetry indicators which determine what portion of the employees, large or small, receives a high or low wage relative to the average).

Since the wage level is expressed by an average amount, in analyzing its dynamics or plan fulfillment it is possible to employ a system of interrelated indexes which reflect the influence of the earnings of employees in individual groups, categories and so forth as well as the structural shifts on a change in the overall average wage. In accord with the provisions of statistical theory, this system can be represented as follows:

$$\frac{\sum f_1 d_{T_1}}{\sum f_0 d_{T_0}} = \frac{\sum f_1 d_{T_0}}{\sum f_0 d_{T_0}} \cdot \frac{\sum f_1 d_{T_1}}{\sum f_1 d_{T_0}}, \quad \text{where} \quad d_T = \frac{T}{\sum T}.$$

The result of the interaction of the factors (the covariance) is considered by the index for the influence of structural shifts. The establishing of the third co-multiplier (the covariance index) provides little in practice as it is difficult to mention a measure which would influence the interaction of the designated factors. In an analysis of plan fulfillment or the dynamics of the wage fund it is of interest to describe the influence of changes in average wages and the number of employees also on a basis of an index method, using the known dependence of the indicators $F = fT$ for this and
where F--the wage fund.

In successively employing the chain method, we will obtain the influence of each of these two factors, namely $\Delta_f = (f_1 - f_0)T_1$ and $\Delta_T = f_0(T_1 - T_0)$. The combined influence is $\Delta = \Delta_f + \Delta_T$.

A study of the ratio of the growth rates of average wages and average employee output is an important question in wage analysis. Labor productivity should outstrip a rise in average wages. Only in this instance will an important condition be met for reducing product costs, for obtaining socialist accumulation and an equal allocation of the consumption fund. The lead factor for average wages is the indicator which describes the ratio of the growth rate of labor productivity (T_w) and the growth rate of average wages (T_f). This is defined as $K_\ell = T_w : T_f$. If $K_\ell > 1$, then there have been economically sound growth proportions for labor productivity and the wage level. Naturally in calculating the lead factor it is essential to proceed from full wages, that is, considering payments from the material incentive fund. In an analogous manner it is possible to compare the coefficients of plan fulfillment for output and average wages for the employees of a contracting organization.

CHAPTER VII: FIXED CAPITAL STATISTICS

§1. The Tasks of Fixed Capital Statistics and Its Classification

In the process of production, along with labor, an important role is held by the means of production which consist of the means of labor and the subjects of labor. The main features by which these economic categories are differentiated are the role and place of them in the labor process, the nature of the circulation of the value of fixed and working capital and the conditions for recovering their cost and consumer value. The means of labor are the aggregate of objects by which and with the aid of which people create material goods in the labor process. Among them the leading role is played by the implements of labor. In construction, for example, these are excavators, erection cranes, dump trucks and so forth. A subject of labor is a material which man transforms with the aid of the means of labor into the products needed by him. Under the conditions of the socialist economic system, the means of production form the material content of fixed and working capital.

Fixed capital participates repeatedly in periodically reoccurring production cycles in maintaining that physical form in which they entered the production sphere. Fixed capital circulates only in its value, and this value is gradually, piecemeal, in keeping with its production consumption, to the products over the entire time of its functioning. As a result of the circulation of the value of fixed capital, money is accumulated (the amortization fund) needed for its reproduction.

The economic particular features of fixed captial make it possible to differentiate this from working capital. However, in practice articles are encountered which in terms of their functions would be considered as means of labor but which also have a low value or brief service life. Such articles are complex and for this reason it is not advisable to consider them as part of fixed capital. In accord with the Regulation Governing Bookkeeping Reports and Balances as approved by the USSR Council of Ministers, the following cannot be considered as fixed capital and should be considered as part of working capital: a) articles which are used for less than 1 year, regardless of their value; b) articles with a value under 50 rubles per unit, regardless of their service life.

The fixed capital of construction includes the entire aggregate of material and physical elements which, in their economic and formal features, correspond to this concept and have been allocated to the construction organizations and sites. The accounting feature which determines the moment the articles go into construction as fixed capital is their entry on the balance sheet for the basic operations of the construction organization or site (builder). In a number of instances the balance sheets of the organizations (builders) include temporary projects which comprise a separate group of the means of production and serve construction but only during one production cycle (after the completion of the project they are liquidated). In accounting these are termed temporary title objects and expenditures on them are included in the first part of the construction estimate. For example, these would be the buildings of warehouses, stock "construction lumber," bypass canals, temporary barriers (dams) and so forth. The temporary title projects in accounting and statistics are considered among construction fixed capital.

Fixed capital accounting in the construction, design and research organizations is carried out by the bookkeeping office. Among the tasks of fixed capital statistics in construction are: a description of the volume and composition of the fixed capital, a study of fixed capital dynamics, characteristics of the state of the fixed capital, a study of the effective use of fixed capital, and a study of the amount of fixed capital available to the construction workers.

The extreme diversity of the means of labor employed in construction leads to the necessity of studying their composition and structure using a fixed capital classification which is an important condition for successfully carrying out the tasks confronting statistics as well as for correctly organizing fixed capital accounting for the construction organizations. A construction organization as an economic unit, along with construction and production activities, encompasses other types of production as well as nonproduction activities. The dividing of the entire aggregate of fixed capital into two large groups is the consequence of such an organizational structure for the construction organizations. These groups are: fixed productive capital and fixed nonproductive capital.

Among the production capital a distinction is drawn between the construction-end fixed productive capital and this is the leading capital and holds the largest part (around three-fifths) in the total aggregate of the fixed capital of the construction organizations, as well as the fixed productive capital of the other national economic sectors. The construction-end fixed capital comprises the aggregate of the means of labor which directly or indirectly participate in the carrying out of construction and installation work and, consequently, transfer their value to the construction product. The production capital of the other sectors consists of the means of labor utilized in industrial, supply, agricultural and other systems which are administratively separate but carried on the balance sheet of the construction organization, with the exception of the construction-end capital. The fixed nonproductive capital of the construction organizations is used to satisfy the social, cultural and domestic needs of the construction organization employees. For example, this includes the housing with all types of amenities, bath houses, buildings occupied by clubs, children's institutions and so forth.

The construction-end production fixed capital, depending upon its functional role in production and physical form, according to the standard classification in effect since 1972, is divided into the following groups: I. Building; II. Installation; III. Transfer devices; IV. Machinery and equipment, including: power machinery and equipment, operating machinery and equipment, metering control devices and laboratory equipment, computers; V. Means of transport; VI. General purpose tools; VII. Production supplies and appertenances; VIII. Office supplies; IX. Other types of fixed capital. In statistical reporting, the fixed capital of groups VI-IX is combined into one common group.

The current classification is employed primarily to describe the specific structure of the construction-end fixed capital. A notion of this is provided by the values for the proportional amount of individual types of fixed capital. It is also used to study the technological structure of the fixed capital in the form of the proportional weight and ratio of its active and passive parts. Among the active construction-end fixed capital are usually put operating machinery and equipment (construction machinery and mechanisms) and power machinery and equipment, means of transport and production tools. In this instance the buildings, installations and other fixed capital comprise the passive part.

§2. A Study of the Volume, Dynamics and State of Fixed Capital

For solving many problems in fixed capital statistics it is essential to have information on its amount both as a whole as well as for the component parts. The volume of the individual types of fixed capital can be expressed in physical and cost terms. The total volume of the different means of labor can be given only in cost terms. In accounting and statistical practices, depending upon the goals and tasks, the following four types of fixed capital evaluation are used:

1) In terms of full initial value which is determined by the actual price paid for the given new object in its acquisition, including expenditures on the delivery and installation of the object. Fixed capital is entered on the balance sheet for the basic activities of the organization at this estimate and it is also used in setting the amortization deductions and the amount of the capital payment;

2) According to the initial cost considering wear and equal to the full initial cost of the object minus the total wear on the fixed capital (residual value). The total wear is given in the liabilities of the bookkeeping balance for the basic activities of the organization while the residual initial value of the fixed capital is carried in Form No 11 (construction) "Report on the Presence and Movement of Fixed Capital and the Amortization Fund";

3) For the full replacement value measured by the expenditures required to purchase a new object (including delivery and installation) in the prices and under the production conditions when the reestimate is made;

4) For the replacement value considering wear which corresponds to that amount at which the given object could be estimated proceeding from the present conditions for its reproduction and taking into account its actual wear.

In comparing the economic importance of the various fixed capital estimates, it is possible to draw a conclusion on the advantage of an evaluation using the replacement value over the initial one in solving many economic problems, and in particular in studying the fixed capital volume and its dynamics. For obtaining data on the replacement value it is essential to carry out an across-the-board reevaluation of the fixed capital.

In the USSR national economy a reevaluation of fixed capital has been carried out several times but this has far from always involved construction fixed capital. Prior to 1960, only one instance was known of carrying out an across-the-board reevaluation of fixed capital and this was on 1 October 1925. On 1 January 1960, a second one was carried out and on 1 January 1972, a third general inventorying and reevaluation of fixed capital in all the national economic sectors, including construction. The last reevaluation was based on wholesale prices in effect on 1 July 1967 as well as the estimated standards, prices and rates in construction introduced on 1 January 1969.

Using the accounting documents of a construction organization the amount of fixed capital can be determined on any date but usually it is figured for the end of each report period (month, quarter and so forth). This information is given in the balance sheet for the basic activities of a construction organization in Form No 1 (Contractor). The statistical reporting in Form No 11 (Construction) contains data on the amount of fixed capital at the start and end of the report year in terms of the full value and residual value at the year's end in the amount at which it is carried on the balance sheet of basic activities. Here the fixed capital objects which have been revalued are entered on the organization's balance sheet at the full replacement value while new projects put into operation since the reevaluation are carried at the full initial value. Thus, the balance sheet estimate of the fixed capital is mixed.

The volume of fixed capital for the contracting organizations over time can change and for this reason, along with the moment indicators, statistics also calculates the average value of fixed capital over a calendar period, usually for a year. The average annual value of the fixed capital can be calculated using the formula of the chronological average from the data on the first of each month (this is the practice followed) or quarter, that is:

$$\bar{F}_{ch} = \frac{\frac{F_1}{2} + F_2 + \ldots + F_{n-1} + \frac{F_n}{2}}{n-1},$$

where $F_{1, 2, \ldots, n}$--the value of fixed capital at the end of each month (quarter); n--the number of moment indicators from which the average is calculated.

In those instances when the construction organization has not operated a full year, in calculating the average all the components are used (data on the available fixed capital at the end of each month or quarter), including that which equals zero.

Over time, because of many factors, changes occur not only in the volume but also in the composition and condition of the fixed capital. For obtaining these characteristics of the fixed capital, statistics uses data on its value. In order to construct time series or calculate indexes for the fixed capital volume it is essential to express the fixed capital volume in the same prices, more often in the prices of the last reevaluation. However, the possibility of employing the replacement value in studying the fixed capital volume lasts only as long as the prices and conditions for producing the means of labor do not change. Since the new fixed capital received since the reevaluation is carried on the construction organization's balance sheet at current and not replacement prices, the problem arises of eliminating the influence of the various estimates on the indicators of fixed capital volume and its dynamics.

In practice several methods are known for eliminating the influence of price changes on the fixed capital volume. One of them consists in a direct evaluation of the newly acquired fixed capital at prices employed as replacement ones in the last reevaluation. Another method is to recalculate the value of the fixed capital by using price indexes. In this instance two price indexes are employed corresponding to the two parts of the capital investments in creating the fixed capital, namely a price index for equipment and a price index for the construction of buildings and installations. In practice either each index is used independently and the value of the fixed capital of industrial and construction origin are recalculated separately or an average arithmetic price index is employed for fixed capital as a whole.

A notion of the reasons for a change in fixed capital over the year is provided by the fixed capital balance given in the annual report of a construction organization in Form No 11 (Construction). The fixed capital balance of contracting organizations is compiled both for the complete value (Table VII.1; data in 1,000 rubles) as well as for residual value. In the latter instance the scheme of the fixed capital balance is somewhat altered, namely to the value of the withdrawn fixed capital carried at residual value is added the total amortization deductions earmarked for fixed capital rennovation and this should correspond, according to the adopted accounting procedures, to the wear on fixed capital over the period.

Table VII.1

a Наличие на начало года	b Поступило в отчетном году			g Выбыло в отчетном году			j Наличие на конец года	k Наличие на конец года за вычетом износа (остаточная стоимость)
	c всего	d в том числе		c всего	d в том числе			
		e ввод в действие новых основных фондов	f безвозмездно поступило от других организаций		h ликвидация фондов	i безвозмездно передано другим организациям		
2 480	650	516	134	280	191	29	2 850	2 069

Key: a--On hand at year's start; b--Received during report year; c--Total; d--Including; e--Putting of fixed capital into operation; f--Gratis receipt from other organizations; g--Withdrawn in report year; h--Capital liquidation; i--Turned over gratis to other organizations; j--On hand at year's end; k--On hand at year's end minus wear (residual value)

The data of the balances can be used as the basis to draw conclusions on the absolute and relative amounts of the delivery and withdrawal of fixed capital. The relative indicators describing the movement of fixed capital are the replacement coefficient and the withdrawal coefficient. The fixed capital replacement coefficient is calculated as the ratio of the value of new fixed capital put into operation during the given period to the value of the fixed capital at the end of the period. This coefficient characterizes the degree of fixed capital replacement. From the example's data (see Table VII.1), the fixed capital newly put into operation in the year was 18.1% $\left(\frac{516}{2,850} \cdot 100\right)$.

The coefficient of fixed capital withdrawal is calculated as the ratio of the value of the means of labor withdrawn over the given period to their value at the start of the period. If the withdrawal coefficient is calculated using data on the value of the fixed capital withdrawn solely as a consequence of wear and decrepitness, it will show the intensity of withdrawing the means of labor that have completed their circulation, that is, those consumed in the production sphere. In the example all the fixed capital withdrawn over the year was 11.3% $\left(\frac{280}{2,480} \cdot 100\right)$, while the fixed capital withdrawn as a consequence of the completion of the process of its circulation in production was 7.7% $\left(\frac{191}{2,480} \cdot 100\right)$.

An important indicator for the condition of fixed capital is the degree of its wear. The physical wear on fixed capital depends directly on its service life or the amount of work performed by it. In using this dependence, in statistical practice the degree of physical wear is established for the individual fixed capital objects in proportion to their actual service life or the volume of work performed. A more accurate notion of an object's physical wear is provided by an expert evaluation of the technical state of its structural elements and mechanisms. But this is involved and difficult work carried out only with the general inventorying and reassessment of fixed capital.

The wear coefficient and the fitness coefficient are general indicators describing the condition of fixed capital at a certain moment of time. The calculating of these coefficients is based on the assumption that a cost expression of fixed capital wear expresses the measure of its physical wear and partially its obsolescence. The total wear on the means of labor since 1977 has been considered equal to the total of the portion of amortization deductions earmarked for renovation.

Amortization deductions are determined by the amortization rates in effect since 1 January 1975. These rates consider the physical wear and obsolescence of the means of labor. The amortization deduction rates have been differentiated for the groups and types of fixed capital and set in percent of the initial (balance sheet) value of the fixed capital. Along with the overall annual amortization rate, deduction rates have been set separately for the full replacement (renovation) of the fixed capital and for major overhaul and the modernization of the means of labor.

The total fixed capital wear as a whole can also be determined from the data of statistical reporting (Form No 11) as the difference of its full and residual value at the year's end. The fixed capital wear coefficient is obtained by dividing the total of its wear by the full balance sheet value of this fixed capital. In the example, the total wear is 2,850 - 2,069 = 781,000 rubles and hence the wear coefficient at the year's end will be: $\frac{781}{2,850} \cdot 100 = 27.4\%$. The difference of 100 percent and the wear coefficient provides the amount of the fitness coefficient for the fixed capital, that is, 100% - 27.4% = 72.6%. The fitness coefficient characterizes the share of the fixed capital value which has not yet been transferred to the product and not its operability. These coefficients should be calculated both as a whole and for the individual groups and types of fixed capital, as there are substantial differences between them in terms of the intensity of wear.

§3. Indicators of Fixed Capital Utilization

The problem of increasing the efficiency of social production holds a central place in the development of the socialist economy. Of great significance in solving it is to improve fixed capital utilization. In this regard construction statistics is confronted with a number of tasks in improving the system of indicators for fixed capital utilization and the employment of this system in a statistical economics analysis of construction organization operations. In the practices of construction statistics, a number of indicators for fixed capital utilization are calculated among which the most widespread are the output-capital ratio, the capital-output ratio, the coefficient of absolute effectiveness and the coefficient for the profitability of fixed productive capital.

The output-capital ratio or capital productivity ratio is a cost indicator expressing the degree of efficient use of fixed capital in the production of a product. Its level is determined by the ratio of the estimated cost of the construction product produced over the given period (Q_p) to the cost of the fixed capital employed in producing this product (F), that is, $f = Q_p:F$. Ordinarily the level of the output-capital ratio is the volume of construction and installation work carried out by own forces over the year calculated per 1, 100 or 1,000 rubles or value for the construction-end fixed productive capital.

Fixed capital must be taken at full cost, since the cost considering the wear does not correspond to the change in production capacity with which the means of labor each time enter into production. The calculating of the output-capital ratio at the estimated cost of the work and the replacement value of the fixed capital makes it possible to eliminate the influence of price changes. However in practice fixed capital is accounted for according to the mixed (balance sheet) estimate and for this reason the output-capital ratio is usually figured per unit of the balance sheet value of the fixed capital. Here it is essential to proceed from the average value of the fixed capital over the report period, as a rule, over a year.

Since the individual organizations in the process of carrying out the work employ not only their own building machines and mechanisms but also rented or leased equipment from other organizations, the calculation of the average annual value of the fixed capital (F_p) for the output-capital ratio must consider these particular features, that is, be determined by the formula

$$F_p = F_i + F_o - F_\ell,$$

where F_i--the average annual value of the organization's own fixed capital;
F_o and F_ℓ--the average annual value of fixed capital which has been, correspondingly, brought in from outside or rented or leased to other organizations.

In determining the output-capital ratio for a glavk, ministry or the sector as a whole, the differences in the forms of operation are not of importance and, consequently, these corrections need not be made.

In addition to the output-capital ratio, statistics also employs its inverse value, the capital-output ratio.[1] The capital-output ratio characterizes the value of the fixed productive capital per unit of the value of the product produced by the construction organization or the sector over the given period (ordinarily a year). A decline in the capital-output ratio in a general form describes the saving of labor embodied in fixed capital participating in production. The capital-output ration is chiefly of significance in solving analytical problems, making it possible to establish the demand for fixed capital as a whole and for its individual types.

For describing construction fixed capital utilization, as the criterion of its effectiveness, net product can be employed. The output-capital ratio measured by the amount of the net product (in fixed prices) per unit of fixed capital value is called the coefficient of absolute fixed capital effectiveness. This indicator can be determined only on a sector-wide scale. In studying fixed capital utilization it is possible to proceed from the profit, calculating the coefficient of fixed capital profitability for this. This is obtained by dividing the annual profit from the organization's basic operations by the average annual fixed capital value. This indicator in its economic nature is close to the capital investment effectiveness coefficient for which the rates have been worked out and this provides a basis for comparing the fixed capital profitability coefficient with these rates.

Improved fixed capital utilization in construction is an important source for the growth of production. The influence of an increased output-capital ratio on the growth of product output can be calculated by the index method. Proceeding from the ratio in which product volume equals the product of the average annual fixed capital value and its productivity, that is, $Q_p = \bar{F}f$, it is possible to construct a system of factor indexes and determine the effect of the absolute amount of the corresponding factors on this basis. From the example's data on the operation of the trust for 2 years (Table VII.2) we have: the influence of a change in the output-capital ratio on the change in the amount of work will be $\Delta f = \bar{F}_1(f_1 - f_0) = 1{,}424 \cdot 0.03 = 42{,}720$ rubles, while the influence of the change in the fixed capital volume will be: $\Delta_F = f_0(\bar{F}_1 - \bar{F}_0) = 0.92 \cdot (-11) = -10{,}120$ rubles. As a whole, the influence of the two factors is: $42.72 + (-10.12) = 32{,}600$ rubles.

Also of practical interest is a study of the impact of fixed capital utilization on the total demand in construction for this capital. Here it is possible to use the following dependence of the indicators: $\bar{F} = Q_p \cdot h$. A calculating of the influence of the factors in absolute terms is done using the above-examined methodology. In the example, the influence of an increase in the amount of work in the change in demand for fixed capital will be: $\Delta_Q = h_0 \cdot (Q_{p_1} - Q_{p_2}) = 32.6 \cdot 1.087 = 35{,}400$ rubles, that is, the additional need for fixed capital equals 35,400 rubles. The influence

[1] The amount of the capital-output ratio, like the output-capital ratio, is influenced by the length of the period. For this reason we assume that it would be more accurate to call this indicator not the level of the capital-output ratio but rather the coefficient for the allocation of fixed capital by analogy with the working capital coefficient (see Chapter XI, §3). The capital-output ratio, like the labor- or materials-output ratios, should not depend upon the length of the period and it must be calculated as the ratio of the total amortization deductions over the period to the volume of work carried out in the same period.

Table VII.2

Indicators	Symbol	Index	Previous year	Absolute deviation
Estimated cost of construction-installation work, 1,000 rubles	Q_p	1,320.2	1,352.8	32.6
Average annual value of fixed productive capital, 1,000 rubles	$\overline{F}$	1,435	1,424	-11
Output-capital ratio, rubles	f	0.92	0.95	0.03
Capital-output ratio	h	1.087	1.053	-0.034

of the reduced capital-output ratio on the change in the need for fixed capital will be: $\Delta_h = Q_{p_1}(h_1 - h_2) = 1{,}352.8(-0.034) = -46{,}000$ rubles, that is, the demand for fixed capital as a consequence of its improved utilization declined by 46,000 rubles. As a result, the total demand for average annual fixed capital has declined by 11,000 rubles. The reduced need for fixed capital expresses a hypothetical savings in capital investments for obtaining an increase in product volume.

By analogy with the designated methodology, it is possible to study the influence of various factors on the dynamics of the output-capital ratio. For example, in practice a study is often made on the influence of a change in the use of the active means of labor (f_a) and their share (d_a) on the dynamics of the overall output-capital ratio, relying on the following relationship of the indicators: $f = f_a d_a$. The problem of a more thorough analysis of the output-capital ratio is better solved by constructing multifactor statistical mathematics models based on the regression correlation method and the apparatus of production functions.

Under the conditions of the continuous growth and strengthening of the physical plant of construction organizations, the task of a statistical study made on the level of fixed capital available to the workers has assumed great significance. For solving this problem the indicators for the fixed capital available for workers are calculated; this can also be done for the individual types of capital. The amount of fixed capital available per worker as a whole is the ratio of the value of construction-end fixed capital to the number of workers in basic production on the fullest shift. This is determined by the fact that the same means of labor are employed by workers on different shifts and most fully during the fullest shift. For calculating the coefficient, for the considerations given in 2, one proceeds from the data on the balance sheet value of the fixed capital.

In statistical practice, due to the absence of information on the shift factor and the initial data for calculating it, a different methodology is employed for calculating the amount of capital available per worker. This is figured as the ratio of the average annual value of fixed capital to the average annual number of workers. An indicator calculated by this method distorts the level of fixed capital available per worker, as it depends upon the number of operating shifts in the organizations. Under the conditions of a stable shift system, it can be applied in studying the relationship between the fixed capital available per worker (v) and labor productivity (w) and the output-capital ratio, that is, $w = fv$, in the aim of determining the influence of a change in the corresponding factors on a change in output.

In addition to the designated indicator, statistics also calculates the machinery available per worker. This is determined as the ratio of the value of construction machinery to the average listed number of workers employed in construction and installation jobs.

§4. Accounting for the Number, Power, Composition and Condition of Construction Machines

Over the period that the Soviet state has existed, construction has been turned into a major economic sector equipped with modern technology. The technical base of construction by the beginning of 1979 numbered some 156,900 excavators, 196,600 mobile cranes, 161,800 bulldozers, 43,300 scrapers and so forth. The construction machinery and mechanisms, called operating machinery and equipment in the fixed capital classification, hold a leading place in terms of their role in production and in terms of the proportional amount in the value of the fixed productive capital. They include those types of the means of labor which are designed for directly carrying out the individual types of construction work as well as the operations which prepare for the execution of this work (the transporting of materials to the place of their use, loading within the work zone of the construction site and so forth).

In the statistical study of construction machines there are the following tasks: accounting for the number and composition of the machines, describing the capacity, condition and renewal of the machines, studying the utilization of the machines and disclosing reserves for increasing production by improving machinery use.

Construction machines and mechanisms employed in the organizations for carrying out the work differ in terms of purpose, power, method of operation and other features. A classification of the construction machines is essential for solving many of the problems of construction machine statistics. The basic feature for classification is the type of construction and installation work for which the machine is to be used. By this feature all construction machines can be divided into groups, among which the most numerous are machines for earthmoving, freight-lifting machines and mechanisms (power, truck-mounted and other types of cranes), road-building machines (steamrollers, graders and so forth), machines for mixing concrete and other materials (concrete mixers, pumps and so forth), loading machinery, mechanized tools (electric drills, pneumatic drills and so forth) and others. Each of the groups of construction machines is then divided into smaller positions for other features. For example, in terms of the method of performing the work, in the group of earthmoving machines there are earthmoving machines (excavators and so forth), earthmoving and transport machines (scrapers, graders and so forth) and hydromechanical equipment; in terms of the design features of the working parts of the machines, in the group of earthmoving machines a distinction is made between single-bucket and multibucket excavators. The degree of detailing for the classification positions of construction machines is determined by the aims and goals of the economic research. Here the closer one is to analyzing the study of the production process the more one feels a need for the most detailed classification.

For correctly judging the composition of construction machines and their utilization as well as for other purposes, information is needed on the number of machines and their power. A stock object is considered the accounting unit for construction machines and by this one understands an independent technical device or machine with an engine, accessories, mountable equipment and a set of tools. For example, a tower crane with a set of attachments for lifting various shapes and types of loads. A special stock card is kept for each stock object.

In the machinery accounting practices, a distinction is made between the following categories of their number: all on-hand machines at the disposal of the construction organization, that is, the organization's own machines as well as those rented and leased from other organizations; own on-hand machines, that is, kept on the balance sheet of the given construction organization; actual operating machines (own and outside), that is, those which during the given period were used in production, regardless of the length of operation, and including own machines. The power of the machines is expressed, as a rule, by the amount of the basic operating parameter of the machine, by its productivity, engine power and so forth. For example, the power of excavators and scrapers is characterized by shovel capacity in cubic meters, the capacity of cranes by their lifting capacity in tons. Information on the number and power of own construction machines can be obtained from Form No 12 of the annual report "Availability and Composition of Fleet of Basic Construction Machines."

For describing the number and capacity of machines over a period, the following values are calculated: the average listed (daily) number of machines, the average (daily) power of the machines and the power of one average listed machine.

The average listed (daily) number of machines is obtained as the result of dividing the number of machine-days that all the on-hand machines are available to the construction organization (the available calendar time of the machines) by the calendar number of days in the period. From the data in the example (Table VII.3), this indicator for the half-year equals: $\frac{27 \cdot 181 + 18 \cdot 151 + 36 \cdot 53}{181} = \frac{9,513}{181} = 52.6$ machines, that is, each day the trust had 53 excavators available.

Table VII.3

Power of excavators in terms of shoval capacity, m^3	Number of machines	Period machines stayed in organization	Number of days machines stayed in operation
0.5	27	from 1 Jan thru 30 Apr	181
0.75	18	from 1 Jan thru 31 May	151
2.5	36	from 9 May thru 30 Jun	53

The average (daily) power of the machines over a period is figured by dividing the total power of all available machines for all the days they are available to the construction organization by the number of calendar days in the period. The total power of the machines is the total of the products of the power of one machine, the number of machines of this power and the time they remain at the construction organization. In the example the average power of the excavators over the 6 months equals:

$$\frac{27 \cdot 0.5 \cdot 181 + 18 \cdot 0.75 \cdot 151 + 36 \cdot 2.5 \cdot 53}{181} = \frac{9,252}{181} = 51.1\ m^3.$$

This means that each day over the 6 months the construction organization had available an average of more than 51 m^3 of excavator capacity.

The power of one average listed machine over a period is determined by dividing the average power of the given type of machines over the report period by their average listed number over the same period. In the example the power of one average listed excavator in terms of shovel capacity over the first 6 months equals: $\frac{51.1}{52.6} = 0.97\ m^3$.

The productivity of construction machines and the degree of their utilization depend upon their condition and this is described by the wear on the machines, their age, technical condition and other features. The wear indicators for construction machines are analogous to those examined in 2 of this chapter for fixed capital as a whole. For describing the age condition of machines, groupings are employed in terms of the years of their output or for the number of years they have been operating. In addition on the basis of these data the indicators of average machine age are also calculated. A notion of the technical condition of the machines can be gained from their grouping in terms of degree of readiness to work. In terms of this feature a distinction is made for the following: machines ready to work; machines requiring a major overhaul; machines unfit for work as a consequence of complete wearing out or breakdown where repair expenditures are economically unjustified. In the statistical reporting (Form No 12) information is given on the number of machines which have served their life and have been withdrawn as a consequence of wear.

An independent area in describing machine condition is a study of the reliability and durability of equipment employed in construction, particularly under the conditions of the mechanization for full mechanization of construction work, when trouble-free operation of the machines is an essential condition for the continuity of the production process. In order to gain a notion of the level of operational reliability of construction equipment, statistics calculates a number of indicators which describe the reliability, durability and repayability of machines.

The general indicator for the reliable operation of machines is the share of the number of reliably operating machines in the total number of all the machines which have been operated during the given period. Correspondingly, the share of the number of machines having even one breakdown in work over the given period in the total number of machines operated during this period will show the frequency of construction equipment breakdowns.

Table VII.4

Indicators	Previous year	Report year
Actually worked machine-hours	10,800	12,600
Time spent on repair, machine-hours	810	840
Number of breakdowns in operation	180	140

Indicators for the reliable operation of the machines has calculated using data on their operating time provide a more accurate assessment of machinery operational reliability. These indicators include: the average number of operating hours of one machine until one breakdown (average operation until failure) and the coefficient for the intensity of equipment failures in operation. The first of them is determined by dividing the time actually operated by the machines over the given period by the number of breakdowns in their work over the same period. This indicator characterizes the average length of machine operation between two shutdowns as a consequence of failure. The second indicator (the failure frequency coefficient) is an amount which is inverse to the first indicator and describes the number of failures as an average per 10, 100 and 1,000 operating hours of one machine. A failure in the operation of a machine is considered to be its halting because of any breakdown. According to the data in the example on the work of hoisting cranes in a trust over a 2-year period (see Table VII.4), we have: the average number of operating hours per failure in the previous year was $\frac{10,800}{800} = 60$ and in the report year $\frac{12,600}{140} = 90$, that is, the average length of operating a crane between two failures increased by 1.5-fold (90:60) in the report year in comparison with the preceding one. The failure frequency coefficient in the operation of the tower cranes during the previous year equaled $\frac{180}{10,800} = 0.017$ and in the report year $\frac{140}{12,600} = 0.011$, that is, for every 1,000 hours of crane operation in the previous year there were 17 failures and in the report year 11.

For describing the repairability of construction machines, by which one understands the actual speed of their servicing in eliminating malfunctions and restoring their workability (repair), the average length of eliminating one failure is determined. This is calculated by dividing the total time required to eliminate the causes of failures, that is, to repair the machines over the given period, by the number of failures in the operation of the machines over this same period. In the example the average length of eliminating one failure on a power crane in the previous year was $\frac{810}{180} = 4.5$ hours, but in the report year $\frac{840}{140} = 6$ hours, that is, it increased.

§5. A Statistical Study of the Extensive Use of Construction Machines

For ensuring control over the use of construction machines, the contracting organizations account for the worked and unworked time for the machines. Various units are employed in accounting for this time, including: machine-day, machine-shift and machine-hour. As a rule, machine-days are used to account for the time the machines stay in construction organizations as well as the operating and stoppage time of the machines. A machine-day for the remaining of machines at an organization is considered to be the day when the machine was listed by or available to the given organization. A worked machine-day is considered to be a day when the machine was employed in work regardless of the length of its work. A worked machine-shift is considered to be a shift during which a given machine was employed in work regardless of its duration. An hour of actual work by a machine must be considered a worked machine-hour.

These same units are used to account for the time of work interruptions for machines and, in particular, the stoppage time during which the machine should have operated according to the plan but actually stood idle. Here the machine-day, machine-shift or machine-hour of interruption (stoppage) in the work of the machine describes exclusively the time the machine stood idle. Intrashift stoppages and interruptions are accounted for in machine-hours while the remaining time machines stand idle is given in machine-days and machine-shifts. The shift report of the operators is used as the basis for calculating the worked and unworked time of construction machines.

The designated elements of time comprise the various available machine times and the initial amount used to construct these is the available calendar machine time. This is the time during which the given machine is available to a construction organization. For example, during a month consisting of 30 days the machine stays at the given organization, the available calendar time equals 30 machine-days or 270 machine-hours (30 24). The calendar available time for the aggregate of machines is determined as the total machine-days (hours) the machines stay in the organization over the given period. The contents of the other available machine times is represented by the scheme of the available calendar machine time given below.

<table>
<tr><td colspan="5">Available calendar time</td></tr>
<tr><td colspan="4">Nominal time available</td><td>Extra-nominal time</td></tr>
<tr><td colspan="2">Available operating time</td><td>Repair time</td><td>Time for moving, installation and disassembly of equipment</td><td></td></tr>
<tr><td>Actually worked time</td><td>Stoppage time</td><td></td><td></td><td></td></tr>
</table>

Diagram VII.1. Composition of available calendar machine time

The structure of the available calendar machine time is of significance not only in organizing machine time accounting but chiefly for describing the use of construction machines and mechanisms. In the statistical reporting (Form No 1-NT "Report on the Mechanization of Construction and the Use of Construction Machines") there is information on the available calendar machine time in machine-days and on the worked time for a number of machines in days and hours.

A study of machinery use is an important task for the statistics of construction fixed capital. Improved use of machinery is one of the essential factors for raising worker labor productivity and, consequently, one of the factors for increasing the efficiency of construction work. Construction statistics studies machinery use in three areas: extensive, intensive and in terms of the volume of work as a whole. In the extensive use of construction machines, statistics differentiates the characteristics of machine utilization in terms of the number of machines and the use of the machines in time. A notion of the use of machines by number can be gained by comparing the number of the different categories of machines. Thus, in comparing the number of actually operated machines with the number of the total available machines in an organization, we gain an answer to the question of the use factor for the fleet of construction machines available to the given organization.

The machinery operating shift factor holds an intermediate position between the indicators for machinery use by time and by number. This describes the load factor on the machines over the shifts, that is, it indicates how many shifts as an average each machine was operated during the work day. In construction this indicator is calculated both for the operating and for the available machines. The machine shift factor for a day is determined as the arithmetic average of the number of shifts weighted for the number of machines operated in them. For the operating period (month, quarter and so forth), the machine shift factor is determined in the following manner: for operating machines, as the result of dividing the number of actually worked machine-shifts by the number of worked machine-days for the report period; for available machines, by dividing the number of actually worked machine-shifts by the maximum possible number of machine-days of work for all the available machine (the nominal available time for the available machines).

Let us assume that in a construction trust during April there were 18 excavators available. With three-shift operating conditions and 23 workdays, these machines worked 298 machine-days or 1,070 machine-shifts. The shift factor for the excavators at the trust in April will be: for the operating excavators $\frac{1,070}{398} = 2.7$; for the available excavators $\frac{1,070}{18 \cdot 23} = \frac{1,070}{414} = 2.6$.

If the machine shift coefficient is divided by the number of shifts operating in the organization, we will obtain an indicator for the use of the shift system. In the example this indicator for operating excavators was $\frac{2.7}{3} = 0.9$ and for the on-hand one $\frac{2.6}{3} = 0.87$. The numerical discrepancy of these indicators, like the shift coefficients for the operating and on-hand machines, is caused by the incomplete utilization of the fleet of available machines.

An improvement in the use of construction machines over time is a major reserve for increasing labor productivity and for raising the production volume in construction. A statistical description of machine use over time is given, as a rule, for operating machines. The uniqueness of studying machine use over time is that here it is a question of the fact of the operation or idleness or the machines and the amount of time the machines remain in one or another state. For precisely this reason the indicators of machine use over time can be generalized for any machine aggregate. The machine load factor over time is described by the amount of worked time for one machine over a given calendar period. For an aggregate of machines this level is determined by dividing the time worked by all the machines by the average listed number of machines over the given calendar period. Since machine operating time is accounted for in different units, the machine load factor over time can be expressed by an average number of worked machine-days or machine-shifts or machine-hours per average listed machine. The methodology for calculating these load factors is shown using the example of operating bulldozers in a trust (Table VII.5). Of all the types of load factors, machine use over time is most fully shown by the one expressed in machine-hours and less fully in machine-days.

Table VII.5

Indicators	Index	Previous year	Report year	Dynamics coefficient
1	2	3	4	5
1. Time machines remain in organization (available calendar time), machine-days	T	2,920	4,380	1.50
2. Machine-days worked by machines	T_d	1,840	2,880	1.56
3. Machine-shifts worked by machines	T_s	2,723	4,320	1.59
4. Machine-hours worked by machines	T_h	19,607	30,672	1.56
5. Average listed number of machines (line 1:365)	L	8	12	1.50
6. Average number of workdays per listed machine (line 2:line 5)	U_d	230	240	1.04
7. Average number of work shifts per listed machine over year (line 3:line 5)	U_s	340	360	1.06
8. Average number of operating hours per listed machine over year (line 4:line 5)	U_h	2,451	2,556	1.04
9. Shift coefficient for operating machines (line 3:line 2)	K_s	1.48	1.50	1.01
10. Average length of shift in hours (line 4: line 3)	C_h	7.2	7.1	0.99

The machine load factors over time are interrelated in a system of indicators which can be used as the basis for factor index analysis. Thus, the average number of worked machine-hours per listed machine over the given period can be represented by the following expression: $U_h = U_d K_s C_h$. In other words, the average number of operating hours per listed machine equals the product of three indicators: the average number of operating days per listed machine, the shift coefficient for the operating machines and the average length of time the machines operate a shift. The machine load factors over time are of significance in working out operating time standards for various types of construction machines and for describing their fulfillment. The percentage of fulfilling the machine operating time standards can be determined by the index formula $I_{fn} - \frac{\Sigma U_h h}{\Sigma U_n h}$. The index numerator is composed of the total time worked by all machines over the given period while the denominator shows the total operating time of these same machines according to the standards for the same period.

For describing the use of machine time overtime it is possible to calculate a dynamic coefficient (growth rate) using the formula

$$K_u = u_1 : u_0,$$

where u_1 and u_0--the amounts of worked time by one listed machine, respectively, in the report and base periods.

In calculating the dynamic coefficient it is essential that the compared periods be uniform in length. An illustration of the calculations for all the above-examined indicators is given in Table VII.5.

Along with the designated indicators for machinery use over time, statistics also employs relative indicators which describe the degree machines are used over time during a given period. The basis for calculating these is the structure of the available machine calendar time. The indicator which most fully reflects the result of machine use over time is the coefficient for the use of calendar machine available time. This is calculated as the ratio of the time actually worked by the machines to their available calendar time. According to the data of the example, the coefficient for the use of available calendar time (in machine-hours) for the machines over the previous year is $\frac{19,584}{2,920 \cdot 24} = 0.279$ and for the report year $\frac{30,672}{4,380 \cdot 24} = 0.292$. As the basis for calculating the indicators for the degree of machine use it is possible to employ the nominal machine time or the available operating time. In the current statistical reporting (Form No 1-NT) data are found only for calculating the coefficient for the use of the available machine calendar time.

In addition to the general indicators for the use of machines over time, in the construction organizations attention is given to studying machine stoppages. For this relative amounts (proportional amounts) of machine stoppage time as a whole and for the reasons of their occurrence are calculated. Among the most frequently encountered reasons for stoppages are the absence of electric power, awaiting for repairs, the absence of a workfront and the absence of a worker.

§6. Indicators for the Use of Construction Machines for Capacity and Work Volume

The intensity of construction machine utilization reflects the second area in the use of the active means of labor in production. The level of the intensive machine load factor usually is expressed by the amount of work performed in a unit of time actually worked by them for a machine-hour, machine-shift and so forth. The coefficient for the dynamics of intensive machine use can be obtained by comparing the corresponding levels of the report and base periods, that is:

$$\frac{q_1}{T_{м_1}} : \frac{q_0}{T_{м_0}},$$

where q_1 and q_0--the amount of work performed by the machines in the report and base periods;

T_{m_1} and T_{m_0}--the time worked by the machines in the report and base periods.

For the construction machines which are of the same type but differ in power, the level of their intensive load factor is determined considering the power differences. This is expressed by the amount of work per unit of capacity (the basic operating parameter) for the given type of machine as performed over a unit of worked time, that is:

$$v = \frac{q}{T_m N} .$$

For example, for excavators this level is characterized by the amount of dug (moved) dirt per m^3 of shovel capacity per worked machine-hour. Hence the dynamic coefficient for the intensive use of the machines (in terms of power) is figured using the formula:

$$K_v = \frac{q_1}{T_{M1}\overline{N}_1} : \frac{q_0}{T_{M0}\overline{N}_0},$$

where $\overline{N}_1$ and $\overline{N}_0$--the power of one average listed machine in the base and report periods.

Information necessary for the calculation can be found in the reporting of Form No 1-NT (Construction). Using the data of the example on the operation of scrapers at a mechanization trust during two quarters (Table VII.6) with an average capacity of one listed machine in the first quarter of 3.2 m^3 of shovel capacity and 3.5 m^3 in the second quarter, the coefficient for the dynamics of the intensive use of the scrapers will be: $\frac{199,396}{1,596 \cdot 3.5} : \frac{165,826}{1,406 \cdot 3.2} = 35.7 : 36.86 = 0.968$, or 96.8%.

Table VII.6

Type of machine	Worked man-days		Earth-moved, m^3	
	1st quarter	2d quarter	1st quarter	2d quarter
Scrapers with 3 m^3 shovel	846	962	93,060	110,634
Scrapers with 4 m^3 shovel	560	634	72,836	88,762
Total	1,406	1,596	165,896	199,396

The indicators for the use of machinery over time and for power characterize individual aspects of a single economic phenomenon, the use of the machines in terms of the volume of their work. An indicator expressing the overall result of utilizing the machines in terms of the volume of their work is termed an integral one. In the instance when the same type of construction machines with the same power are employed, the integral use level is expressed by the amount of work carried out in a unit of the maximum possible time of one machine and is determined by the formula $w = q/T$. As the maximum possible time of the machines (T) the available calendar time, the nominal time or even the available operating time of the machines can be used. The level calculated per unit of available machine calendar time most fully describes machine utilization in terms of the volume of work. The coefficient for the dynamics of the use of machines in terms of the volume of work is calculated by comparing the integral level of machine utilization in the report period with the analogous level of the base period, that is,

$$K_w = \frac{q_1}{T_1} : \frac{q_0}{T_0},$$

where T_1 and T_0--the calendar, nominal or available time of the machines for the report and base periods.

For construction machines of the same type but with different capacity, the integral level of machine utilization can be measured by the volume of work performed per unit of maximum possible machine time calculated per unit of capacity of the given type of machines. This is determined using the formula:

$$w = \frac{q}{TN} = \frac{q}{T_c N},$$

where T_c--the calendar length of the period and
N--average daily machine capacity.

The initial data for calculating the integral level is to be found in Form No 1-NT.

On the basis of the integral levels of machine utilization, dynamic coefficients are calculated using the formulas:

$$K_w = \frac{q_1}{T_1 N_1} : \frac{q_0}{T_0 N_0} \quad (1), \qquad \text{or} \qquad K_w = \frac{q_1}{T_{c1} N_1} : \frac{q_0}{T_{c0} N_0} \quad (2)$$

Let us assume that in our example the total time the scrapers remained in the construction organization (the calendar time) was 1,894 machine-days in the first quarter and 1,720 machine-days in the second. Then the dynamic coefficient of machine utilization for the volume of work as calculated for the data in machine-days will be:

$$\frac{199,396}{1,720 \cdot 3.5} : \frac{165,896}{1,894 \cdot 3.2} = 33.12:27.37 = 1.21 \text{ or } 121\%.$$

In construction for the basic types of machines directive output rates have been set calculated per listed machine or per unit of its capacity per year. The carrying out of the directive output rate is determined by comparing the actual integral level of utilization for the given type of machines (W_f) as calculated over the report period with the directive standard corresponding to this period (W_n), that is, according to the formula:

$$I_{f/n} = W_f : W_n .$$

The above-examined indicators for machine utilization for time, power and the volume of work are interrelated in a system: the levels $W = uv$, the dynamic coefficients $K_w = K_u K_v$. In the example, the relationship of the dynamic coefficients is as follows:

$1.25 \cdot 0.968 = 1.21$, where 1.25--the dynamic coefficient for machine utilization over time, that is $\left(\frac{1,596}{1,720} : \frac{1,406}{1,894}\right)$. The given relationship makes it possible to carry out factor analysis on machine utilization using the index method.

CHAPTER VIII: A STATISTICAL STUDY OF THE SUBJECTS OF LABOR IN CONSTRUCTION

§1. The Tasks of the Statistics of the Subjects of Labor

An important condition for the carrying out of the production program by each construction organization is the continuous and complete supply of it with the essential subjects of labor and their rational utilization in production. In construction the subjects of labor comprise such material elements as the construction and other materials, structural elements, parts, fuel, electric power and so forth which, in the production process, operate in the form of working productive capital.

A statistical study of the supply of the construction organizations with the subjects of labor and their use in production is of important significance as construction is among the most material-intensive national economic sectors. A study of material and technical supply, as a national economic sector, is a subject of the corresponding sectorial statistics. For this reason in a course on construction statistics, only those questions of material supply statistics will be examined which bear directly on the production and economic activities of construction organizations.

Construction statistics in the area of the supply and utilization of the subjects of labor carries out the following tasks: a study of the availability and composition of materials and other subjects of labor in the construction organizations; a study of the receipt and expenditure of materials; a description of the availability of materials for construction work; a study of the use of materials in production and an analysis of the influence of the factors on the dynamics and fulfillment of the material consumption rates.

§2. A Statistical Study of the Availability and Composition of Materials

The subjects of labor employed in construction work are extremely diverse in terms of their role in the labor process, their purpose and their physical, chemical and other properties. The heterogeneous composition of the subjects of labor necessitates a classification of them in the process of study. In construction all subjects of labor in terms of their role in the production process are distributed into three groups: equipment for installation, materials and inexpensive and rapidly used up articles.

Equipment for installation is among the subjects of labor for a number of reasons and primarily because this is assembled and installed by workers in the process of construction work as a component part of the sector's end product. For example, lathes, drilling machines, milling machines and other metalworking machine tools installed in a machine shop under construction. However, as a consequence of the specific procedures for the planning, acquisition, storage and financing of equipment requiring installation, it is accounted for only on the balance sheet of the builder regardless of the method for carrying out the installation work. The contracting organization which installs the equipment merely receives it under responsible custody until the object is put into operation. Consequently, equipment for installation can be viewed as a specific representative of the subjects of labor which, in contrast to materials, is not included in the economic turnover of a construction organization.

Materials are the aggregate of subjects of labor forming the physical content of the product and participating in its manufacture. In terms of the nature of the function performed in production, materials are divided into basic and auxiliary. The basic materials include the subjects of labor which in the labor process directly undergo processing and are physically part of the created product, for example, blocks, panels, lumber, slate and so forth in erecting a building. Within the basic materials, two subgroups are established: a) ordinary or traditional building materials which are almost always employed in construction, for example, sand, stone, brick, cement, lumber, metal and so forth; b) structural pieces, elements and assemblies used in prefabricated industrial construction. These include large structural elements manufactured at industrial enterprises (wall units, panels, beams, stairways, bathroom assemblies and so forth).

Auxiliary materials are comprised of the subjects of labor for diverse production and operational needs of the construction organizations. These help to create the product, for example, welding and lubricating materials, fuel, explosives and so forth. Subsequently, the basic and auxiliary materials are classified by types, grades and so forth in accord with their physical, chemical and other properties.

Inexpensive and rapidly used up articles comprise a separate group of production and economic assets which in their role in production more often perform the function of the means of labor and not subjects of labor. In accounting and statistics, this group of articles includes tools, office supplies, attachments, special clothing and other articles which cost under 50 rubles per unit regardless of their service life and articles which are used less than 1 year regardless of their cost.

In construction organizations materials are accounted for in physical and cost units. As the physical units of measurement the physical measurements of weight, length, area and volume are used. Materials are accounted for in cost terms at the plan-calculation prices given in the price list for the construction site and at the ex-factory (wholesale) prices adopted in drawing up the estimates (at present, in 1967 prices).

Information on the availability, composition and movement of materials is contained in the documents of operational warehouse and bookkeeping accounting of the construction organization (the accounting ledgers, inventory statements, waybills and material reports). At the end of each month for the construction areas, material reports are drawn up according to Form M-19 and for the construction organization as a whole using Form M-29. On the basis of these primary documents, each quarter the construction organization compiles the statistical "Report on Balances, Receipt and Consumption of Materials in Capital Construction" using Form No 2-SN. For obtaining more detailed information on the quantity, composition, condition and movement of material resources, state statistics conducts censuses and one-shot surveys of the materials and equipment balances in construction.

§3. Indicators for the Movement of Materials

Material supply within a construction organization is a process the individual stages of which entail the receipt of materials and other subjects of labor at the contracting organization's warehouses and their consumption in production. These stages form a unified process for the movement of materials and a quantitative description of this is one of the tasks in the statistics of the subjects of labor.

A general and fullest idea of the availability and movement of materials in the sphere of activities of contracting organizations is provided by the building materials balances. As a rule, these are drawn up in physical units for the most important types of building materials, for example, for cement, prefabricated reinforced concrete products and elements, metal, slate and so forth. Under the conditions of socialist production, plan and report (actual) balances are made up and these make it possible to describe the particular features of carrying out the material and technical supply plan of capital construction. The balance consists of two parts: resources and distribution of materials. An idea of the contents of each part of the balance can be gained from the below-given Table VIII.1 using the example of the delivery and consumption of slate in a trust during April.

Table VIII.1

Resources	1,000 units of standard sheet	Distribution	1,000 units of standard sheet
1. Balance at start of period	900	1. Expended over period--total	2,240
2. Deliveries--total	2,300	a) For construction-installation work by own forces	2,100
Including:		b) Dispatched to subsidiary production	--
a) From centralized stocks	1,770	c) Turned over to other organizations	140
b) From noncentralized stocks	--	2. Balance at end of period	960
c) From own subsidiary production	--		
d) Received from other organizations (construction)	530		
Total	3,200	Total	3,200

The building materials balance is used in a somewhat abbreviated form in Form No 2-SN. In this report information on the movement of materials is given in physical units for the established range of building materials numbering some 81 items. The data of the balances can be used not only to describe the movement of materials but also in calculating other derivative indicators for the availability of materials in construction work and the indicators of their use.

In studying the individual aspects of material supply of importance are the indicators describing the evenness, intensity and steadiness of this process. The evenness of materials deliveries can be shown by indicators for the variation of intervals between deliveries as well as by the scope of the minimum and maximum values of the intervals. A notion of the intensity of materials supply is provided by the average frequency of deliveries, by the average volume of one delivery and so forth. The average frequency of deliveries (receipt) for a material is calculated in days using the formula:

$$\bar{t} = \frac{T_n}{n-1},$$

where T_n--the calendar length of the period from the first to the last delivery of the material in the report period;
n--the number of material deliveries in the report period.

This indicator, in essence, describes the average amount of the interval between two deliveries of material.

The average actual volume of one delivery (receipt) of a material is determined as a simple arithmetic average, that is,

$$\bar{M} = \frac{\Sigma M}{n},$$

where ΣM--the volume of material delivered over the report period.

Let us give an example. Let us assume that in September a construction trust had the following deliveries of wall modules (units): 140 on 2 September, 84 on 6 September, 28 on 11 September, 162 on 18 September and 76 on 29 September. According to the plan there were to be 6 deliveries with an interval of 5 days between them. In the example, the length of the period for all the deliveries is 30 - 2 = 28 days and the number of deliveries in September was 5. Hence the average frequency of delivery was 28/(5-1) = 7 days. This means that the actual average interval between deliveries exceeds the planned delivery interval by 1 day and, consequently, the intensity of supply slowed down in comparison with the plan. The average volume of one delivery was: $\frac{140+84+28+162+76}{5} = 98$ units.

An idea of the steadiness of materials receipts can be gained from the coefficient of supply steadiness (K_p) and this can be obtained from data on their number, that is, according to the formula

$$K_p = \frac{\Sigma M_f}{\Sigma M_{p\ell}},$$

where ΣM_f--the quantity of the received given type of material within the plan and on the planned delivery days;
$\Sigma M_{p\ell}$--the volume of materials received according to the plan for the report period.

Let us examine an example for calculating this indicator, the initial data of which are given in Table VIII.2 for a construction trust in April.

Table VIII.2

1 Дата поставки		2 Поступление пиломатериалов, куб. м		3 Засчитано в счет ритмичного снабжения
4 по плану	5 фактически	4 по плану	5 фактически	
2	3	26	20	—
6	6	30	30	30
10	10	24	22	22
14	14	20	23	20
19	20	24	21	—
22	22	20	26	20
26	26	32	30	30
30	30	30	34	30
month average		206	206	152

Key: 1--Delivery date; 2--Receipt of lumber, m^3; 3--Counted as steady supply

According to the data of the table, in the trust the lumber supply plan was fulfilled for April. However, during the month there were two overdue lumber deliveries, that is, one-quarter of all the planned deliveries. The steadiness coefficient for the supply of materials during the month equaled: 152/206 = 0.74, or 74 percent. This means that under the existing production conditions, 74 percent of the volume of of lumber deliveries according to the plan were carried out in accord with the established delivery dates within the planned delivery volume. The remaining portion of material deliveries according to the plan which represents in relative terms the difference between 100 percent and the above-calculated indicator and in absolute terms the difference between the numerator and denominator of the calculated fraction, describes that portion of planned material deliveries which was received in violation of the supply conditions or was not received at all in the report period. The overdue delivery of materials is also considered an infraction of supply plan conditions. Thus, the designated coefficient describes the steadiness of the supply process over time and in terms of the volume of materials received together. In studying the steadiness of material deliveries it is possible to employ the method of unsteadiness numbers as proposed by V. Ye. Adamov (see Chapter V, §14).

§4. A Statistical Study of the Availability of Construction Materials

A continuous construction process is achieved by the planned, steady and complete supply of materials for the construction organizations. For this reason a description of the level of their supply for construction work is an important task in statistics. The amount of the stocks of material resources is set in accord with the volume and composition of the planned construction and installation work. Consequently, the supply of materials to each construction organization can be judged primarily from the degree of fulfilling the material supply plan as well as from the number of contracts signed for the delivery of materials.

The indicator for the fulfillment of the material delivery plan is calculated by the index method and for an individual type of material using the data on its quantity in physical units while for an aggregate of types of materials by using data on their quantity in monetary units, that is, respectively by the formulas:

$$i = \frac{M_1}{M_{p\ell}} \quad \text{and} \quad I = \frac{M_1 p}{M_{p\ell} p},$$

where M_1 and $M_{p\ell}$--the quantity of the given type of material in the report period and according to the plan;
p--estimated or planned-calculation prices for materials.

Having determined the fulfillment of the delivery plan for each type of material over a report period, it is possible to gain a certain notion of the comprehensiveness of material deliveries to the construction organizations and to the construction projects. Here as the overall indicator for complete material deliveries it is possible to use the least of the calculated indicators for the fulfillment of the delivery plan for the individual types of materials. Since there can be interchangeable materials among those delivered to the site, it is logical to count the above-planned delivery of the given material during the report period in fulfilling the plan in the place of a lacking material but one interchangeable with the given material. The designated indicators should be employed for describing the completeness of fulfilling the material supply plan in prefabricated construction.

The degree of carrying out planned material deliveries under constracts with suppliers can be described for each type of material by the ratio of the volume of deliveries carried out by contract in the given period to the planned delivery volume. By subtracting the latter indicator from the former it is possible to show that portion of the planned deliveries which was not covered by contracts with suppliers. Table VIII.3 shows the result of calculating the designated indicators for a construction trust during the report year. Information on the volume of material deliveries according to the plan, including those covered by contracts with suppliers, is to be found in the report of the construction organization's supply department while the methodology for calculating the remaining indicators is given in the table. In the example with slate and beams, the planned demand for the report year was not fully covered by contracts with suppliers and this can be the reason for the nonfulfillment of the plan for construction-installation work in the report period.

Table VIII.3

Name of materials	Unit	Volume of material deliveries			% of planned deliveries covered by contracts (col. 3:col. 2) 100)
		Plan, total	Covered by contracts with suppliers	Not covered by contracts with suppliers (col. 2-col. 3)	
Lumber	m^3	3,100	3,100	--	100.0
Slate	pieces	8,400	6,800	1,600	81.0
Beams	tons	1,260	840	420	66.7

For obtaining a full idea of the supply of materials for construction work, in constructing the corresponding indicators, it is essential to consider the daily need of production for materials to carry out the construction-installation work in the report period. For example, if the daily need for brick to carry out the construction-installation work equals 16,000 pieces and its supplies at the construction site at the end of the given period are 96,000 pieces, then in the following report period the construction organization has a brick supply of just 6 days (96:16). If these indicators are calculated for each type of planned basic materials, then the least of them can be used as the general index for the supply of materials for construction work in terms of volume and completeness.

For judging the supply of production with materials over the report period it is not enough to have information on the fulfillment of the material supply plan. The plan during the report period can be fulfilled and overfilfilled while during the period production stoppages may occur due to shortages of materials. For this reason for studying the supply of materials during a period it is important to consider not only the quantity of the delivered material but also the date of its delivery as well as the daily need for this material. Let us assume that in September, according to the plan, 6,000 wall blocks should be received with an average daily requirement of 200 pieces (6,000:30). Actually in September 7,200 wall blocks were received and, consequently, the supply plan for these materials was fulfilled by $\frac{7,200}{6,000} \cdot 100 = 120\%$. However from this one must not conclude anything about the degree of supplying wall blocks for construction by the trust in September. In order to obtain an answer to this question, it is also essential to consider the prompt delivery of materials to the construction site. Below, in Table VIII.4, data are given on the deliveries of wall blocks as well as the calculations for the indicators of their supply for construction by the trust considering the material delivery date.

Table VIII.4

Indicators	Avail. on 1 Sep	Dates of receiving wall block in Sep					Met demand in Sep
		3	11	16	24	29	
Number of wall blocks, units	600	1,200	1,300	800	1,800	2,000	
Number of days of month supplied with received material	3	6	7	4	7	--	27
Amount of material corcoresponding to number of days supplied with it in report month	600	1,200	1,400	800	1,400	--	5,400

The calculation of the number of workdays in a report period supplied with the given material (in the example, with wall blocks for a month) is carried out in the following manner. The balance of the wall blocks on 1 September, with their daily need of 200 pieces, ensures the carrying out of construction and installation work for 3 days (600:200), that is, up to 3 September inclusively. The first delivery of wall blocks was on 3 September and this ensured the operation of the construction trust for another 6 days (1,200:200), that is, until 9 September inclusively. On 10 September the trust was without blocks. The delivery of wall blocks on 11 September provided for the operation of the trust for another 7 days, that is, from 11 through 17 September inclusively. The delivery of material on 16 September provided for construction for another 4 days, that is, through 21 September inclusively. On 22 and 23 September the trust was without blocks. The delivery of blocks on 24 September provided for the operation of the organization up to the end of the month, that is, for 7 days. The last delivery of wall blocks was of no importance for ensuring the continuity of construction in September. Thus, during the report period, production in the trust was supplied with the given material for 27 days. In other words, of the 6,000 wall blocks needed for work in September, in fact only 5,400 were actually delivered on time. Consequently, the supply level of construction, in fulfilling the material supply plan by 120%, was: $\frac{5,400}{6,000} \cdot 100 = 90\%$.

The computed indicator can be used as a general one for the given type of material during the report period. In knowing the consumption of material per unit of construction product and the amount of material promptly delivered to the construction organization, it is possible to determine the amount of work not carried out because of disrupted supply for the given material. Let us assume that in our example two wall blocks are used for 1 m^3 of wall laying. Then the volume of incomplete construction over the report period due to the shortage of this material would be: $(6,000-5,400):2 = 300\ m^3$.

§5. The Statistical Study of Materials Utilization in Construction

A study of the use of material resources in construction is an important and timely task of materials statistics. Statistics should describe the use level of the materials in construction, determine the relative and absolute change in this in comparison with the standards and over time and establish how this influences the savings of materials. The material use level in construction is characterized by the average amount of material consumption per unit of construction product. This indicator usually termed the proportional consumption of material (m) is determined by dividing the quantity of material expended on producing the construction product (M) by the volume of construction product created in the report period (q), that is, by the formula $m = \frac{M}{q}$.

Depending upon the indicator adopted in the calculation for the construction product and the method of measuring it, proportional expenditure can be calculated per unit of capacity, power or any other unit for measuring the completed construction object as well as per unit of executed construction and installation work. In the first instance the indicator expresses the complete or partial material intensiveness of the end construction product for an individual type of material and for this reason it describes the influence of factors related to the design decisions and the construction process jointly.

The proportional consumption of material per unit of completed object can be calculated not only as a whole for the object but also individually for the stages, work complexes and so forth. For example, the proportional consumption of cement, metal or other materials for building just the exterior walls, interfloor slabs, roof and so forth, calculated per m^3 of effective housing area. This indicator, in contrast to the one examined above, can be calculated in the construction process and for this reason is of operational significance. A general level for the use of the material can be gained from the total proportional expenditures of material according to the stages, work complexes and structural elements per unit of measurement for the completed project (m', m'' and so forth), that is, $m = m' + m'' + \ldots + m^n$.

In the second instance, the proportional consumption of material is calculated per unit of construction-installation work. This describes the use of the material for the specific type of work done in erecting the project. Information for calculating the proportional consumption of material per unit of performed work is to be found in the material reports of Form No M-19 and M-29.

For generalizing the results of materials utilization, in carrying out many types of construction work, the need arises to calculate the proportional consumption of material not in physical but in cost terms. Thus, in planning and statistical practices, the proportional consumption of material is determined per 1,000 or million rubles of estimated cost of construction-installation work. In contrast to the above-examined indicators, this one, along with purely production factors which determine the material utilization level, reflects the influence of cost factors which can distort the actual level of materials use and its dynamics if the conditions for comparability for prices and work composition have been violated.

In the struggle to save material resources, of important significance is the monitoring of the consumption of materials in accord with the established standards. In construction estimated standards and planned production standards for the consumption of materials are employed. For all construction organizations uniform estimated standards have been set and this creates the basis for generalizations on any organizational levels of construction. These standards have been worked out in great detail for the type of construction-installation work and structural elements and are given in physical units in Part IV of the Construction Standards and Rules. The planned production materials consumption standards are employed in planning and monitoring the consumption of materials in construction. They reflect the advanced experience of the construction organizations and are annually revised and supplemented. Consequently, these standards are technically sounder than the estimated ones and it is preferable to employ them in studying materials utilization. In contrast to the estimated standards, these have been set for large units of construction product, for example, per km of road, per m^3 of housing, and so forth. On the level of the glavks, Union republic ministries and the national economy as a whole, material consumption standards are employed per million rubles of estimated cost of construction-installation work.

The index method holds an important place in the statistical study of materials utilization. Under the conditions of construction work several variations have arisen for calculating the indexes for materials consumption and the saving (over-expenditure) of material resources. The simplest case is when a study is made of the consumption of one type of material to perform one type of work. In this instance the index for the proportional consumption of material is calculated by the formula $i = m_1 : m_0$,

where m_1 and m_0--proportional consumption of material, respectively, in the report or base periods (or according to the standard).

In the example given in Table VIII.5, the index for the proportional expenditures of lumber for flooring equals: $\frac{0.21}{0.2}\cdot 100 = 105\%$, that is, in comparison with the standard there has been a 5 percent overexpenditure of lumber; this is 0.01 m^3 of lumber per m^2 of flooring (0.21-0.2). For the entire amount of this work, the savings or overexpenditure of the material in contrast to the standard is determined using the formula $\Delta_m = q_1(m_1-m_0)$,

where q_1--the actually completed volume of work in the report period in physical units.

In the example, as a consequence of exceeding the proportional consumption standards, an overexpenditure of 3.2 m^3 of lumber has occurred, or $320\cdot(0.21-0.2)$.

Table VIII.5

Виды конструктивных элементов 1	Выполнено работ, кв. м 2	Виды израсходованных материалов 3	Единица измерения 4	Цена материала, руб. 5	Норма расхода на единицу работ 6	7 Фактически: общий расход материала 8	7 Фактически: удельный расход материала 9	Индекс выполнения нормы, % 10
Полы (a	320	Пиломатериалы (c	куб. м	5	0,2	67,2	0,21	1,05
		Гвозди (d	кг	2	0,1	35,2	0,11	1,1
Перегородки (b	560	Пиломатериалы (c	куб. м	5	0,3	156,8	0,28	0,93
		Гвозди (d	кг	2	0,15	67,2	0,12	0,8

Key: 1--Type of structural element; 2--Work performed, m; 3--Types of expended materials; 4--Unit; 5--Price of material, rubles; 6--Consumption rate per unit of work; 7--Actual; 8--Total material consumption; 9--Proportional material consumption; 10--Index for fulfillment of standard, %; a--Floors; b--Partitions; c--Lumber; d--Nails

In the second instance when one type of material is spent to carry out several types of work, the index for the proportional material consumption can be calculated by the formula:

$$I = \frac{\Sigma q_1 m_1}{\Sigma q_1 m_0} = \frac{\Sigma M_1}{\Sigma q_1 m_0},$$

where $\Sigma M = \Sigma q_1 m_1$--actual consumption of material for fulfilled amount of work of given type.

The influence of a change in the proportional consumption on the saving of material can be determined by subtracting the denominator of the index from its numerator, that is, according to the formula $\Delta_m = \Sigma M_1 - \Sigma q_1 m_0$. In our example, the index for the proportional consumption of lumber for flooring and for building partitions, taken together, will be: $\frac{67.2+156.8}{320\cdot 0.2+560\cdot 0.3} = \frac{224}{232} = 0.966$, or 96.6 percent, that is, for the entire volume of work performed there has been a savings of lumber of 3.5 percent, or 8 m^3 (224 - 232) in comparison with the standard.

The above-examined methodology lies at the basis of compiling the reports for Forms No M-19 and M-29. Information on the savings (overexpenditure) of materials as given in these reports can subsequently be generalized for the types of materials within an individual construction organization and within departments.

In the third case, when the use of several types of materials for carrying out one type of work is being studied, the index for the proportional material expenditures is determined by the formula

$$I = \frac{\sum m_1 p}{\sum m_0 p}.$$

In calculating this index the need arises to comeasure different types of materials by using prices and for these the estimated or plan-calculation prices are usually employed. The difference between the numerator and demoninator of the index shows the amount of savings (overexpenditure) in materials as a consequence of a change in the proportional consumption of materials per unit of construction product, that is, $\Delta_{m1} = \Sigma m_1 p - \Sigma m_0 p$, and for the entire volume of work performed $\Delta_m = (\Sigma m_1 p - \Sigma m_0 p) q_1$. In our example, the index for the proportional material consumption for flooring will be:

$$\frac{0.21 \cdot 5 + 0.11 \cdot 2}{0.2 \cdot 5 + 0.1 \cdot 2} = \frac{1.05 + 0.22}{1.0 + 0.2} = \frac{1.27}{1.2} = 1.058, \text{ or } 105.8\%.$$

Consequently, in laying 1 m^2 of flooring the standard for proportional material expenditures was exceeded by 5.8 percent, or by 0.07 ruble, and for the entire volume of this type of work, 22.4 rubles (320·0.07).

In the fourth, most general instance, when the use of several types of materials for performing several types of construction-installation work is being studied, the index for the proportional expenditures can be calculated by the formula:

$$I = \frac{\sum m_1 p q_1}{\sum m_0 p q_1}.$$

The saving or overexpenditure of materials for all the performed volume of work, as a consequence of the change in the proportional expenditures, is determined analogously to the third case, that is, by the formula:

$$\Delta_m = \sum m_1 p q_1 - \sum m_0 p q_1.$$

From the data of the example, the overall index for proportional material consumption equals:

$$\frac{(67.2 + 156.8) \cdot 5 + (35.2 + 67.2) \cdot 2}{320 \cdot 0.2 \cdot 5 + 320 \cdot 0.1 \cdot 2 + 560 \cdot 0.3 \cdot 5 + 560 \cdot 0.15 \cdot 2} = \frac{1,324.8}{1,392} = 0.9517, \text{ or } 95.2\%.$$

Thus, as a whole a reduction has been achieved in the proportional material expenditures in comparison with the established rates by 4.8 percent while the savings of all materials in all the work in cost terms has been 67.2 rubles (1,324.8-1,392).

Subsequently the study of the use of materials is to be developed in a direction of elucidating the factors which have caused deviations in the proportional material expenditures from the base level. In this regard it is advisable to study the deviations from the material consumption standards in terms of the component elements.

CHAPTER IX: STATISTICS OF TECHNICAL PROGRESS IN CONSTRUCTION

§1. The Tasks of Technical Progress Statistics

Technical progress is a most important factor in increasing the efficiency of social production and in developing all the national economic sectors, including construction. The realization of technical progress in construction is inseparably linked with its industrialization. The main technical element in industrializing construction at the present stage of its development is the broad use in production of standardized elements, assemblies and other prefabricated pieces manufactured under plant conditions. The introduction of industrial methods and, in particular, prefabricated construction is closely tied to the development of standardized designing.

The characteristic areas of technical progress in construction are the introduction into production of advanced production methods and new advanced methods for carrying out the construction and installation work, the use of new construction equipment and efficient materials as well as full mechanization and automation of the production processes. The economic conditions for technical progress and industrialization in construction are specialization, cooperation, integration and concentration of construction work.

Statistics plays an important role in studying the areas and conditions of technical progress and industrialization in construction and it is confronted with the following specific tasks: describing the elaboration of standard designs and decisions and their introduction into construction; studying the use of new advanced industrial methods in construction and primarily the introduction of prefabricated construction; describing the introduction of new equipment, efficient materials and advanced technological methods in construction work; studying the mechanization and full mechanization of the most labor-intensive and widespread construction and installation jobs; studying specialization, cooperation, integration and concentration in construction; determining economic effectiveness from introducing new equipment, advanced production methods and technology in construction.

§2. Indicators for the Elaboration and Application of Standardized Designing

An important prerequisite for introducing industrial methods in construction is the development and wide use of standard designs. By a standard design one understands a design planned for repeated use in building the same type of projects. A statistical study of standard designing has two basic areas: 1) a description of the standard designing as a result of the design and research activities carried out by the corresponding organization; 2) determining the scale and pace of introducing the standard designs into construction.

A notion of the scope of standard designing in the sectors, ministries or construction as a whole is provided by the number of standard designs created over a certain period and their proportional amount in the total number of individual and standard plans. Recently, on the basis of standardizing the layout and structural designs, the USSR Gosstroy has worked out new ones which are based not on the standard plans for the projects as a whole but rather plans for standard sections, spans and other parts of the projects. From these sections, spans and so forth, standardized buildings and structures of varying size are built. The spread of this progressive trend in designing can be described by the number of created standard designs for sections, modular sections, spans of buildings and installations for the national economic sectors, for types of production and so forth.

For studying the process of introducing standard designing in construction of fixed capital projects, statistics has elaborated a series of indicators which differ in the purpose and method of their calculation. The simplest indicator is the number of fixed capital projects being built under standard designs as well as the proportional amount of the number of these projects in the total quantity of erected projects. A fuller description of the use of standard designing in construction is provided by the indicators for the estimated cost of the projects being erected under standard designs as well as by its proportional amount in the total estimated cost of the projects being built by individual and standard plans.

Standard designing does not always encompass projects and sites as a whole. Sometimes this applies to their component elements, particularly in the construction of production projects. For this reason, in calculating the indicators, it is desirable to proceed from the estimated cost of the construction-installation work on the projects and those parts which are being erected under standard plans. The relative amount of the coverage of construction by standard designing is the ratio of the estimated cost of the construction-installation work carried out under the standard plans and designs to the estimated cost of the work on all the construction projects or those projects which can be covered by standard plans. In Soviet construction, the proportional amount of the work carried out under standard plans in the total volume of work was 81 percent in 1973.

The frequency of employing standard designs in construction can be described by the number of projects built using the given standard design. For a general description it is possible to calculate the number of projects built as an average per standard design over a certain period, that is:

$$\bar{m} = \frac{m}{n},$$

where m--the number of projects built using standard designs and plans in the given period;
n--the number of standard designs used in the given period.

The proposed indicators should be figured for uniform aggregates of projects and sites formed according to the features of sectorial and departmental jurisdiction, functional and economic purpose, territorial location and so forth. Such groupings can disclose the sectorial and other features in the development of standard designing as well as the scale and direction of its spread. The state statistical bodies systematically observe the state of standard designing and its introduction. This information is collected under Form No 6-ks "Report on the Use of Standard Designs in Construction Carried Out from Capital Investments Envisaged in the State Plan."

§3. The Statistical Study of Introducing Advanced Industrial Methods

The main area of industrialization and progress in construction equipment and methods in construction at the present stage of national economic development is the use of prefabricated pieces and assemblies for erecting fixed capital projects. Construction statistics has worked out and employed a system of indicators which from various aspects describe the scope of prefabricated construction, the level of its prefabrication and other particular features. The prefabricated elements in practice include the parts and elements of buildings and installations made from concrete and reinforced concrete as well as metal and wooden structural elements which are industrially manufactured. For example, these are the concrete, reinforced concrete, haydite and other modules and panels, bathroom assemblies, beams and columns.

The prefabrication coefficient is a widespread indicator describing the degree of employing prefabricated elements in construction. Construction statistics recommends several methods for calculating the given indicator with a varying economic content. Most often the prefabrication coefficient (K_{pf}) is defined as the ratio of the estimated cost of construction-installation work using prefabricated elements and parts, including the cost of the prefabricated elements ($\Sigma q_{pf}p$) to the estimated cost of the construction and installation work on the project, site or aggregate of projects and sites (Σqp), that is, $K_{pf} = \Sigma q_{pf}p : \Sigma qp$.

The prefabrication coefficient can be obtained by finding the proportional amount of the cost of prefabricated elements and assemblies ($\Sigma M_{pf}p$) in the total value of all the materials employed in constructing the given project (ΣMp), that is, $K_{pf} = \Sigma M_{pf}p : \Sigma Mp$. This indicator only approximately shows the degree of prefabrication, as it involves only the structure of material expenditures on erecting the project. Moreover, it depends upon the price level for the materials and this will tell on its dynamics. Let us give an example. Let us assume that the following data are known (1,000 rubles of estimated cost) for a trust during a 2-year period (Table IX.1). The construction prefabrication coefficient according to the data on the work performed is: in the previous year $\frac{5,250}{8,200} = 0.64$; in the report year $\frac{8,120}{11,600} = 0.70$. The construction prefabrication coefficient according to the data on consumed materials was: last year $\frac{4,608}{6,400} = 0.72$; in the report year $\frac{7,030}{9,048} = 0.78$. The divergence in the change of the coefficients is caused by the different sense of the indicators and by the methods of determining them. While the former indicator reflects changes in the composition of the work carried out as well as in the cost of the employed materials and other production resources, the latter considers changes only in the realm of material expenditures.

Table IX.1

Indicators	Previous year	Report year
Volume of construction-installation work carried out	8,200	11,600
Including for projects erected from prefabricated elements	5,250	8,120
Value of expended materials	6,400	9,048
Including prefabricated pieces and structures	4,608	7,030

Finally, the degree to which the prefabrication method has spread in construction can be judged from the number of projects built from prefabricated pieces and structures and their proportional amount in the total number of projects. In housing construction, analogous indicators can be calculated using data on the number of m^2, respectively, of the effective or dwelling area of the buildings put into operation. The statistical Form No 1-ks gives information in the area of buildings put into operation with the isolating of buildings from factory-manufactured large-sized elements and assemblies. This information is given separately for industrial, housing, civil and rural construction and this makes it possible to consider the sectorial differences of prefabricated construction.

For studying the prefabrication level in construction, indicators are also calculated for the proportional amount of prefabricated assemblies and units in physical terms. The proportional consumption of prefabricated elements is determined per unit of capacity or power of the fixed capital project as well as per 100, 1,000 and so forth rubles of the estimated cost of construction and installation work. Information on the consumption of prefabricated elements in physical terms can be found in Form No 2-SN and No 1-ks.

Let us give an example. Let us assume that during the report year a construction trust completed 21,000 m^2 of housing, including 14,200 m^2 of housing from prefabricated elements. For constructing the buildings from prefabricated elements, 4,800 m^3 of prefabricated reinforced concrete elements were used along with 5,200 m^3 of large wall modules and 1,800 m^2 of large wall panels. Let us determine the proportional expenditure of prefabricated elements per m^2 of housing. As a whole for housing construction $\frac{4.8+5.2+1.8}{14.2} = \frac{11.8}{14.2} = 0.831$ m ; including for the prefabricated reinforced concrete units $\frac{4.8}{14.2} = 0.338$ m ; for wall modules $\frac{5.2}{14.2} = 0.366$ m , for wall panels $\frac{1.8}{14.2} = 0.127$ m . The prefabrication coefficient for housing construction at the given trust was: $\frac{14.2}{21.0} = 0.676$, or 67.6 percent.

The statistical methodology for studying other industrial construction methods is analogous to the above-examined one for prefabricated construction.

§4. A Study of the Introduction of New Technology, Progressive Production Methods and Efficient Materials

Technical progress in construction is characterized not only by an increase in the fleet of construction machines but chiefly by the ongoing improvement in the means of production. This is aided by the creation of highly productive, more powerful and economic machines, by the introduction of new progressive technology and by the use of new types of efficient materials. Technical progress statistics should provide answers to the questions of how the plans for the introduction of new technology are being carried out and what is the actual scale of the spread of new technology, improved production methods and new efficient materials in construction.

New equipment is studied by statistics primarily using data on the composition, number and power of the new, advanced types of machines. From these same indicators the fulfillment of the plan for the technical development of the construction organizations and sites is monitored. On the basis of data concerning the number and power of new machines at contracting organizations, it is possible to determine relative indicators for their introduction into construction, for example, the proportional amount (by number and cost) of new advanced machines in the total fleet of the given type of construction equipment. The absolute and relative indicators for new equipment must be compared with the analogous indicators of the worn out and obsolete machines to be replaced. Among the new types of construction machines in practice are those which differ substantially from the previously produced and employed analogous models of Soviet and foreign equipment in terms of the most important technical an' economic specifications, for example, in terms of improved design, increased po\er and other features which make the new machine more productive and economic.

In describing new construction equipment it is important to have the average unit values for the operating parameters of the machines, for example, the average shovel capacity of an excavator (clamshell) and scraper, the average hoisting capacity of a given type of crane and so forth (see Chapter VII, §4). Such average indicators are employed in studying the dynamics of new equipment and the prospects for its development.

The coefficient for the renewal of the fleet of construction machines can be a general summary indicator for the introduction of new equipment in construction. This is figured as the ratio of the value of new construction equipment put into production over the period (ordinarily a year) to the total value of the fleet of existing construction machines at the end of the period (year). In employing this coefficient in a study of technical progress, it is essential to consider that with an increase in the period for which it is calculated the machines considered new at the start of the period can be obsolete at the end of it. For this reason it is essential to systematically adjust the list of construction machines which in the national economic plan are considered among new equipment.

An important manifestation of technical progress is the use of new, efficient (progressive) materials in construction as they make it possible to improve the quality, reliability and economy of the fixed capital construction projects. For example, an increase in the output volume and the use of synthetic materials (epoxy resins, plastics and so forth) on the basis of introducing chemistry in industrial production makes it possible to substantially reduce the weight of buildings and installations, to obtain high thermoacoustic and waterproof properties in the projects and obtain an economic effect in reducing expenditures on materials and as a whole for the construction product. The introduction of new efficient materials can be judged from the very list and number of types and grades of these materials employed in construction. But a more certain notion of the improvement in the subjects of labor is provided by the quantity of the individual types of efficient materials employed in construction over this period. By comparing the absolute actual and planned indicators for the use of efficient materials, it is possible to gain a notion of the degree of fulfilling an important part of the technical development plan for the contracting organizations.

Technical progress is also manifested in the improving of production methods. The introduction of new, more advanced technology provides the same economic effect as the use of new equipment. Statistics, in studying this area of technical progress, monitors the fulfillment of the plan for introducing new technology into construction and describes the dynamics of this process. The indicator most often used for judging the amount of the introduction of new progressive technology is the volume of construction-installation work carried out over the report period under conditions of new technology. An analogous relative indicator is the proportional amount of the volume of construction-installation work carried out under the conditions of employing new technology in the total volume of all the estimated cost of the work carried out during the given period.

§5. A Statistical Study of Construction Mechanization

The mechanization of construction is an important factor in raising labor productivity of the workers. In the long-range national economic plans primary measures are envisaged to mechanize the labor intensive and most widespread jobs in construction. These include earthmoving and loading, the installation of metal structural elements, finishing work and many others. Construction statistics studies plan fulfillment and the dynamics of work mechanization in terms of their individual types and as a whole, it determines the effectiveness of mechanizing the work and brings out the influence of factors on changing the degree of work mechanization in construction.

In carrying out these tasks, it is essential to delimit and determine the basic concepts related to construction mechanization. In construction, all work performed from the viewpoint of its mechanization can be divided into unmechanized and mechanized. The unmechanized includes work which is performed by man using simple implements of labor powered by human muscles, that is, manual jobs, for example the laying of walls from brick, digging a pit or ditch with a pick and shovel. Work is considered mechanized when one or several of the basic operations is performed using machines or mechanisms driven by any type of engine but not by human muscle power. Jobs where all the basic and auxiliary labor-intensive operations of the production process are performed by machines or mechanisms are considered to be fully mechanized or integrally mechanized. For example, full mechanization of earthmoving occurs if the digging of the dirt, its transporting, unloading, leveling out and compacting are done by machine.

A notion of the level (degree) of mechanizing construction and installation work is provided by the following statistical indicators: coefficients of mechanization and full mechanization of individual types of construction and installation work; a summary coefficient for the mechanization of construction and installation work; a coefficient of labor mechanization.

The coefficient for the mechanization of individual types of construction and installation work is calculated by comparing the amount of work performed by any mechanized method with the total volume of work performed in physical units, that is, according to the formula

$$K_{mc} = \frac{q_m}{q_m + q_n},$$

where q_m--the amount of work performed mechanically in physical units;
q_n--the amount of work performed manually in physical units.

This indicator expressed in percent is termed the mechanization level. It characterizes the overall mechanization level of the given type of construction or installation work in the broad sense, since the numerator of its formula includes the amount of work done by a mechanized method and, in particular, a fully mechanized one. In 1978, the level of full mechanization for the installation of concrete and reinforced concrete elements in the USSR reached 97.1 percent and for earthmoving, 98.0 percent.

The coefficients for the full mechanization of work are calculated by dividing the amount of work performed by the fully mechanized method by the total volume of the given type of performed work. In calculating this indicator it is possible to use data from the quarterly reporting of Form No 1-NT "Report on the Mechanization of Construction and the Use of Construction Machines." Along with the mechanization coefficients, in construction indicators are calculated for the fulfillment of the mechanized work plan such as $I_m = q_{mf} : q_{mp\ell}$.

The degree of mechanization for several types of construction and installation work can be described by a summary mechanization coefficient in which the volumes of various types of work are compared in their labor intensiveness, that is, by the formula:

$$K_{sm} = \frac{\Sigma q_m t}{\Sigma q_m t + \Sigma q_n t},$$

where t--working time expenditures per unit of work (labor intensiveness).

In calculating the summary coefficient using this formula, as the comeasurements, it is possible to use the actual and normed labor intensiveness levels in mechanized and unmechanized jobs as well as the average actual levels of labor intensiveness in mechanized and manual jobs taken together. The choice of the comeasurement is determined by the availability of initial data for calculating the coefficient. In practical terms an always possible but not unconditional variation for determining the summary work mechanization coefficient can be considered the one in which the average labor intensiveness of the work performed by the mechanized and unmechanized method is adopted as the comeasurement. The summary work mechanization coefficient can be employed for an aggregate of jobs united in a single production process in building a project, for example, for painting and stuccoing and so forth. Let us give an example. Let us assume that the following data are available on finishing work and the time expensitures for them in a construction trust in September of the report year (Table IX.2).

Table IX.2

Indicators	Plan		Actual	
	a	b	a	b
1. Volume of work performed, total, m^2	1,780	4,360	2,000	4,000
2. Including mechanized	1,510	3,050	1,600	3,000
3. Man-hours spent, total	600	2,150	640	2,160
4. Including in mechanized jobs	325	1,380	320	1,560
5. Level of work mechanization, % $\left(\frac{\text{line 2}\cdot 100}{\text{line 1}}\right)$	85	70	80	75
6. Level of labor mechanization, % $\left(\frac{\text{line 4}\cdot 100}{\text{line 3}}\right)$	54	64	50	72

Key: a--Painting; b--Plastering

In the table, line 5 shows the mechanization levels of the individual types of finishing work. In particular, in comparison with the plan the painting mechanization level has dropped while that for plastering has risen. Here the mechanized painting plan was fulfilled by 106% $\left(\frac{1,600}{1,510}\cdot 100\right)$ and for plastering by 98.4% $\left(\frac{3,000}{3,050}\cdot 100\right)$.

The summary work mechanization coefficient can be calculated by the last method. The actual overall labor intensiveness for mechanized and manual painting for 1 m^2 of surface equals 0.32 man-hour (640:2,000) and for plastering 0.54 man-hour (2,160:4,000). Hence the actual summary coefficient for painting and plastering mechanization during the report month will be:

$$\frac{1,600\cdot 0.32+3,000\cdot 0.54}{2,000\cdot 0.32+4,000\cdot 0.54}=\frac{2,132}{2,800}=0.761, \text{ or } 76.1\%.$$

The labor mechanization coefficient is calculated by comparing labor expenditures in mechanized jobs (T_m) with the overall labor expenditures for the given type of jobs (T), namely $K_{mt} = T_m:T$. Expressed in percent, this indicator is called the labor mechanization level. The table gives the initial data and the calculation of the labor mechanization level for the report month (line 6). The summary labor mechanization coefficient in finishing work for September equals: $\frac{320+1,560}{640+2,160}=\frac{1,880}{2,800}=0.671$, or 67.1%.

In determining the labor mechanization level it is possible to proceed from the number of workers employed in mechanized jobs and the total number of workers employed in the given jobs as of a separate date. Here, however, it is essential to clearly define the professions of the workers involved in mechanized jobs. Basically these are workers who are employed in controlling or servicing construction machines and mechanisms, for example, bulldozer, crane or excavator operators and others. The indicator calculated by this methodology describes the labor mechanization level on an individual date.

The labor mechanization coefficient is always less or equal to the corresponding work mechanization coefficient. The reason is that the labor mechanization coefficient reflects only the ratio of the volumes of labor expenditures on mechanized and manual jobs and gives no consideration to the differences in labor productivity in this work. One hour of work by an excavator operator in terms of its productivity cannot be equated to an hour of work by a ditchdigger supplied with a shovel, although in the denominator of the labor mechanization coefficient the work time of both workers is added together. For this reason, in the mechanization of manual labor, the labor and work mechanization coefficients will rise. With further mechanization of labor already equipped with machines, with other conditions being equal, the labor mechanization coefficient will decline since the quantity of manual labor or the equal volume of work remains unchanged while the quantity of mechanized more productive labor declines.

The above-examined dependence of economic characteristics can be expressed in a system of interrelated indicators:

$$K_{mw} = K_{mt} \cdot K_{pr} = \frac{T_m}{T} \cdot \left(\frac{q_m}{T_m} : \frac{q}{T}\right),$$

where K_{mw}--work mechanization coefficient;
K_{mt}--labor mechanization coefficient;
K_{pr}--relative amount indicating by how many times the productivity of mechanized labor is greater than labor productivity in the given type of work as a whole.

This system of indicators can underlie factor index analysis for the mechanization of construction-installation work and from its methodology it is possible to determine by how many percent the labor mechanization level has changed depending upon a change in the degree of labor mechanization (the labor mechanization coefficient) and the change in mechanized labor productivity in comparison with all labor productivity. Let us show the influence of these factors from the example of plastering (see Table IX.2). The excess of mechanized labor productivity over the productivity of all labor in September equaled:

$$\text{actual } \frac{3,000}{1,560} : \frac{4,000}{2,160} = 1.92:1.85 = 1.038,$$

$$\text{plan } \frac{3,050}{1,380} : \frac{4,360}{2,150} = 2.21:2.03 = 1.089.$$

Hence the change in the work mechanization level as a consequence of the change in the labor mechanization level $\Delta_{kmw} = K_{pr1}(K_{mt1} - K_{mt0}) = 1.038(0.72 - 0.64) = 0.083$, or 8.3%. The change in the work mechanization level as a consequence of a change in the ratio of the productivity of mechanized and all labor of the workers is: $\Delta_{kpr} = K_{mt0} \cdot (K_{pr1} - K_{pr0}) = 0.64(1.038 - 1.089) = -0.033$, or -3.3%.

The total deviation in the mechanization levels of plastering in percent equals the total of the changes for the factors: $8.3 + (-3.3) = 5\%$. Consequently, the plastering mechanization level increased in comparison with the plan due to a rise in the labor mechanization level in pastering and mainly because of the mechanizing of manual labor (according to the plan 770 man-hours should have been worked in manual plastering but in fact 600 man-hours were worked).

§6. A Statistical Study of Specialization, Concentration, Cooperation and Integration

Specialization, cooperation [subcontracting] and other forms of managing construction are an important condition for accelerating industrialization and technical progress in construction. These contribute to the successful carrying out of the long-range capital construction plans in our nation. Two types of specialization among contracting organizations are distinguished: sectorial (product) and technological (by types of work). Sectorial specialization occurs when the construction organizations focus their basic operations on the performing of work to erect the projects of a single sector, for example, power plants, metallurgical plants, railroads, housing and so forth. Technological specialization consists in the focusing of a construction organization's basic operations on the performing of individual types of construction and installation work or on erecting individual parts of buildings and installations.

The designated types of specialization lie at the basis of the statistical study of construction organziations in this area. An idea of sectorial specialization can be gained from the grouping of construction organizations by the sectors of industry, transportation, agriculture and so forth as well as in terms of the nonproduction sphere of the national economy, for example, the housing and utility systems, public health and so forth. The distribution of the aggregate of contracting organizations by sectorial groups can also be carried out using the data of the contracting organization censuses (one-shot counts) conducted annually by the statistical bodies. Current reporting does not contain sufficiently complete materials for this purpose. A structural description of sectorial specialization can be gained from the group absolute and relative data on the number of construction organizations and the volume of construction-installation work performed by their own forces.

The sectorial specialization level of an individual construction organization is described by the proportional amount of the volume of construction-installation work done by its own forces in accord with the sectorial specialization of this organization in the total volume of work carried out during the period. This indicator is calculated in an analogous manner for the aggregate of contracting organizations. But from the statistical reporting it is not always possible to obtain information on the amount of work carried out along sectorial lines. For this reason, for determining the overall sectorial specialization level for the aggregate of construction organizations in a republic or administrative rayon, for the sector and department it is possible to calculate the proportional amount of the volume of work performed by the organizations having sectorial specialization in the volume of work carried out by all the organizations of the studied aggregate.

A study of the development of technological specialization in construction is also based upon the method of grouping the contracting organizations. In practice all construction organizations are divided into two large groups: general construction and specialized. The specialized construction and installation organizations perform only individual types of work or erect the parts of buildings and installations.

Such organizations are considered specialized by the technological feature, for example, organizations performing earthmoving or finishing work and others. A structural description of these two groups of organizations by absolute and relative (proportional) indicators for the number of organizations and the volume of work performed by them provides an overall notion of the level of technological specialization in the aggregate of construction organizations. A more detailed description of the areas and the level of technological specialization can be gained by grouping the aggregate of specialized organizations according to the actually developed types of technological specialization (Table IX.3).

Table IX.3

	1965		1978	
	a	b	a	b
1	2	3	4	5
Total primary contracting organizations	11,890	100	22,932	100
Including:				
General construction	5,482	44	9,800	37
Specialized	6,408	56	13,032	63
Including by types of work:				
Earthmoving	663	4.0	1,021	4.5
Laying exterior utilities	386	3.5	591	2.6
Installation of large-sized building and structural elements	155	2.5	284	2.9
Finishing work	318	2.9	621	2.7
Hydraulic engineering work	124	1.6	108	1.3
Sanitary-technical work	631	5.1	1,013	4.0
Electrical installation	594	5.9	796	5.1
Work on low-voltage equipment	251	1.7	316	1.1
Installation of production and other equipment	542	7.0	966	6.7

Key: a--Number of organizations; b--Proportional amount of work performed by these organizations in total volume of work, percent

The technological specialization level of an individual construction organization is characterized by the proportional amount of the volume of work performed by the organization's own forces in accord with its production specialty in the total volume of work performed by it during the period. In an analogous manner this indicator is calculated for the aggregate of organizations specialized in the given type of work. However, the information needed for the calculation is found only in the organization's accounting documents. From the data of statistical reporting (Form No 1-ks), the level of an individual type of technological specialization can be determined as the proportional amount of the volume of work carried out by the own forces of the organizations having the given specialty in the total volume of the work carried out by all the specialized organizations in the given aggregate. Frequently in statistical practices as the basis they employ the amount of work carried out by all the construction organizations (specialized and general construction).

Table IX.3 gives the indicators for the technological specialization of primary construction and installation organizations according to the individual types.[1] From this it follows that the highest specialization level has been achieved for equipment installation while the greatest growth in the technological specialization level has been achieved in earthmoving.

Specialization in construction requires the establishing of production ties between the construction organizations and the enterprises involved in the joint erection of fixed capital projects. The planned organization of these ties is termed cooperation. The forms of cooperation in construction are rather diverse. In terms of the affiliation of the organizations, a distinction is drawn between intradepartmental cooperation and interdepartmental cooperation. From the viewpoint of the territorial location of the organizations, there is also intraregional and interregional cooperation.

Cooperation in construction can be described by different indicators. An approximate notion of the cooperation level can be gained from the number of specialized organizations participating in the given construction or the aggregate of sites as well as from the number of specialized organizations acting as subcontractors for the general contracting organization. A general indicator for the cooperation level is the average number of subcontracting organizations per general organization for the aggregate as of a certain date. This can be calculated from the formula:

$$K_{op} = \frac{\sum O_s}{O_g},$$

where O_s--the number of subcontracting organizations for the given general organization;

O_g--the number of general organizations in the given aggregate of contracting organizations.

Since cooperation is cloaked in the appropriate contractual form, the fullest notion of its level is provided by an indicator calculated using data on the amount of work carried out by the organizations under different contracts. The cooperation level using these data is expressed by the proportional amount of work carried out by the organizations under subcontracts in the total amount of work done under general contracts. According to the data of statistical reporting in Form No 1-ks, it is possible to determine the cooperation level achieved by a construction organization as a whole as well as separately for the existing forms of cooperation.

Let us examine an example. Let us assume that there is information on the fulfillment of the contracting program by the construction organizations for one of the RSFSR oblasts (Table IX.4; 1,000 rubles of estimated cost).

The cooperation level of construction organizations on the oblast scale is characterized in the following manner:

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[1] See: "Narodnoye khozyaystvo SSSR v 1978 g." [The USSR National Economy in 1978], Statistical Annual, Moscow, Statistika, p 356.

Table IX.4

Indicators	Previous year	Report year
Contracting work under general contracts with builders	25,440	38,360
Including:		
By own forces of reporting organization	13,605	16,440
By outside organizations, total	11,835	21,920
Including:		
Other trusts of one's glavk	10,215	21,498
Other ministries of given Union republic	1,620	422

As a whole in the previous year: 46.5% $\left(\frac{11,835}{25,440} \cdot 100\right)$, and in the report year: 57.1% $\left(\frac{21,920}{38,360} \cdot 100\right)$, that is, the production ties between the contracting organizations in the oblast increased;

With the trusts of their own glavk in the previous year: 40.1% $\left(\frac{10,215}{25,440} \cdot 100\right)$, and in the report year 56.0% $\left(\frac{21,498}{38,360} \cdot 100\right)$;

With trusts of other ministries in the given Union republic in the previous year: 6.4% $\left(\frac{1,620}{25,440} \cdot 100\right)$, and in the report year: 1.1% $\left(\frac{422}{38,360} \cdot 100\right)$.

The overall cooperation level in each year can be represented as the total of the particular cooperation levels with the organizations of the various systems: in the previous year 46.5 = 40.1 + 6.4; in the report year 57.1 = 56.0 + 1.1.

By a parallel comparison of cooperation levels it is possible to describe not only their overall change but also the role of the specific production ties which have developed in the given period among the construction organizations from different systems as well as the direction and amount of their changes over the period. In the example, along with an overall rise in production ties, there has been significant development of cooperation among the construction organizations within their own glavk and a decline in the cooperation level with the organizations of different ministries.

Along with specialization and cooperation, integration is an effective form for organizing construction in a number of instances. This form is characterized by the organizational unification of the construction enterprises with different specialties as well as by combining them with industrial enterprises. The latter type of integration has been expressed in the creation of the housing construction combines (DSK), plant construction combines (ZSK) and other combines, associations and firms. The scale of integration in construction can be judged from the number of the DSK, ZSK and other associations as well as from the volume of product produced by them. The integration level in construction can be expressed by the proportional amount of the volume of construction-installation work carried out by the integrated associations in the total volume of the work carried out by all the construction organizations of the sector, ministry, republic and so forth.

Significant reserves for increasing construction efficiency by specialization and integration can be activated by increasing the level of its concentration. The advantage of large construction enterprises over small- and medium-sized ones is great and they operate more successfully and profitably. For studying this process, statistics works out indicators which describe the concentration level and its dynamics and determines the influence of production concentration on its effectiveness.

A notion of the level and dynamics of concentration can be gained on the basis of average indicators expressing the amount of the production volume, the fixed capital or the number of employees per organization. Let us assume that a main administration has 30 construction trusts of which four trusts have an annual work volume of 3 million rubles; six trusts have 4 million rubles, eight trusts have 5 million rubles, ten trusts have 6 million rubles and two trusts have 10 million rubles. The average annual volume of work for one trust of the glavk equals:

$$\bar{q} = \frac{3.4 + 4.6 + 5.8 + 6.10 + 10.2}{30} = \frac{156}{30} = 5.2 \text{ million rubles.}$$

If in the base year the average annual volume of one trust in the glavk was 5 million rubles, then production concentration occurred in the given glavk and its growth rate was 104 percent (5.2:5.0)•100. As an additional description for this indicator, the coefficient of variation is determined making it possible to differentiate the aggregates of organizations having the same average but a varying range of fluctuation in the concentration feature.

Attention should be given to the theoretical recommendation for measuring the production concentration level by an antiharmonic average using the formula:

$$\bar{q}_{ah} = \frac{\sum_{i=1} q_i^2}{\sum_{i=1} q_i},$$

where q_i--the volume of work carried out by the given organization over the period (or other variations of the feature to be averaged).

According to the data of the previous example, the average annual volume of work for one trust is:

$$\bar{q}_{ah} = \frac{3^2 \cdot 4 + 4^2 \cdot 6 + 5^2 \cdot 8 + 6^2 \cdot 10 + 10^2 \cdot 2}{3 \cdot 4 + 4 \cdot 6 + 5 \cdot 8 + 6 \cdot 10 + 10 \cdot 2} = \frac{892}{156} = 5.7 \text{ million rubles.}$$

The average calculated using the formula of the antiharmonic is much greater than the arithmetic average. This is caused by the fact that the given indicator, in contrast to the one examined above, also considers the characteristics of the average arithmetic value of the concentration feature as well as the variation of organization sizes. This is confirmed by the following equality:

$$\bar{q}_{ah} = \frac{\Sigma q_i}{n}(1 + v^2),$$

where n--number of organizations;
v--coefficient of variation for feature.

In analyzing concentration it is advisable to calculate the average indicators not for one but rather for several concentration features simultaneously and a multidimensional average should be employed as the general indicator.[2] These indicators make it possible to judge not only the level but also the qualitative features of concentration. Table IX.5 as an example gives the average sizes of construction organizations according to a series of features and their growth rates in Soviet construction.[3] The increased concentration level of the construction volume has occurred as a result of a concentration of the means of labor and a reduced level of manpower concentration. This has been caused by the growth of worker labor productivity as a consequence of increasing the amount of equipment available per worker.

Table IX.5

	Average per construction organization		Growth rate, %
	1965	1975	
Volume of construction-installation work over year in 1,000 rubles of estimated cost	2,239	2,276	101.7
Average listed number of employees	602	462	76.7
Value of fixed productive capital at year's end, 1,000 rubles	992	1,500	151.2

It is also possible to describe the concentration level by a graphic method (by a Lorenz curve). Its essence consists in constructing a curve on the basis of the two-dimensional distribution of variants for the ranked, cumulative series of indicators, that is: the share of the number of organizations and the proportional amount of the volume of their work. Here along the abscissa axis the first indicator is plotted off while the second indicator is plotted on the ordinate axis. In the event that the accumulated share of the number of organizations and their proportional amount by the volume of work are equal, that is, there is 10 percent of the volume of work for 10 percent of the number of organizations, 20 percent of the volume of work, respectively, for 20 percent of the organizations and so forth, then the curve on the graph coincides with the diagonal of the square. The higher the level of concentration the more convex the curve will be.

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[2]See: G. S. Kil'dishev and Yu. I. Abolentsev, "Mnogomernyye gruppirovki" [Multidimensional Groupings], Moscow, Statistika, 1978.

[3]Calculated from the data of the statistical annual "Narodnoye khozyaystvo SSSR" [The USSR National Economy in 1975].

Increased concentration of construction is a factor for increasing its efficiency. In a statistical study of this process, an important place is held by the grouping method which is of independent importance also as a basis for employing the methods of regression correlation analysis. It is advisable to use the size of the construction organizations in terms of the production volume as well as in terms of the amount of the resources of the means of production and labor as the grouping features.

§7. A Statistical Study of the Economic Effectiveness of Technical Progress

In the decisions of the 25th CPSU Congress, great attention was given to scientific and technical progress and to its role in raising production efficiency. For precisely this reason a study of the economic advisability of measures to be carried out in construction practices in the area of new equipment is an important task of technical progress statistics.

The effect from employing new equipment is a diverse one. In construction this is expressed by indicators describing the increased amount of work carried out (production capacity), the savings of live labor and materials, a reduction in operating expenditures and generally the expenditures on the work to be performed, an improvement in the quality of work, working conditions and so forth. The economic effect from technical progress is established from one or several of the listed indicators as well as from the general indicator. Uniform methodological principles for calculating these indicators have been established in the "Procedure for Determining the Economic Effectiveness of Employing New Equipment, Inventions and Rationalization Proposals in the National Economy" (1977).

In this procedure the advisability of employing new equipment is established on the basis of an economic effect calculated per annual production volume. The first year after completing the planned time for starting up the new equipment is used as the calculation base. The economic effect is established by comparing production results before and after the introduction of the new equipment. Let us examine the indicators which characterize the individual aspects of the economic effect.

In studying the effect from the introduction of new equipment, it is frequently necessary to establish the degree of the increased productivity of the new equipment in comparison with the old operating equipment and determine the influence of the growth of the new equipment's productivity on the increased amount of work carried out by it. In the first instance an index for the productivity of new equipment is calculated, that is, for several types of construction machines performing the same job, using the formula

$$I = \frac{\sum v_1 r_1}{\sum v_0 r_1},$$

and for one machine:

$$i = v_1 : v_0,$$

where r_1--the average listed number of the given type of new machines;
v_0 and v_1--the productivity of one average listed old and new machine over the period.

In the second instance the influence of the increased productivity of new equipment in comparison with the old on increasing the amount of work carried out is defined as the difference between the numerator and denominator of the corresponding index, that is, by the formulas: for several types of machines $\Delta_v = \Sigma v_1 r_1 - v_0 r_1$, and for one type of machine $\Delta v_i = r_i(v_1 - v_0)$.

Table IX.6

Indicators	Machines	
	Old	New
Capital investments for the purchase of machines, rubles	26,800	36,400
Annual output of machines (calculated for effective area), m^2	14,880	16,200
Average listed number of machines over year	24	18
Average listed number of workers operating machines over year	106	90
Expenditures on materials handling work per m^2 of effective area, rubles	4.4	4.1

From the data of the example given in Table IX.6, the annual productivity of a new crane in comparison with the old one was: $\frac{16,200}{18} : \frac{14,880}{24} = 900:620 = 1.452$, or 145.2%, that is, it increased by 45.2%. As a consequence of this the new cranes carried out an additional work volume of 5,040 m^2 of effective area, 18(900 - 620).

In utilizing the data on the change in machinery productivity, it is possible to determine the influence of this factor on the savings of capital investments using the formula $\Delta K_e = (K_o I - K_n)Q_n$,
where K_o, K_n--proportional capital investments per unit of annual work volume before and after introduction of new equipment;
Q_n--the amount of work in calculated year of introducing new equipment.

In the example the savings of capital investments calculated per tower crane will be:

$$\Delta K_e = \left(\frac{26,800}{14,880} \cdot 1,452 - \frac{36,400}{16,200}\right) \cdot 16,200 = 5,965.6 \text{ rubles.}$$

The increased productivity of live labor or its savings as a consequence of employing the new equipment is also determined by the index method. Here in the calculations it is advisable to proceed from a formula of the labor productivity index calculated in terms of the actual labor intensiveness levels, that is,

$$I = \frac{\Sigma q_1 t_0}{\Sigma q_1 t_1},$$

where t_0 and t_1--actual levels of labor intensiveness for a unit of the given type of performed work, respectively, before and after the use of new equipment.

The savings of live labor is obtained as the difference in the numerator and denominator of this index, that is, $\Delta_t = \Sigma q_1 t_0 - \Sigma q_1 t_1$. If the new equipment is employed only in one type of work, then the index is $i = t_0 : t_1$, while the absolute amount is found using the formula $\Delta_{t1} = q_1(t_0 - t_1)$. In finding the number of workers released as a result of employing the new equipment, one proceeds from the labor intensiveness of the work expressed in "average annual employees." From the data of the previous example, the labor productivity index for the new tower cranes in comparison with the old ones was: $t_0 : t_1 = \frac{106}{14,880} : \frac{90}{16,200} = 0.0071 : 0.0055 = 1.290$, or 129.0%.

Consequently, as a consequence of introducing the new cranes worker labor productivity rose by 29.0 percent and 26 workers were let go, that is, 16,200(0.0071 - 0.0055).

In practice the number of released workers is determined by comparing the average number of workers in maintaining basic output (ω_0) with the average number of workers during the period of employing the new equipment ($\bar{C}$), that is, according to the formula

$$\Delta_c = \frac{q_1}{\omega_0} - \bar{C}_1,$$

or from the data of the example:

$$\Delta_c = \frac{16,200}{(14,880:106)} - 90 = 26 \text{ workers}.$$

The relative savings from reducing expenditures on construction product as a result of introducing new equipment can be determined proceeding from the following cost index:

$$I = \frac{\Sigma q_1 z_1}{\Sigma q_1 z_0},$$

where q_1--the volume of work during the period of employing the new equipment;
z_0, z_1--expenditures (depending upon the use of new equipment) in cost terms per unit of work before and after the application of new equipment.

The total savings of expenditures is determined as the difference between the numerator and denominator of the index, that is, according to the formula $\Delta_z = \Sigma q_1 z_1 - \Sigma q_1 z_0$. If the new equipment is employed for one type of work, then all the calculations are simplified and the index is determined as $i = z_1 : z_0$, and the savings according to the formula $\Delta_z = q_1(z_1 - z_0)$. From the data in the example, as a result of employing the new tower cranes, the cost of materials handling work calculated per m^2 of effective area was reduced by 6.8% $\left(100 - \frac{4.1}{4.4} \cdot 100\right)$ and this is 6,480 rubles of savings a year, 16,200(4.5-4.1).

The economic effectiveness of new equipment, in contrast to its effect, is characterized by indicators which express the ratio of the basic result (effect) achieved with the aid of the new equipment to the expenditures used to acquire the new equipment. The basic indicators here are the capital investment repayment time (for the full and additional investments) and the proportional capital investments (see §2 of Chapter IV).

The repayment time of the additional capital investments into the new equipment is determined by the formula:

$$T_{re} = \frac{K_{ad}}{\Delta p},$$

where K_{ad}--additional capital investments for the introduction of new equipment;
Δp--the increase in profit as a consequence of introducing the new equipment.

This describes the time (number of years) over which the additional capital expenditures on new equipment are fully repaid. In instances when the profit data cannot be obtained, one proceeds from the cost of the work and the total operating expenditures related to the use of the new and old equipment.

The indicator which describes the proportional capital expenditures (the capital in tensiveness of the new equipment) is defined as the quotient from the dividing of capital expenditures on the new equipment by its power or by the annual volume of work carried out with its aid. In the example the capital invensiveness of a unit of annual work volume, respectively, equals 26,800:14,800 = 1.8 ruble for the old crane and 36,400:16,200 = 2.25 rubles for the new one, that is, it increased by 1.2-fold.

The annual economic effect of new equipment is a general indicator and describes the total savings of all production resources (live labor, materials and capital investments) which the national economy obtains. This is determined by comparing the adjusted expenditures (see §2 of Chapter IV) for the base and new equipment, that is, according to the formula:

$$Z = [(C_o + E_n K_o) - (C_n + E_n K_n)]Q_n,$$

where E_n--the normed coefficient for capital investment effectiveness equal to 0.15;
C_o, C_n--the cost of a unit of work before and after the use of the new equipment.

The annual economic effect from the use of one new tower crane in housing construction equals: $Z = (4.4 + 1.80 \cdot 0.15) - (4.1 + 2.25 \cdot 0.15) \cdot 16{,}200 = 3{,}766$ rubles.

The initial data for calculating the indicators for the effectiveness of capital expenditures on new equipment can be obtained only as a result of a special statistical survey or directly from the accounting documents of a contracting organization.

CHAPTER X: STATISTICS OF CONSTRUCTION PRODUCT COSTS

§1. The Tasks of a Statistical Study of Construction Product Costs

Product costs are an important qualitative result in the work of construction organizations. Costs are influenced by all the factors and conditions of construction work. For this reason the cost level is validly considered to be a synthetic indicator which in a general form characterizes the effectiveness of expenditures by a construction organization. A reduction in costs as a result of saving expenditures on production is the main source of socialist accumulation. This ensures a reduction in the ex-factory prices for the products of all the national economic sectors and thereby helps to raise the material and cultural level of the workers.

Costs are a portion of product value expressed in money and consisting of the expenditures of previous labor which has been transferred to the product and a portion of the expenditures of live labor operating in the form of wages. In construction these are the expenditures on a certain volume and composition of construction-installation work involved in erecting buildings and installations and other products. Under the new planning and economic incentive conditions for production, costs do not include the portion of the expenditures of live labor in the form of payments to the employees from the material incentive fund formed from profits. At the same time a portion of the value created by surplus labor operates in the form of the outlays by the construction organizations and is included in costs (deductions for social security of the workers, for mass cultural work and so forth).

At present the quota to reduce the costs of construction and installation work is not set for all the contracting organizations as an evaluation indicator. However, this circumstance does not reduce the importance of the indicator for lowering work costs. The cost indicators are of great significance in working out the profit plan and in analyzing the operating results of the contracting organizations. The economic reform in construction has created a solid basis for reducing costs and this is a prerequisite for increasing construction efficiency.

The calculating of expenditures and the costing of construction product are a function for bookkeeping of construction organizations. Among the tasks of cost statistics are: a description of the fulfillment of the plan to reduce costs; a study of cost dynamics; a study of the cost structure of construction product; an analysis of the influence of factors and individual types of expenditures on the dynamics of actual costs and their deviation from planned costs.

§2. Types of Construction Product Costs

In accord with the aims and tasks of planning and construction, in the actual work of the construction organizations a distinction is made between the following types of costs: estimated, planned and actual. The obtaining of a numerical description for each of these cost types involves the estimated cost of construction product and for the establishing of profit, also its planned cost.

The estimated cost of construction and installation work is the normed value of the work determined by the total expenditures on the work and planned accumulation (see Chapter V, §6). In studying costs, this category usually is used as the basis of comparison. Planned or otherwise-called contractual cost of construction and installation work is expressed by a monetary amount (price) paid by the client for the performed work. This is based on the estimated cost of the work and it differs from the latter by the amount of expenditures, compensation and benefits to recover the expenditures paid above the estimated cost of the performed work, for example, additional payments for work in remote areas, the use of the piece-bonus wage system, surpayments for the mobile nature of work and others. The term "planned cost" for this reason does not correspond completely accurately to its content and it would be more accurate to speak about contractual costs. The financial payments by the contracting organizations with the clients are carried out according to the contractual cost and the profit of construction organizations is also determined by this.

Estimated costs characterize the total normed expenditures on construction and installation work. Its amount can be obtained either by adding up the direct expenditures and overhead or by subtracting the total planned accumulation from the estimated cost of the work. This is 6 percent of the estimated cost or 5.66 percent of the estimated value of the work.

Planned costs characterize the expenditures on producing a construction product considering the quotas to reduce their cost. In contrast to industry, planned product costs in construction are determined indirectly, that is, proceeding from the estimated or planned value of the work. In the first instance the planned costs of the work are obtained by subtracting planned accumulation and the total savings planned for the reduction in production outlays from the estimated cost and by adding the total compensation above the estimated cost. In the second instance, only the planned accumulation and the planned savings of expenditures are subtracted from the planned cost of the work. The planned saving is determined on the basis of quotas for reducing work costs as set in percent in relation to the estimated cost of the work. Planned costs are important as a major criterion for evaluating the work of a contracting organization in checking plan fulfillment for reducing product costs.

The actual costs of construction and installation work are the total outlays made by the construction organization to carry out the work under the existing production conditions. These are determined from the bookkeeping data. Let us give an example for calculating the value and costs of work related to erecting a cowbarn building by a trust during a quarter:

Direct expenditures on construction work according to the YeRYeR, thousand rubles	485
Overhead in percent of the total direct expenditures	12
Planned accumulation in percent of estimated costs	6.0
Quota for reducing costs in percent of estimat d cost	3.0
Compensation above estimated cost, thousand rubles	4.2

The estimated costs of construction-installation work during the report quarter for the building of a water tower is:

$485 + 485 \cdot 0.12 = 485 + 58.2 = 543{,}200$ rubles;
estimated cost of construction-installation work:
$543.2 + 543.2 \cdot 0.06 = 543.2 + 32.6 = 575{,}800$ rubles;
planned cost of construction-installation work:
$575.8 + 4.2 = 580{,}000$ rubles;
planned costs of construction-installation work proceeding from their estimated cost:
$575.8 - 32.6 - 575.8 \cdot 0.03 + 4.2 = 530{,}130$ rubles;
the same, proceeding from the planned cost of the work:
$580 - 32.6 - 575.8 \cdot 0.03 = 530{,}130$ rubles.

In accord with the costing objects used in the accounting, that is, those product types the costs of which are calculated, in planning and statistics the estimated, planned and actual costs are determined for the produced and commodity construction product, for the completed construction project, work stage or other stages of completeness for the construction product. However, in construction as a consequence of the existing accounting cf expenditures, the costs of a unit (capacity or power) of a completed project are extremely rarely figured.

Under the new conditions of construction economic incentives, expenditure planning and accounting have been maintained for the entire volume of the work performed in a report period, chiefly for the purposes of ensuring operational control over the cost level during the current period. This is understandable since, as a consequence of the great length of the production cycle in construction, a contracting organization cannot, for example, during a month begin and end a work stage, all the more build the project as a whole. The costs of the work carried out in the report period are obtained as the total of the fixed expenditures during this period in the accounting documents. This indicator is given in the "Report on the Costs of Construction and Installation Work" in Form No 2-s.

In the statistical reporting there is no direct information on the cost of commodity construction product, but this indicator can be obtained by calculation. The initial data for calculating the costs of commodity construction product (C_{cp}) is the total expenditures on the volume of work carried out in the report period (C_{cmp}), the expenditures on incomplete construction at the beginning (C_{np}) and the end of the report period (C^e_{np}) as given in the reporting in Form No 2-ks. The costs of commodity construction product are determined by the balance method using the scheme: $C^e_{cp} + C_{cmp} = C_{np} + C^e_{np}$. Hence the cost of the commodity product: $C_{cp} = C_{cmp} + C^s_{np} - C^e_{np} = C_{cmp} - (C^e_{np} - C^s_{np}) = C_{cmp} - U_{np}$. In other words, the cost of the commodity construction product over the report period equals the difference in the costs of the work performed over the given period and the change in the balance of expenditures for incomplete construction (U_{np}). Let us examine an example.

Table X.1

Indicators	Actual Costs, thousand rubles	
	July	August
Incomplete construction at start of month	148	134
Volume of construction-installation work carried out over month	312	320
Incomplete construction at end of month	134	153

Let us assume that the following data have been given on actual expenditures for construction-installation work at a construction administration for 2 months of the third quarter (Table X.1). The costs of the commodity construction product (work turned over to the clients) will be in July: 312 - (134-148) = 312 - (-14) = 326,000 rubles, and in August 320 - (153-134) = 320 - 19 = 301,000 rubles.

§3. A Statistical Study of the Fulfillment of Quotas for Reducing Costs

Using the methodology adopted in the plans of construction organizations, the product cost level is set in relation to the estimated cost in the form of expenditures per ruble of estimated cost of construction-installation work, that is:

$$\frac{\Sigma q_{p\ell} z_{p\ell}}{\Sigma q_{p\ell} p} = \frac{\text{expenditures under plan for amount of work in given period}^1}{\text{estimated cost of amount of work for given period according to plan}},$$

where $q_{p\ell}$--the volume of construction-installation work according to the plan in the report period;

$z_{p\ell}$--planned cost of a unit of work;

p--estimated prices.

Since planned costs are determined in current prices and production conditions, the planned expenditure level per ruble of estimated cost of the work includes the compensation above the estimated cost. If the compensation above the estimated cost (K) is subtracted from the planned costs, then we will obtain the planned level of expenditures which depend solely upon the activities of the given organization, that is,

$$\frac{\Sigma q_{p\ell} z_{p\ell} - K}{\Sigma q_{p\ell} p}.$$

The quota set in the plan of reducing costs is designated in percent of the estimated cost of the volume of work, but can also be expressed for the given product

[1]The designating of the costs of the work by Σqz and their value by Σqp does not correspond to the methodology for calculating these indicators in practice (see §2 of this Chapter) but this brings out the economic sense of these indicators.

volume of work, but can also be expressed for the given product volume by an absolute amount, that is, in rubles. This quota is set by the contracting organization in the plan for organizational-technical measures aimed at saving production outlays by raising labor productivity, by improving fixed capital utilization, by the more rational expenditure of materials and so forth. In the statistical reporting, the quota to reduce costs is not given but on its basis the planned work costs are calculated and these are used for evaluating plan fulfillment to reduce costs. When it is necessary to know the amount of the quota to reduce costs, it is possible to use the data given in the reporting in Form No 2-s on the planned costs of the work carried out and the compensation above the estimated cost. The setting of the quota is based upon the method of calculating planned costs for the work performed (see §2 of this Chapter), according to which the latter is $\Sigma q_f z_p \ell = \Sigma q_f p - \Delta_e - \Delta_a + K$, where Δ_e--the savings in expenditures set by the quota to reduce costs;
Δ_a--planned accumulation.

Since the relative amount of the quota for reducing costs (Y) is ordinarily set in percent of the estimated cost, we will divide all the components of the expression by the estimated cost of the work and we will determine the sought indicator:

$$\frac{\Sigma q_f z_p \ell 100}{\Sigma q_f p} = \left(\frac{\Sigma q_f p}{\Sigma q_f p} - \frac{\Delta_e}{\Sigma q_f p} - \frac{\Delta_a}{\Sigma q_f p} + \frac{K}{\Sigma q_f p}\right) 100, \text{ hence}$$

$$Y = \frac{\Delta_e 100}{\Sigma q_f p} = 100 - \left(\frac{\Sigma q_f z_p \ell - K}{\Sigma q_f p}\right) 100 - \frac{\Delta_a 100}{\Sigma q_f p}.$$

Thus, the percent of reducing costs according to the plan equals the difference of 100 percent (the estimated cost level) and the planned level of expenditures which depend upon the operations of the contracting organization and the planned accumulation rate from the estimated cost which equals 5.66 percent. Let us give an example. Let us assume that from Form No 2-s we know the following data on the construction work carried out by a trust in June and the expenditures for the work (thousand rubles):

Estimated cost of performed work	825
Planned cost of performed work	792
Actual cost of performed work	776
Compensation and benefits above estimated cost	50

According to the plan, the expenditure level per ruble of estimated cost of construction work over the report period will be: considering compensation above the estimated cost (the full level) $\frac{792}{825} = 0.96$ rubles, that is there are 96 kopecks of expenditures according to the plan per ruble of estimated cost of the work; without compensation above the estimated cost (the incomplete level) $\frac{792 - 50}{825} = 0.9$ rubles, that is, 90 rubles of expenditures per ruble of estimated cost of the work. The quota to reduce the cost of the work in the trust will be:

$$Y = 100 - \frac{792}{825} \cdot 100 - 5.66 - \frac{50 \cdot 100}{825} = 100 - 5.66 - \frac{792-50}{825} \cdot 100 = 100 - 5.66 - 90 = 4.34\%.$$

By analogy with the planned indicator for a general relative description of expenditures for construction product, the actual expenditure level per ruble of the estimated cost of the work carried out over the report period is calculated, that is:

$$\frac{\Sigma q_f z_f}{\Sigma q_f p} = \frac{\text{actual cost of work carried out in report period}}{\text{estimated cost of work carried out in report period}}.$$

According to the data of our example, the full actual costs per ruble of estimated cost (the cost level) of construction work (considering compensation) are $\frac{776}{825} = 0.94$ ruble, and not counting compensation the cost level (incomplete) reflecting the influence of just the factors depending upon the contracting organization equals 0.88 ruble $\left(\frac{776 - 50}{825}\right)$.

The actual and planned expenditure levels per ruble of estimated cost of the work are intercomparable and their ratio characterizes the degree of fulfilling the plan to reduce costs. In statistical practice another method of calculating the indicator is also employed and this is the index for the deviation of actual costs from the planned, using the formula $I = \frac{\Sigma q_f z_f}{\Sigma q_f z_{p\ell}}$. This is the ratio of the actual costs of the construction-installation work carried out in the report period to its planned cost. In our example, the index for the deviation of actual costs from the plan equals: $\frac{776}{792} \cdot 100 = 98\%$, that is, the actual cost declined by 2 percent in comparison with the plan and this produced a savings of 16,000 rubles.

In the designated index, the planned costs of the actually performed work, as a consequence of the methodology adopted to determine them, reflects the influence of the planned composition of construction-installation work, and, consequently, the index for the deviation of actual work costs from the planned will also consider the influence of changes in the composition of the work which distorts its actual amount.

§4. Studying the Dynamics of Construction Product Costs

One of the tasks in a statistical study of the results of construction is to describe the change in the product cost level over a year and over a number of years, that is, its dynamics. This problem can be solved relatively simply in instances when it is a question of the cost dynamics of fixed capital projects which are complete and have the same purpose and when their size or capacity can be measured by the same physical units. For example, in housing construction it is possible to compare the cost of a m^2 of housing or effective area, in the construction of power plants the actual expenditures can be compared over time for the various types of plants per 1, 100, 1,000 and so forth kilowatts of turbine capacity. The product cost index for these instances can be calculated by the formula:

$$I = \frac{\Sigma q_1 z_1}{\Sigma q_1 z_0},$$

where q_1--the power, area, length or capacity of the completed project in the report period;
z_0, z_1--the costs of a unit of power, area, length or capacity for a completed project, respectively, in the base and report periods.

The cost index for construction-installation work can be calculated relatively easily using the above-given formula if the conditions for the comparability of construction product are not violated. For example, it is not always possible to establish the base costs of work carried out in the report period, for precisely such work may not have existed from the viewpoint of its composition in the base period and this more often happens in practice.

The necessity of calculating the cost dynamics indicator, on the one hand, and the limited use of the aggregate formula for the index, on the other, have led to a measuring of product cost dynamics in construction on a basis of the expenditure level per ruble of the estimated cost of the completed work. The formula for the so-called index of expenditures per ruble of estimated cost of the work has the following form:

$$I = \frac{\sum q_1 z_1 - K_1}{\sum q_1 p} : \frac{\sum q_0 z_0 - K_0}{\sum q_0 p},$$

where q_1 and q_0--the volume of construction-installation work, respectively, in the report and base period;
z_1 and z_0--the costs of a unit of work, respectively, in the report and base period;
p--the estimated prices adopted in the report period.

In this index, the volume of construction-installation work for the report and base periods should be set in uniform estimated prices. Otherwise the comparability of the cost level will be disrupted and the index will be influenced by changes in the estimated prices in addition to all the other factors.

In order to gain a notion of the cost dynamics of work as a consequence of the influence of only those factors which depend upon the production activities of a construction organization, in calculating the index it is essential first to exclude from the actual costs of the report and base periods those expenditures covered through compensation and benefits above the estimated cost (K). Let us give an example. Let us assume that from Form No 2-s the following data are known on the work carried out by the trust and the expenditures made on it (thousand rubles).

	Previous Year	Report Year
Cost of executed construction-installation work in comparable estimated prices	7,560	9,072
Actual cost of performed construction-installation work	6,955	8,256
Compensation and benefits above estimated cost	152	252

The index for the expenditures per ruble of estimated cost considering all the factors is:

$$\frac{8,256}{9,072} : \frac{6,955}{7,560} = 0.91:0.92 = 0.989, \text{ or } 98.9\%.$$

The index for expenditures per ruble of estimated cost as a consequence of the influence of factors depending upon the organization is:

$$\frac{8,256-252}{9,072} : \frac{6,955-152}{7,560} = 0.88:0.90 = 0.98, \text{ or } 98\%.$$

The algebraic difference in the levels of the compared periods describes in absolute terms the change in the actual expenditures per corresponding unit of the estimated work cost. In our example, this amount for the first instance is 1 kopeck of savings in expenditures per ruble of the estimated cost of the work, and for the second, respectively, two kopecks. The total savings (overexpenditure) for the entire volume of the work performed is determined by the product of the amount of the savings (overexpenditure) in expenditures per ruble of the estimated cost of the work and the amount of work carried out in the report period. In the example, the overall savings of expenditures, as a consequence of the influence of just the factors which depend upon the contracting organization, will be 0.02•9,072,000 = 181,440 rubles. The designated method for calculating the expenditure index per ruble of estimated cost can also be employed for establishing quotas to reduce costs in the annual and long-range plans. Here, instead of the actual expenditure level in the report period, one must take the planned expenditure level per ruble of estimated cost of the planned volume of work.

The expenditure index per ruble of estimated cost of the work is among the so-called indexes of variable composition and describes not only the change in costs but also the influence of a change in the proportional amount of different types of construction-installation work having a differing expenditure level. One can be convinced of this from the following example. Let us assume that for a construction administration data are known on expenditures for construction and installation work during 2 years (Table X.2). In the example the expenditures per ruble of the estimated cost of the individual types of work in the report year remained on the level of the previous one while for all work as a whole the index showed a decline in in expenditures (98.9 percent). This happened as a consequence of the increased share of work for major overhauls which had a lower expenditure level per ruble of estimated cost.

It is possible to eliminate the influence from a change in the composition of the work on the expenditure index per ruble of estimated cost if one calculates a fixed composition index in which the shares of the individual types of work $\left(d_{q0} = \frac{q_0 p}{\sum q_0 p}\right)$ of the base period according to the estimated cost in their total volume serve as the weights for the average expenditure levels, that is:

$$I_{f/c} = \frac{\sum s_1 q_0 p}{\sum q_0 p} : \frac{\sum s_0 q_0 p}{\sum q_0 p} = \frac{\sum s_1 d_{q_0}}{\sum s_0 d_{q_0}},$$

where $s = \frac{qz}{qp}$ --expenditures per ruble of the estimated cost of each type of work.

Table X.2

a Виды работ	b Объем работ за 1977 г. в тыс. руб. по		e Затраты на один рубль сметной стоимости работ, руб.	f Объем работ за 1978 г. в тыс. руб. по		e Затраты на один рубль сметной стоимости работ, руб.	g Индекс затрат на один рубль сметной стоимости, %
	c сметной стоимости	d фактической себестоимости		c сметной стоимости	d фактической себестоимости		
h) Строительные работы	8 000	7 600	0,95	8 200	7 790	0,95	100
i) Капитальный ремонт	320	288	0,90	2 640	2 376	0,90	100
j) Всего	8 320	7 888	0,948	10 840	10 166	0,938	98,9

Key: a--Types of work; b--Volume of work in 1977 in thousand rubles according to; c--Estimated cost; d--Actual cost; e--Expenditures per ruble of estimated cost of work, rubles; f--Volume of work in 1978, thousand rubles, according to; g--Expenditure index per ruble of estimated cost, %; h--Construction work; i--Major overhauls; j--Total

Since in the example the expenditures per ruble of estimated cost have not changed for the type of work, the fixed-composition expenditure index per ruble of estimated cost will equal one. The index for the influence of structural shifts in accord with the adopted weighting system can be determined by the formula:

$$I_{str} = \frac{\sum s_1 d_{q_1}}{\sum s_1 d_{q_0}}, \text{ that is, } I_{str} = \frac{0{,}95 \cdot \frac{8\,200}{10\,840} + 0{,}9 \frac{2\,640}{10\,840}}{0{,}95 \frac{8\,000}{8\,320} + 0{,}9 \frac{320}{8\,320}} = 0{,}989, \text{ or } 98.9\%.$$

Consequently, the change in expenditures per ruble of estimated cost has been completely caused by structural shifts in the composition of the cost of the work performed, including the influence of covariation, that is, the joint interrelated influence of both factors.

§5. A Study of the Composition of Expenditures on Construction Products

A study of the composition of expenditures is of importance in describing costs and elucidating reserves for further reducing them. In construction statistics, expenditure groupings are primarily employed for two areas: for economic elements and for the costing items of the expenditures. The essence of studying product costs in terms of economic elements consists in determining the expenditures of live and previous labor and the ratios between them. This is essential for calculating the sector's net product and national income for the country as a whole as well as for establishing the amounts of current expenditures, for example, the wage fund and so forth.

The composition of expenditures on construction products includes the following economic elements: Basic materials, auxiliary materials, fuel and electric power, amortization, wages and deductions for social security and other monetary expenditures. However, in the bookkeeping offices of construction organizations, expenditures are not accounted for by the economic elements and this information is not given in the reporting. Data on the structure of expenditures of live and embodied labor in construction are obtained by statistics only from materials of one-shot sampling surveys. The last sampling survey for expenditures on production in construction was conducted in 1959. Starting in 1967, the statistical reporting (Form No 2-s) has given information on wages with deductions for social security and this is essential for determining construction net product.

The grouping of expenditures by costing items is aimed at establishing the place of making the expenditures, their purpose and type. For this reason a majority of costing items has a comprehensive nature, bringing together expenditures related to the consumption of live and previous labor. For example, the item "Materials, Structural Elements and Pieces" includes the expenditures on the wages of storekeepers, loaders and so forth, amortization deductions and other expenditures. The grouping of the expenditures by costing items is reflected in the accounting of construction organizations and in the statistical reporting in Form No 2-s. All expenditures in compiling the estimates and in accounting are divided into two major groups: direct expenditures and overhead.[2] The direct expenditures include those directly related to carrying out the work and provided for in the uniform rates for each type of work. These include the following costing items: 1) expenditures on materials, pieces and structural elements including expenditures f.o.b. the site warehouse for basic and auxiliary materials as well as fuel, electric power, steam, water and so forth expended on construction-installation work; 2) basic wages of workers which include all types of wages to workers engaged in building the projects and additional payments related to time worked; 3) expenditures on the operation of construction machines and mechanisms including expenditures on the upkeep, operation and maintenance of the machines; 4) other direct expenditures.

The overhead includes expenditures set according to a general norm on the basis of direct expenditures for construction work and basic wages of workers in installing equipment. These are not directly related to the carrying out of a certain type of work and are not included in the uniform estimate rates. Overhead is distributed into the following integrated items: 1) administrative and managerial expenses consisting of the expenditures for the support of personnel employed in managing and servicing production; 2) expenditures on organizing and carrying out work related to the recruitment of workers, the support of line personnel and other expenditures not accounted for in the uniform estimate rates; 3) expenditures on serving workers related to labor safety and safety equipment, cultural and domestic services for the employees of the organizations and so forth; 4) unproductive expenditures caused by violations of normal production conditions by the construction organizations, for example, stoppages of workers and equipment and other violations

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[2]The division adopted in construction for expenditures on direct expenses and overhead contradicts the concepts of the same name adopted in accounting practices in enterprises of other national economic sectors and in use there. Generally accepted is the dividing of expenditures by their role in production into basic expenditures and overhead and in terms of the method of their distribution into direct and indirect expenditures. But in construction accounting one mixed grouping has been made up from the two expenditure groupings.

causing additional expenditures, fines, penalties, forfeits and so forth. This item is not provided for in the estimate and plan but, as a rule, is employed in the actual expenditures. A detailed study of this item is of importance for elucidating individual shortcomings in the work of the organization.

In analyzing the results of operations by a construction organization, it becomes important to compare the actual structure in the report period with the planned (estimated) or actual cost structure of work in previous years. Thus, the expenditure structure over the period from 1940 through 1978 has undergone substantial changes. The proportional amount of expenditures on materials has risen from 48.9 to 53.8 percent, while for basic wages it has declined from 20.9 to 14.1 percent and this indicator has increased by more than 4-fold for expenditures on operating machines.

§6. Studying the Dynamics and Fulfillment of the Work Costs Plan by Expenditure Items

A study of the costs of construction work is not limited to an overall estimate of fulfilling the quota for reducing costs or for their change over time. An elucidation of the influence of factors on the cost level and its deviation from the corresponding base level comprise a task for statistical economics analysis of construction product costs. This problem is solved by various ways, in particular, on the basis of calculating the absolute and relative amounts (subindexes) in the deviations of the actual expenditures from the planned or the estimated in terms of the expenditure items, that is:

$$\Delta_z = \Sigma q_1 z_1' - \Sigma q_1 z_{p\ell}' \quad \text{or} \quad i = \Sigma q_1 z_1' : \Sigma q_1 z_{p\ell}'$$

where $\Sigma q_1 z_1'$ and $\Sigma q_1 z_{p\ell}'$--correspondingly, the actual and planned expenditures for the individual items on the actually performed amount of work.

The relative indicator showing the influence of changes for the individual expenditure items on the overall cost deviation is calculated as the ratio of the savings (overexpenditure) for each item to the planned costs of the work (or to the corresponding level of estimated costs), that is:

$$\ell_z = \frac{\Sigma q_1 z_1' - \Sigma q_1 z_{p\ell}'}{\Sigma q_1 z_{p\ell}} = \frac{\Delta_{z'}}{\Sigma q_1 z_{p\ell}},$$

where $\Sigma q_1 z_{p\ell}$--planned (estimated) costs of work actually carried out in report period.

The algebraic total of these relative indicators in percent for all the costing items equals the total percentage of the deviation in costs from the adopted base (the planned or estimated costs of the work), that is:

$$\Sigma \ell_z = \frac{\Delta_{z'} 100}{\Sigma q_1 z_{p\ell}} + \ldots + \frac{\Delta_{zn} 100}{\Sigma q_1 z_{p\ell}} = \frac{\Sigma \Delta_{zn}}{\Sigma q_1 z_{p\ell}} 100.$$

The expression $\Sigma\Delta_z n$ describes the total savings (overexpenditure) in expenditures for all the costing items in comparison with the planned costs while its ratio $(\Sigma\Delta_z n : \Sigma q_1 z_{p\ell})100$ shows the above-planned reduction (rise) in the cost of the work performed in percent.

The above-examined subindexes mathematically can be linked with the overall cost index in defining this as the arithmetic average of the subindexes weighted by the fractions of the expenditures for the items, that is:

$$I = \Sigma i d_z,$$

where $d_z = \frac{\Sigma q z'_{p\ell}}{\Sigma q_1 z_{p\ell}}$ --the portion of expenditures for the individual items in the total expenditures according to the plan.

Table X.3

Expenditure Items	Costs of performed work, 1,000 rubles		Subindex (col.2:col.1) ×100, %	Savings "-", over-expenditure "+" (col.2-col.1), 1,000 rubles	Percent of deviation of actual cost from planned $\left(\frac{\text{col.}4\times100}{\text{total of col. 1}}\right)$
	Planned	Actual			
	1	2	3	4	5
Materials	6,240	6,096	97.7	-144	-1.2
Basic wages of workers	2,520	2,496	99.1	-24	-0.2
Expenditures on operating of machines	600	672	112.0	+72	+0.6
Other direct expenditures	600	552	92.0	-48	-0.4
Overhead	2,040	1,944	95.3	-96	-0.8
Total	12,000	11,760	98.0	-240	-2.0

The breaking down of the overall change in costs into its components makes it possible not only to disclose the reasons for deviations but also to bring out their importance for the given organization and to seek the main area for reducing work costs. The statistical reporting of Form No 2-s contains the initial data for such an analysis in terms of the volume of contracting work. In Table X.3, from the example of reporting data of Form No 2-s on expenditures for the work carried out by a trust during the year, the above-examined indicators have been calculated (see cols. 3, 4 and 5).

From a comparison of the subindexes it is possible to conclude that in the trust the greatest reduction rate in expenditures in comparison with the plan has been achieved for other expenditures (92 percent), although the absolute savings for this expenditure item is less than for the others. However, from the viewpoint of the absolute amount of savings (overexpenditure) for the individual items, expenditures on materials have had the greatest influence on the overall percentage of cost reduction in comparison with the plan.

The total amount of the deviation of actual costs from the planned is caused not only by the rate of decline in expenditures for the items but also by their proportional amount in the total expenditures. The role of these factors for each item can be seen from a calculation of the components in the overall arithmetic cost index, $\Sigma id_z = 97.7\frac{6,240}{12,000} + 99.1\frac{2,520}{12,000} + 112.0\frac{600}{12,000} + 92\frac{600}{12,000} + 95.3\frac{2,040}{12,000} = 50.8 + 20.8 + 5.6 + 4.6 + 16.2 = 98.0$. Each component of the overall index describes in a way the contribution of the corresponding factor to the overall percentage of deviation in actual costs from the planned.

The above-examined methodology for studying the influence of a saving (overexpenditure) for the expenditure items on the overall indicator for the change in costs is also applicable for a comparison with planned or estimated costs but not over time. In the latter instance the actual expenditures on the work carried out in the report period cannot be directly compared with an analogous indicator in the base period, since they have been established for a varying volume of construction product. In order to eliminate the influence of the amount of work on the change in expenditures over time, it is essential to calculate the deviations of actual costs on a basis of comparing the expenditure levels per ruble of estimated work cost. Here the absolute changes in expenditures over time for the costing items will describe the expenditures not for all the produced construction product but rather as an average per ruble of its estimated cost. It is possible to determine the change in expenditures for the entire amount of work carried out due to the influence of changes in each item of expenditures per ruble of the estimated cost of the work by employing the formula which derives from the corresponding cost index, namely $Q_{p1}(s'_1 - s'_0)$,

where Q_{p1}--the estimated cost of the work carried out in the report period,
s'_1, s'_0--expenditures for the given item per ruble of the estimated cost of the work carried out in the report and base periods.

The total deviations for all the items equal the total change in expenditures due to a change in the expenditure level per ruble of estimated cost of the work, that is, $\Delta_z = \Sigma Q_{p1}(s'_1 - s'_0)$.

§7. Methods of Analyzing the Influence of Individual Factors on Construction Product Costs

Under construction conditions not all the expenditure items and, consequently, the factors influencing them play the same role in reducing costs. From the viewpoint of the scale of expenditures of the greatest importance in their saving are basically three expenditure items: materials, wages and overhead. A study of the influence of the factors on the change in expenditures is most often made by the index method, by the grouping of expenditures for various features as well as by the methods of regression correlation analysis.

A change in expenditures for the material elements of working capital is caused not only by a change in the amount of work but also by the influence of numerous factors related to the purchasing and procurement conditions for building materials, their storage, transporting, utilization as well as to a change in the prices and rates for transporting them. The influence of all these factors for analysis purposes can be viewed in a grouped form and namely as the change in the amount of work and expenditures on materials as a consequence of a change in the quantity of materials per unit of construction product, that is, the proportional consumption of materials (m) and the change in expenditures per unit of each type of material (p'_1). Then a numerical description of the influence of these consolidated factors in terms of the entire volume of work (q) can be represented by the following system of indexes:

$$\frac{\Sigma q_1 m_1 p'_1}{\Sigma q_0 m_0 p'_0} = \frac{\Sigma q_1 m_0 p'_0}{\Sigma q_0 m_0 p'_0} \cdot \frac{\Sigma q_1 m_1 p'_0}{\Sigma q_1 m_0 p'_0} \cdot \frac{\Sigma q_1 m_1 p'_1}{\Sigma q_1 m_1 p'_0}.$$

In this system the overall index of expenditures for materials reflects the joint influence of the three above-listed factors. The first factor index characterizes the change in expenditures under the impact of a change in the amount of work, the second under the influence of changes in proportional material expenditures and the third under the influence of changes in expenditures per unit of each type of material.

If in the analysis a comparison is made between the actual cost and the planned in terms of the actual amount of work, then the first factor index will equal one while the overall expenditure index for materials will reflect the influence of only two factors: a change in the proportional material expenditures and the expenditures per unit of each type of material. The result of the influence of each of the factors on the change in expenditures in absolute terms is obtained by subtracting the denominator of the corresponding factor index from its numerator. The initial data for calculating the above-examined indicators are to be found in the accounting documents of construction organizations.

Table X.4

Types and volume of work performed	Name of material and unit of measurement	Proportional expenditure of material per unit of work volume		Planned-calculated price per unit of material, rubles	Actual cost of a unit of material, rubles
		Norm	Actual		
Laying foundation, 2,680 m^3	Concrete, m^3	0.80	0.75	11.0	10.5
	Brick, thousand pieces	0.04	0.05	32.0	30.0
Laying flooring 1,860 m^2	Asphalt, kg	0.2	0.18	1.2	1.3
	Linoleum, m^2	1.0	1.04	3.8	3.6

Let us give an example. We will assume that the following information is known on the consumption of building materials in a trust for June (Table X.4). In this example, as is accepted in practice, the planned-estimated prices have been adopted as the expenditures per unit of each type of materials according to the plan. The actual cost of a unit of material is obtained by dividing the actual expenditures on acquiring and delivering the materials f.o.b. the construction site by the amount of the given type of material consumed in the report period. Since in the example the actual costs are compared with the planned for the amount of work carried out in the report period, it is essential to determine the influence of only two factors: the change in the proportional expenditurew of materials and the change in material costs. Thus, the overall expenditure index for materials is:

$$\frac{2\,680\,(0{,}75\cdot 10{,}5+0{,}05\cdot 30)+1\,860\,(1{,}04\cdot 3{,}6+0{,}18\cdot 1{,}3)}{2\,680\,(0{,}8\cdot 11+0{,}04\cdot 32)+1\,860\,(1{,}0\cdot 3{,}8+0{,}2\cdot 1{,}2)}=\frac{32\,524}{34\,529}=0{,}942, \text{ or } 94.2\%.$$

The total savings of actual expenditures on materials in comparison with the plan were 2,005 rubles (32,524-34,529). The index for the influence of the change in proportional expenditures (the "norm index") is:

$$\frac{2\,680\,(0{,}35\cdot 11+0{,}05\cdot 32)+1\,860\,(1{,}04\cdot 3{,}8+0{,}18\cdot 1{,}2)}{2\,680\,(0{,}8\cdot 11+0{,}04\cdot 32)+1\,860\,(1{,}0\cdot 3{,}8+0{,}2\cdot 1{,}2)}=\frac{34\,150}{34\,529}=0{,}989, \text{ or } 98.9\%,$$

that is, as a consequence of reducing proportional material expenditures in comparison with the standards, the savings equaled 379 rubles (34,150-34,529). The index for the influence of the change in the costs of the consumed materials (the "price index") is:

$$\frac{2\,680\,(0{,}75\cdot 10{,}5+0{,}05\cdot 30)+1\,860\,(1{,}04\cdot 3{,}6+0{,}18\cdot 1{,}3)}{2\,680\,(0{,}75\cdot 11+0{,}05\cdot 32)+1\,860\,(1{,}04\cdot 3{,}8+0{,}18\cdot 1{,}2)}=\frac{32\,524}{34\,150}=0{,}952, \text{ or } 95.2\%,$$

that is, the savings of actual expenditures as a consequence of reducing the cost of the consumed materials in comparison with that adopted in the plan were 1,626 rubles (32,524-34,150). The combined influence of the factors equals: (-379) + (-1,626) = -2,005.

A further analysis of expenditures on materials should be carried out separately for the factors relating to the formation of the proportional materials expenditures and the cost of a unit of materials. Thus, in studying expenditures per unit of materials one should establish the influence of changes in the wholesale prices of transport expenditures for the delivery, loading and unloading of materials and the procurement and warehousing expenses. The listed type of expenditures are shown in the bookkeeping and the corresponding planning data are taken from the costings of the planned-calculated prices which in terms of sense can be equated to the planned cost of a unit of materials. Table X.5 gives an example of calculating the deviations in actual expenditures from the planned outlays per ton of cement in rubles.

In knowing the total consumption of cement for the amount of work carried out, it is easy to figure the amount of deviations for each type of expenditures and as a whole. If, for example, during the report month 2,860 tons of cement were spent on construction work, then the total overexpenditure of 4,290 rubles (2,860•1.5) consists of the overexpenditure on the transporting of materials of 4,576 rubles (2,860•1.6), on procurement-warehousing expenditures of 286 rubles (2,860•0.1) and a saving of expenditures on loading and unloading work totaling 572 rubles (2,860 × 0.2).

Table X.5

Indicator	Total	Including			
		Wholesale price	Transport expenses	Procurement-warehousing expenses	Expenses on loading and unloading
Planned-calculated price (planned cost)	21.0	18	1.1	1.6	0.3
Actual costs	22.5	18	2.7	1.7	0.1
Deviation of actual costs from planned	1.5	--	1.6	0.1	-0.2

The change in expenditures for the wages of workers is influenced by diverse factors among which an important place is held by the labor productivity of the workers, the use of working time, worker skills and so forth. These factors can be unified and represented in the form of two consolidated ones: average output of employees and their average wages. The theoretical basis for studying the influence of these factors using the index method is the relationship of the wage expenditure level per unit of the estimated cost of the work (u) and the proportional labor intensiveness characterized by the amount inverse to the labor productivity level (t) and average wages (f) per unit of expended labor, that is, u = tf. As a calculation unit for the value of construction product it is possible to use 100,1,000 rubles and so forth of estimated work cost. Let us give an example of calculating the indicators for a trust (Table X.6).

Table X.6

Indicator	Previous year	Report year	Index, %
Expenditures on wages per 1,000 rubles of estimated work cost, rubles	420	385.2	91.7
Proportional labor intensiveness of 1,000 rubles of estimated cost of work (average annual number of employees per 1,000 rubles of work	0.20	0.18	90.0
Average annual wages of one employee, rubles	2,100	2,140	101.9
Total expenditures per 1,000 rubles of estimated cost of work, rubles	962	958	99.6

The total savings from reducing wage expenditures per 1,000 rubles of work cost is set as $\Delta_u = u_1 - u_0$. In the example the trust has achieved a savings of 34.8 rubles (385.2 - 420). As a consequence of the 10 percent reduction in the labor intensiveness of the work or a 11.1 percent rise in labor productivity $\left(100 - \frac{1}{0.9} \cdot 100\right)$, the following savings has been obtained: $\Delta_t = f_0(t_1 - t_0) = 2{,}100 \cdot (0.18 - 0.2) = -42$ rubles. As a consequence of the change in average wages, the corresponding savings (overexpenditure, is determined as: $\Delta_f = (f_1 - f_0)t_1$. In the example the trust has permitted an overexpenditure of 7.2 rubles (2,140 - 2,100)•0.18. The combined influence of the factors is: (-42) + 7.2 = -34.8 rubles.

From the calculated data it is possible to establish the influence of a change for each factor on the total percentage in the deviation of expenditures per unit of work cost. For this the total savings (overexpenditure) for each factor must be divided by the base level of expenditures, in our example, by 962 rubles. The increase in labor productivity led to a decline in the expenditure level per 1,000 rubles of work cost by 4.4% $\left(\frac{-42}{962}\cdot 100\right)$, the rise in average wages led to an increase in the level by 0.8% $\left(\frac{7.2}{962}\cdot 100\right)$, and as a whole to its reduction by 3.6% $\left(\frac{-34.8}{962}\cdot 100\right)$, or (-4.4) + 0.8 = -3.6%. The total savings of wage expenditures for the entire amount of work carried out in the report period can be determined as $Z = \Delta u Q_{p1}$. If in the example the amount of work carried out by the trust in the report year was 1.68 million rubles, then the savings will be 58,500 rubles (1,680•34.8).

In studying overhead the most effective grouping method is the one employed together with the absolute and relative indicators for the change in expenditures in the given item. Here it is advisable to differentiate the expenditures which depend upon the volume of construction-installation work and are therefore called variable and those which do not depend upon the amount of work performed and termed conditionally fixed expenditures. The variable overhead is in a direct dependence and not a proportional one upon the amount of work to be carried out. In these expenditures are the additional wages, deductions for social security, wear on production tools and supplies and so forth. Among the conditionally fixed expenditures are the administrative and managerial expenses, the housing and utility costs, the wear on temporary nontitle structures, the support of guard and fire security and so forth. As a rule, the greatest savings is achieved for this portion of overhead as its amount remains almost constant over a certain time.

In checking the fulfillment of an overhead estimate it is essential to take into account the level of plan fulfillment for the produced construction product (the fulfilled amount of work) and correct the amount of variable overhead for it. The conditionally fixed portion of overhead remains unchanged. In an analysis of overhead attention should be given to studying the aboslute and relative amounts of productive expenditures and their composition.

CHAPTER XI: A STATISTICAL STUDY OF FINANCIAL ACTIVITIES AT CONSTRUCTION ORGANIZATIONS

§1. The Tasks of Financial Activity Statistics

All production and economic activities in a construction organization are reflected in its financial indicators. The financial status of any socialist enterprise is characterized by the state of its assets in monetary terms, by the duration of their circulation and by the financial result, that is, by the amount of obtained profit or loss.

Each self-financing construction organization has been granted fixed and working capital by the state. These assets must be efficiently used for carrying out the production program. As a result of carrying out the production program and selling the product, a construction organization should recover the expenditures made in this and receive a profit above this. The conversion of the construction organizations to the new system of planning and economic incentive has increased the importance of the indicators for their financial results and the role of the efficient use of fixed and working capital in construction.

In studying the financial activities of contracting organizations, along with bookkeeping, an important role has been assigned to statistics. In relying on the bookkeeping data, statistics carries out the following tasks: 1) it studies the volume and structure of working capital in the construction organizations; 2) it describes the efficient use of working capital; 3) it studies profit and profitability of construction organizations; 4) it analyzes the factors which determine the organization's financial results.

§2. A Study of the Volume and Composition of Working Capital

The working capital of construction organizations is a monetary expression of the productive working capital and cash and disposable stocks needed to carry out the production program. The amount of working capital for each construction organization depends upon the production conditions existing at it and its economic activities, in particular, upon the volume and composition of the construction-installation work carried out, the organization of supply, payment principles for the products and so forth. The total amount of working capital in construction at the end of 1978 was 72,838,000,000 rubles and this exceeds its amount at the beginning of the Ninth Five-Year Plan by 3.8-fold.

The total working capital of a construction organization is calculated as of a certain date, usually at the end of a report period. Under the actual conditions of the organization's operation the amount of its working capital varies from one date to another. For this reason, in determining its amount over a period, the average balance of working capital is calculated (using the formula for the chronological average or as the half-total of the balances at the start and end of the period). Information on the amount of working capital at the end of a report period can be found in the assets of the balance sheet for basic operations of a construction organization and this is compiled monthly and for the report year as a whole (Form No 1-Contractor).

As a consequence of the substantial differences in the working capital elements, statistics studies not only its volume but also structure. For this purpose a number of groupings are employed and these describe the structural features of working capital from different aspects. In terms of functional role, working capital in the reproduction process is divided into working capital in the production sphere (as a monetary expression of productive working capital) and working capital in the circulation sphere (cash and disposable stocks). Working capital in the production sphere participates directly in such production stages as the purchasing of materials, structural elements and so forth and the formation of their inventories, production consumption of materials and the creation of the construction product.

Table XI.1

Working Capital Groups	1970	1978
Working capital--total (%)	100	100
Working capital in production sphere	55.4	67.1
Production inventories	40.0	19.9
Basic materials, structural elements and pieces	29.5	14.8
Auxiliary materials	4.7	2.4
Inexpensive and rapidly used-up articles	5.8	2.7
Assets in production	15.4	47.2
Incomplete production	15.2	47.1
Expenditures of future periods	0.2	0.1
Working capital in circulation sphere	44.6	32.9
Cash	13.2	6.7
Assets in accounts	31.4	26.2

According to the form assumed by working capital several subgroups are formed the names of which are given in Table XI.1 for the USSR. From the data of this table it follows that for example, the proportional amount of production inventories has declined noticeably and, at the same time, the proportional amount of incomplete production has risen. The varying dynamics of the working capital elements reflects the changes occurring in construction as a consequence of carrying out the economic reform.

Among the working capital of contracting organizations in terms of the limit feature a distinction is drawn between the normed and unnormed working capital. The normed working capital in construction includes the predominant share of working capital in the production and circulation sphere and the amount of this is determined for each organization within the limits set by the norms. The unnormed working capital includes debts, money in the payment account and the cash of the contracting organization and so forth. Information on the normed and unnormed assets is to be found in the balance sheet for the organization's basic operations, respectively, in sections "B" and "C".

In terms of formation sources, the working capital of construction organizations is divided into four groups. There is the own and equivalent capital which a self-financing construction organization receives at the moment of its formation. These assets are earmarked for forming the normed production stocks and partially for incomplete production not covered by borrowed and other assets. Secondly there are bank credits which comprise a portion of borrowed working capital for contracting organizations and used to form seasonal inventories of materials and in part incomplete construction work. Debts are characterized by the total assets formed as a result of payments between contracting organizations when the client's assets temporarily are in use by the given organization. Under the new management conditions, the contracting organizations are granted client advances to cover large amounts of incomplete production of construction and installation work and these advances also form working capital. Lastly there are other sources, for example, the obtaining of working capital from ministries for temporary use and so forth.

§3. A Study of the Efficient Use of Working Capital

For ensuring the ongoing production process, construction organizations should not only have the necessary amount and composition of working capital but also utilize this capital effectively. A notion of the efficient use of working capital is provided by indicators describing the actual amount or need of working capital for a cost unit of product, the rate of circulation and the length of circulation for the working capital.

An indicator expressing the amount of working capital calculated per cost unit of product called the coefficient for the retention of working capital is determined by the ratio $K_r = \bar{O}:R$,

where $\bar{O}$--the average balance of working capital over the report period;

P--receipts from the sale of the product (the so-called turnover of capital) for the report period.

In calculating the average working capital balance, consideration is given to both the normed and unnormed assets which are in the production and circulation sphere, with the exception of the assets in circulation outside the construction organization. The turnover of the assets considers, correspondingly, the receipts from the turning over of the construction-installation work to the clients, including compensation and benefits above the estimated cost, the receipts from the outside sale of services and products from subsidiary and service production entered on the contracting organization's balance sheet.

The working capital retention coefficient describes the level of its effective use by expressing the resource intensiveness of the product in terms of working capital over the given segment of time. The smaller this coefficient the higher the efficient use of working capital at a construction organization. Let us give an example. We will assume that in the report year the total receipts from the sale of product in the construction trust was 8.45 million rubles, and the average working capital balance over the year was 4,056,000 rubles. Hence the working capital retention coefficient for the trust equals: $\frac{4,056}{8,450} = 0.48$. This means that as an average over the year the construction trust needed 840 rubles of working capital for the manufacturing and sale of each thousand rubles of product.

An indicator measuring the rate of working capital circulation, that is, the turnover coefficient, is an amount calculated by the formula $K_{tu} = R:\overline{O} = \frac{1}{K_r}$. The turnover rate coefficient shows the number of turnovers carried out by the working capital of the construction organization over the given period. In our example $K_{tu} = \frac{8,450}{4,056} = 2.08$. In other words, the trust's working capital turned over 2.08 times during the year. This indicator can be interpreted as the return from the working capital advanced for production. In the example each ruble of advanced assets makes it possible for the construction trust to receive 2.08 rubles of receipts from product sales over the year.

The amount of the turnover rate coefficient, like the working capital retention coefficient, depends upon the length of the period. In order to eliminate this inconvenience in studying the efficient use of working capital over different-lengthed periods, statistics calculates the average lengths of one working capital turnover (T_{tu}) by dividing the calendar length of the report period in days (T_c) by the working capital turnover rate coefficient, that is, $T_{tu} = T_c:K_{tu}$, or as the product of the calendar length of the period by the working capital retention coefficient, that is, $T_{tu} = T_c \cdot K_r$. In the example, the average length of one capital turnover at the trust was: $T_{tu} = 360:2.08 = 173$ days, or $T_{tu} = 360 \cdot 0.48 = 173$ days.[1]

Another method for calculating this indicator is based upon comparing the average working capital balance over the period with the average daily receipts from product sales ($\overline{p}$), that is, $T_{tu} = \overline{O}:\overline{p}$. The average daily turnover is determined by dividing the total receipts from the construction organization's product sales over the report period by the calendar length of this period in days. In the example the average daily turnover of the trust equals: $\overline{p} = \frac{8,450}{360} = 23,470$ rubles, and hence the average length of one turnover at the trust is $T_{tu} = \frac{4,056}{23.47} = 173$ days.

Along with the overall average length of capital turnover at a contracting organization it is possible to determine this indicator for various stages of capital circulation, that is, individually for the production sphere and the circulation sphere, for normed and unnormed working capital and so forth. The general methodological principle for calculating the indicators here is not changed, but one must proceed not from the overall total of the working capital at a construction organization but rather from its component parts. In the Appendix No 1 to the balance sheet for the

[1] In calculating this indicator, the length of the year is considered equal to 360 days, a quarter is 90 days and a month 30 days.

basic operations of contracting organizations, initial data are given for separately calculating the turnover rate of the normed and unnormed working capital as well as the indicators themselves for the turnover rate in days. The total of the capital turnovers in all cases remains the same.

The amount of working capital required for normal continuous production depends directly upon the level of the efficient use of this capital by the contracting organization. For this reason in the analysis it is important to bring out to what degree a change in the effective use of the working capital influenced its overall amount. For this, using the index method, the total working capital released from turnover or additionally involved in turnover is determined using the index method. At the basis of constructing the system of factor indexes lies the proportional dependence of the average balance of working assets upon the retention coefficient and the volume of sold product, that is, $\overline{O} = K_r \cdot R$. In using this relationship it is possible to establish the total of the capital released from turnover or additionally involved in it under the influence of these two factors.

Let us assume that in the example (see page 213) in the previous year the retention coefficient equaled 0.5 while the receipts from product sales were 8 million rubles. Then the influence of the change in the effective use of working capital will be: $\Delta_{K_r} = p_1(K_r - K_r) = 8{,}450(0.48-0.5) = 169{,}000$ rubles, while the influence of the change in the volume of sold product $\Delta_p = K_r(p_1-p_0) = 0.5(8{,}450-8{,}000) = 225{,}000$ rubles. The overall increase in working capital is 50,000 rubles (-169)+225. In both instances, if the amount was obtained with a minus sign, then working capital was freed. A plus sign means that the obtained amount was additionally put into the turnover of the construction organization.

The total of the freed or additionally used capital can be determined not only for the working capital of a contracting organization as a whole but also separately for each component part of the working capital using the same methodology.

§4. The Study of Profit and Profitability of Construction Organizations

The profit and profitability indicators describe the financial results from the production activities of construction organizations. Under the conditions of carrying out the economic reform, the amount of profit becomes one of the planning indicators set by the superior organizations and employed for assessing the operating results of the organizations. Profit serves as the main source of the payment for productive capital and the formation of the material incentive fund for the construction employees, the production development fund and the fund for sociocultural measures and housing construction. In order to obtain the planned profit under the new economic incentive conditions, a contracting organization should complete all the construction and installation work at the starting-up projects, work stages and complexes to be turned over to the client and achieve the planned work cost level.

The profit of a contracting organization is formed chiefly from the sale of construction product as well as from the financial results in the nonbasic activities of the organization (ancillary production and the service systems) and, finally, from extrasale operations. In this regard a distinction is made between the overall (balance sheet) profit obtained from all the activities of the organization and profit from product sales in basic, that is, construction, work. The latter indicator is determined by subtracting the actual cost of the construction and installation work turned over to the client from the contractual (planned) cost.

Let us assume that we possess the following data on the completed amount of work which has been turned over to the client by the trust for the report year (thousand rubles):

Estimated cost	6,100
Planned cost	5,800
Actual cost	5,700
Compensation above estimated cost	275

The planned profit for the amount of construction and installation work completed and turned over to the client in the report year equals: (6,100 + 275) - 5,800 = 575,000 rubles. Actual profit for the report year is: (6,100 + 275) - 5,700 = 675,000 rubles. Thus, in the report year, due to the reduction in work costs in comparison with the plan, an additional (above-planned) profit was obtained totaling 100,000 rubles (675 - 575).

The profit from the product of the subsidiary types of production and service systems is determined as the difference in the value of the sold product from these subdivisions of the contracting organization according to the planned-estimate prices (or wholesale prices) and actual product costs.

At present, along with balance sheet profit, construction organizations also determine calculated profit. Calculated profit equals the balance sheet profit minus the payment for productive capital and the total interest on bank credit. Information on the financial results of the organization is found in Form No 20 "Report on Profit and Losses," and in addition, Form No 2-s contains initial data for calculating the profit from basic production.

For describing the financial state of organizations, along with absolute indicators, statistics also employs relative indicators, namely the level of construction product profitability and the profitability level of the construction organization. The first indicator in construction practices is usually expressed by a percentage ratio of profit to the estimated cost of the costs of the sold construction product. In economic theory this indicator is also determined by the ratio of profit to product costs. The profitability level of the construction product can be established for all the economic activities of an organization (for the balance sheet profit) or only for its basic activities (for the profit from completed contracting work). The second indicator, the profitability level of a construction organization, is determined by the ratio of profit to the average annual value of the fixed productive capital and normed working capital. This can be calculated for the overall (balance sheet) profit and for calculated profit. In the latter instance from the total value of the fixed capital one must exclude that portion for which the capital payment is not charged. In construction, in contrast to industry, profitability levels are not planned but are used as calculation and analytical indicators.

For an illustration of the calculating of profitability indicators, let us use the following example (Table XI.2; thousand rubles).

The overall profitability for construction product in the previous year was $\frac{130}{1,600} \cdot 100 = 8.1\%$, in the report year $\frac{188}{1,648} \cdot 100 = 11.4\%$, that is, product profitability rose by 3.3%.

Table XI.2

Indicators	Previous year	Report year
Sold construction product (estimated cost)	1,600	1,648
Balance sheet profit	130	188
Payment for productive capital, interest on credit	86	95
Annual value of:		
Normed working capital	300	410
Fixed productive capital	2,820	2,880
Including for which payment is not collected	220	190

The calculated profitability of the construction organization was in the previous year: $\frac{130-86}{2,820+300-220} \cdot 100 = 1.52\%$ and in the report year: $\frac{188-95}{2,880+419-190} \cdot 100 = 3.06\%$.

Consequently, calculated profitability rose by 1.54 percent for the organization. The designated method for calculating a construction organization's profitability is applicable to those organizations which have fully been given their own construction-end fixed productive capital. A majority of the construction administrations does not possess their own construction machines but rather use other machines by rental and lease arrangement. For this reason, the given indicator is better applied as a whole for the combines, trusts, associations, glavks and ministries.

§5. Analysis of Factors Influencing the Financial Results of Construction Organizations

Of great importance in studying the fulfillment of the profit plan, particularly for basic production and the change in its dynamics, is an analysis of the factors which influence these changes. In factor analysis of profit it is advisable to employ the index method, as it best meets the conditions of the set task. For this it is essential to represent profit as a function of indicator factors. The simplest analytical form for the dependence of profit (P) can be represented by the following expression: $P = Q_p r$, where Q_p--the volume of sold construction product; r--the profitability level of this product. Hence, the influence of the change in the volume of product on the profit deviations is determined as $\Delta_Q = r_0(Q_{p1}-Q_{p0})$, while the influence of the change in the product profitability levels is $\Delta_r = (r_1-r_0)Q_{p1}$. The combined influence of the two factors is: $\Delta_p = \Delta_Q + Q_r$.

The thoroughest analysis of the change in profits can be made under the influence of the following factors: Changes in prices, changes in the cost of the sold construction product, changes in the composition of the sold product and changes in the volume of this product. In the statistical literature, for solving such problems a methodology for calculating the influence of these factors has been recommended based on mixed (additive-multiplicative) index models.[2]

[2] V. Ye. Adamov, "Faktornyy indeksnyy analiz" [Factor Index Analysis], Moscow, Statistika, 1977, p 169.

In the given instance, the following system of factor indexes has been adopted as the basis of analysis:[3]

$$\frac{P_1}{P_0} = \frac{\Sigma q_1 (p_1 - z_1)}{\Sigma q_0 (p_0 - z_0)} = \frac{\Sigma q_1 (p_1 - z_1)}{\Sigma q_1 (p_0 - z_1)} \cdot \frac{\Sigma q_1 (p_0 - z_1)}{\Sigma q_1 (p_0 - z_0)} \times$$

$$\times \frac{\Sigma q_1 (p_0 - z_0)}{\Sigma q_0 (p_0 - z_0) \dfrac{\Sigma q_1 p_0}{\Sigma q_0 p_0}} \cdot \frac{\Sigma q_0 (p_0 - z_0) \dfrac{\Sigma q_1 p_0}{\Sigma q_0 p_0}}{\Sigma q_0 (p_0 - z_0)}.$$

The difference in the numerator and denominator of each index describes the influence of the change in each of the above-listed factors on the change in profits.

The influence of the change in prices in analyzing the dynamics and fulfillment of the profit plan can be viewed as a change in the estimated prices for construction product and as a change in wholesale prices for materials and the rates for transporting them not accounted for in the estimated prices. A change in estimated prices under the conditions of a value accounting for construction product in a majority of instances has no impact on the deviation in profit as the estimated prices operate without substantial changes for several years. But in instances when the changes in the estimated prices or norms do occur (partial or complete), then the deviation in profit as a consequence of this factor is determined as the difference between the estimated cost of the sold construction product in the new and old estimated prices. The influence of a change in wholesale prices for materials also rarely occurs within 2 years. Ordinarily this is taken into account in the total compensation and partially in determining the influence of a change in costs themselves.

The analysis method which can be recommended for practice can be employed only when comparing actual profit with planned profit. This cannot be done over time as not all the elements of the factor model are available in the accounting of the contracting organizations.

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[3]The form of notation for the indexes reflects only the conditions of this calculation, where Q--the volume of work, p--estimated prices, z--cost of a unit of work.