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AN INDUSTRIAL MONITORING SYSTEM OF THE MINISTRY OF INDUSTRY AND TECHNOLOGY OF TURKEY 1/

(IS/TUR/72/010)

by

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UNIDO Experts

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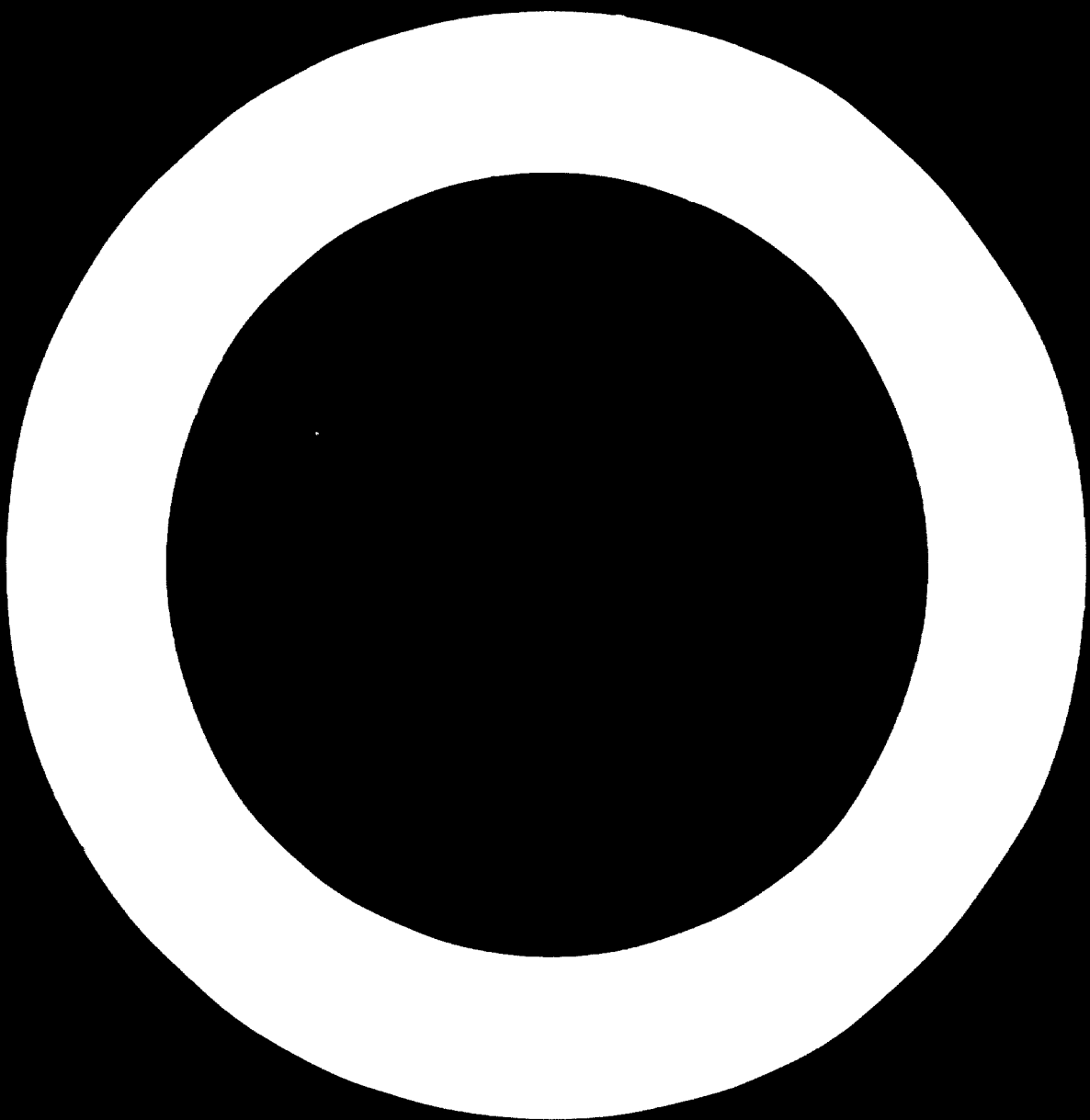
We regret that some of the pages in the microfiche copy of this report may not be up to the proper legibility standards even though the best possible copy was used for preparing the master fiche

The following report is based on the activities of two experts, Dr. Zoltan Roman and Dr. Yrjo Seppala, who spent alltogether 16 weeks in Turkey. They had contacts first of all with the Industrial Department of the Ministry of Industry and Technology. The recommendations based on their suggestions concern primarily the activity of this Department but are of more general character too. The experts would like to express their thanks for the valuable advice and help they received to the representatives of the Ministry, in particular to Mr. Ahmet Selçuk, President of the Industrial Department, to those of the numerous other institutions (SPO, SIS etc.), the regional offices, enterprises visited as well as to the staff of the UNDP Office in Ankara.

The job descriptions for the experts called for the following functions to be performed:

1. Advice on reorganization of the existing card index system to improve coverage and facilitate its use in computer exercises.
2. Advise on programming procedures which will be necessary to extend the annual industrial monitoring effort.
3. Advise on the additional facilities required for an extension of the industrial monitoring effort.
4. Advise on the types of data which should be included in the future industrial inventories.
5. Advise on the types of analysis which would be most useful and would utilize the data collected.
6. Advise on methods for improving the data collection procedure.

TABLE OF CONTENTS



SUMMARY OF FINDINGS AND RECOMMENDATIONS

The industrial monitoring system should be always adapted to the country's industrial development and the prospects and problems faced by industry. The rapid growth of Turkish industry requires continuous modifications in its monitoring system, in particular in the Ministry of Industry and Technology. A number of on-going changes and initiatives testify the awareness of this need in the Ministry. In harmony with and in addition to these efforts, the following recommendations are aimed at increasing the speed and efficiency of this process.

In order to eliminate cases of missing registration of new firms, an agreement is needed between the Ministry and other authorities (including chambers of industry and trade), regarding the obligatory use of the registration code-number in all official letters. All authorities should be asked then to notify immediately both the firm concerned and the Ministry if the absence of this code-number indicates that the firm has not been registered yet.

Communications within the Industrial Department as well as with other Departments of the Ministry could be improved by introducing standardized forms of quarterly and annual reports of the Sections. These reports are integral part of an up-to-date Management Information System for the Industrial Department and the Ministry as a whole. Forms for these reports are given for the Sections of the Industrial Department in Annex II. Similar forms should be elaborated for the Sections of the other Departments too. Also the flow of interdepartmental information should be standerized. Systems analysis of the changing tasks of the Ministry, of the duties, responsibilities and relationships of the Departments would give a solid basis for this regulation.

The weight of the future-oriented activities and thus the need for more information on past trends, prospects and factors of development are increasing in the Ministry and its Industrial Department. As first step to a Data Bank, the files in the Section Industrial Registration and Inventory (IRI) of the Industrial Department should be updated and extended. At a

later stage all Data Bank files should be on disk-unit of a computer. For this purpose a project for a computer-based Data Bank should be initiated.

In the Industrial Department a special Information Unit should be established and could be attached to the IDI Section. This Unit should register all documents with information on industrial development in Turkey and abroad. They should prepare and circulate each month an annotated list of these documents sent to (or drafted in) the Department. Furthermore, this Unit should be responsible for collecting all relevant documents available and of possible use for the Department's activity.

In order to improve statistics and analysis on industrial development the cooperation and the joint efforts of the Ministry, the State Planning Office and the State Institute of Statistics should be strengthened. Attention should be paid in particular to reducing the time needed for processing and editing the data of the annual and periodical surveys, to introducing systematic production index number calculations (according to U.N. standards), elaborating more studies, both overall and sectoral, on the development of the Turkish industry with international comparisons and perspectives.

RECOMMENDATIONS ON POSSIBLE UNIDO ACTIONS

1. Training workshop for users of industrial statistics and analyses.

In order to increase the receiptivity for industrial statistics and analyses, the skills in defining the requirements for such analyses as well as the skills in their utilization for decisionmaking a two-week workshop is suggested for the chiefs of sections, divisions and departments of the Ministry. The UNIDO might consider dispatching an expert for this workshop of 8 - 10 half-day sessions. Topics of these sessions could include:

time-series analysis,
structural analysis,
interfirm comparisons,
factors of growth analysis,
international comparisons.

2. Training workshop for senior staff members on methods of industrial statistics and analyses.

An increasing need is recognized for the Ministry to prepare and evaluate more detailed analyses on developments and prospects of industrial growth in Turkey. Most senior staff members who would be involved in this task have engineering qualifications. Their knowledge in preparing and evaluating such analyses should be up-dated and expanded. A two-week workshop of an UNIDO expert is suggested for them. The participants should be freed from current work for this period. Topics of this workshop could be:

- new developments in and international recommendations for industrial surveys and census,
- index number calculations and time-series analysis,
- statistics and analysis of labour, capital and technical progress,
- structural analyses, regional and sectoral,
- interfirm comparisons, analysis of plant-size and concentration,
- statistical and econometrical methods of factors of growth analysis,
- sources and methods of international comparisons.

3. General management courses for chiefs of division and department

UNIDO could possibly offer for 3 - 5 chiefs of division or department to attend a general management course which make them acquainted with modern management principles and techniques equally useful in business and administration. International management training institutions in Switzerland, France etc. organize a number of such courses with different programmes and length of time; the best could be selected adapting also

to the background of the persons concerned.

4. Fellowships for senior staff members

For 2 - 4 senior staff members of the Ministry who will be in charge of organizing the up-to-date management information system and industrial analyses in the Ministry fellowships could be offered by UNIDO. These might include 3 - 5 weeks for visiting industrial ministries of 1 -2 countries with developed system of information and analysis.

5. Expert for production index number calculations

SIS is preparing the introduction of production index number calculations but did not make much progress in recent years. An expert could be supplied to SIS for 6 weeks to help this effort since such index numbers (available in all industrialized countries) are needed. The first 3 weeks should be spent defining the methods of the calculations and the preparations. The remaining 3 weeks would be devoted to the evaluation of the first results and improvement of the methodology.

6. Systems analysis

UNIDO could help to establish a team for systems analysis of the Ministry's changing duties and responsibilities. The team should consists of four people: two representatives of the Ministry and two experts invited and financed by UNIDO. One expert should be an industrial economist and the other should be a systems analysis expert. The analysis might require about 6 months. The representatives of the Ministry should be freed from other duties for the whole period while the UNIDO experts are needed in the field during the initial and terminal phases (2 men for one month each during both periods - a total of 4 man-months).

THE REGISTRATION SYSTEM

According to Law No. 6948 all industrial firms should be registered by the Ministry of Industry and Technology and have an official registration number. This registration number helps to identify immediately where

the firm is located and the branch (ISIC) it belongs to. Industrial firms are economic units with industrial activity employing at least 10 workers or at least 5 workers and using electric motors as well.

New firms to be registered should send in a form "Sanayi Sicil Beyannamesi" which includes all the basic information on the firm's character of activity, capacity, ownership etc. Each firm has to report annually if changes took place in these basic data and they should send an announcement immediately, of course, in case they cease operations.

In the Ministry of Industry and Technology the Industrial Inventory and Registration (IRI) Section of the Industrial Department is responsible for this system. They have a card-register and archives of the firms' registration and change reports. The cards are classified by the 67 localities of the country and 3-digit branches, the archives by 3-digit branches.

At the end of each year the IRI Section has to send a complete list of the newly registered firms and those that have ceased operations to the State Institute of Statistics. The relevant portion is then provided to each of the 67 regional and liaison offices of the Ministry. In addition, a summary report on the registration is recommended according to the Form No. 1 (see Annex II). This report indicates by sectors the number of firms registerd at the beginning and at the end of the year, the number of firms newly registered and cancelled, among the new registrations the number of firms in the three large cities (Ankara, Istanbul, Izmir), those with employees more than 50 and more than 200. The report should be forwarded first of all to the President of the Department, to the other leaders of the Ministry and also to other authorities (e.g., SPO, SIS) dealing with industrial development.

At the present time about 6600 firms are registered. As far as the number of firms is concerned, the coverage of the register may be about 80 per cent. Measured by production value or employment the coverage must be higher since mostly small firms are missing. The regional and liaison offices of the Ministry make some efforts to increase the coverage but due to their small staff, their manifold other tasks and the lack of information

needed, much improvement cannot be expected from these efforts.

Taking into account the different explanations for incomplete registration coverage, the following solution is recommended. First, an agreement is needed between the Ministry and other authorities (including chambers of industry and trade) about the obligatory use of the registration code-number in all official letters. All authorities should be asked to immediately notify both the firm concerned and the Ministry IRI Section, if the absence of this code number indicates that the firm has not been registered yet. Since the overwhelming number of the firms are members of one of the chambers of industry or trade, an annual check of the lists of the chambers can also be recommended.

The Common Market Section drafts quite a number of reports for and on negotiations. Again, these cannot be standardized but are worthwhile for circulation to the vice-presidents and directors of the Department.

The Automotive Industry Section is concerened with fostering import substitution by setting targets, regulations, controlling implementation and, at the same time, takes charge of the general development of this very important branch of industry. They follow with special attention the 27 producer enterprises. An annual report should be prepared on the activities of these firms and on the development of the branch. Besides data on the major products this might include according to Form No.5, aggregate indicators on output, production factors, investment and foreign trade relations. From this point of view the share of export in total sales and the import content of the products are of primary interest. The yearly increase of gross value of output, value added, capital etc. can be measured for the time being only at current prices. There is a need, however, for volume indexes and therefore for price coefficients and index numbers as well, which will be discussed later.

The firms' percentage shares in output, capital, employment etc. and the changes in these shares as well as their relative position indicated by various management ratios are also worthy of analysis. Form No.6 gives an example of such comparative data to be analyzed.

The Foreign Relations Section is engaged in evaluating license and know-how agreements. Their quarterly report, as suggested in Form No. 7, may indicate the major characteristics of the applicants and the agreements submitted for approval. Their annual report (see Form No.8) might give an overview of the applications concerning the share of applications related to production on-going or to be developed, new agreements or extensions, the foreign capital involved, the costs of transfer, the period covered etc. An analysis of the submitted license and know-how agreements helps to formulate general guidelines and policy measures about this important aspect of technical progress promotion.

The Sectoral Studies Section has been recently established. From this Section studies are expected on the current situation and the development prospects of sectors, primarily those dealt with by the other Sections of this Division. These studies should be based on research, sectoral statistics national and international reports including publications and working materials of the State Planning Office, the State Institute of Statistics, of the various UN organizations, OECD, EEC. etc. The section might be a frequent user of the Data Bank and the Information Unit dealt with later. The output of this Section will be a set of sectoral studies.

INFORMATION FLOW WITHIN THE INDUSTRIAL DEPARTMENT

The Industrial Department has at the present time three divisions: Division Enterprises and Foreign Trade, Division Sectoral Development and Division Finance and Administration. The latter one deals with internal matters of the Department and was not a subject of investigation. The two "substantive" divisions have 10 sections and their main activities are listed in Annex I. A rough distinction is given where possible between activities related to current work or future-responsibilities. The list does not indicate the staff involved in these activities but, seemingly, for the time being daily work constitutes a very heavy load. (premarily carrying out import substitution policy).

Further development of Turkish industry requires, however, more attention to future-oriented activities, technical progress, competitiveness, export promotion, entering in the EEC etc. Some changes in the duties and responsibilities of the Section have been initiated already, others should be clarified, encouraged and harmonized. As far as these changes without an in-depth analysis could be anticipated, they have been taken into consideration in drafting the following recommendations. Nevertheless, in view of the new tasks and requirements for an adequate and forward-looking regulation of the intra- and inter-departmental information flow, a systems analysis of the Department - and the Ministry as a whole - can be also suggested.

The information flow within the Industrial Department could be improved by standardization of the forms of reports to be given to the President of the Department. These reports should be circulated also to the chiefs of divisions and sections (vice-presidents and directors) of the Department, and partly to other departments of the Ministry, too. This latter step might be part of the interdepartmental flow of information in the Ministry which also should be included under the revised regulation.

Annex II includes a set of standardized forms of reports recommended for the Sections of the Industrial Department. The 10 forms cover only the major activities of the Section. Naturally, only those activities which show continuity and common characteristics can be reported in standardised forms. (That is the reason why Section 11 and 16 forms have not been referred to). Usually, in order to fill in such forms, current registrations are needed. These are being prepared already by the Sections. The two registration forms on import permits (R/2 and R/3) are attached as examples.

The Enterprises Section has a great variety of assignments, including surveying industrial development, advice and coordination. The form of its reports varies according to the task given. Thus it cannot be standardised.

The Industrial Registration and Inventory Section has three duties for the time being: registration of firms; collecting, revising and processing the firms' annual reports; and preparing files on the firms' data by localities. Two reports on registration have been suggested in Chapter 3:

the list of newly registered and cancelled firms and summary figures on the number and character of the registrations. The second duty of this Section - collecting, revising and processing the firms' annual reports - will be taken over by the State Institute of Statistics (SIS). This is part of an agreement between SIS and the Ministry aimed at the elimination of overlapping activities. The time gained through this organizational measure should be used for the extension of the files of the Section, for establishing a Data Bank to be dealt with in the next section.

The Foreign Trade Section is engaged primarily in controlling imports (quotas, permits, customs exemptions). Two forms are recommended in Annex II for this Section, No. 2 and No.3. The first form deals with import quotas and their uses. The second one concerns import permits of the so-called List 2. The Section should have, of course, a registration of all quotas and items of List 2 respectively (see Form No.R/2 and Form No.R/3). A complete report would not be needed for the chiefs of the Departments more than once a year. It is suggested that in the first, second and third quarters only those quotas and items of List 2 be listed only where the unused proportion of the quota exceeds 20 per cent. This application of the way of thinking "Management by Exceptions" makes the report more concise indicating only the items of particular interest.

For reports on import permits, Form No. 3 can also be recommended to the Iron and Steel Section. The Industrial Products Section gives expertise rather than permits. A report on the number of applications (coming in and going out) as well as on the expertise given (positive or negative) could be provided as suggested here in Form No. 4.

The Industrial Department handles ten thousand applications for import permits each year. An analysis of the characteristics of these applications, of the percentage shares and reasons of approval and refusal could give new insight and lead to important conclusions about the whole process of import regulation. For this purpose a low-cost sample survey can be suggested.

Though these studies cannot be standardized, most probably Forms No.5 and No.6 will be often used. In addition, however, longer time series and, thus, volume and price index calculations would be also needed.

The share and the role of the public sector is very significant in the Turkish industry. The Ministry of Industry and Technology has to supervise 7 State Economic Enterprises managing 88 factories. The State Economic Enterprises Section can and should report quarterly on the production and investments of these enterprises. Annually an in-depth analysis is needed. The quarterly production report according to Form No.9 shows the production, stocks and sales of the major products of these enterprises. In order to have aggregate production index numbers, further efforts are needed. The investment report (see Form No.10) indicates the planned dates and costs of the projects and the progress in implementation, measured by the actual expenditures.

The annual surveys can be based partly on the evaluation of the detailed reports of the enterprises, partly on summarizing tables and aggregate figures as indicated in Forms No. 5 and No. 6. Suggestions on various specific analyses will be given in Chapter 6.

DATA BANK AND INFORMATION UNIT IN THE INDUSTRIAL DEPARTMENT

In the Industrial Department the Industrial Registration and Inventory Section keeps in archives the annual reports of the enterprises from 1967 on and has files on data for the years 1967, 1968 and 1969 classified according to 67 localities of the country. The processing of the data for the years 1970 and 1971 is in progress.

According to the new arrangements the Section will be freed from the revision and processing of the annual reports of the enterprises. They will receive both the revised annual reports of the enterprises - from 1972 on - and the processed data from the State Institute of Statistics. This gives time and the possibility for the Section's staff to develop more complete files and thus to meet the Department's increasing requirements for more data, prepared in a better form and accessible.

These files might be the core of a Data Bank which should be computerized later and filled in with the data of the individual enterprises. With the present state-of-affairs before the establishment of a computerized Data Bank

a number of preconditions should be satisfied concerning the coverage, reliability of the data, the length of time of their processing and editing etc. Therefore, successive measures are recommended both for the content and wealth and for handling the Data Bank. This maturation period would afford experience also regarding the different uses of the Data Bank.

At the first stage three types of files are to be established: sectoral files (see Tables 1 - 5 of Annex III), product files (Table 6) and enterprise files (Table 7). All files include only annual data, first from the year 1967 on (these data are available now in Section IRI) but later at least the sectoral and product files should be complemented with data on previous years as well. Efforts are needed to update the files as soon as possible, making use of the preliminary reports of the State Institute of Statistics. The sectoral files can be completed first according to two-digit branches of the ISIC, the product files on the major 25 - 50 products, the enterprise files on the largest 100 enterprises. The files successively can be extended taking into consideration both the availability of the data and the needs of the users.

Table 1 of the sectoral files gives an overview of the concentration of the manufacturing industry as measured by the number of establishments, number of persons employed, and value added, according to 4 size-classes. In addition, from time to time the share of the 3 and 5 largest enterprises can be analyzed too.

Table 2 indicates the major figures on output (gross value and value added) and on the factors of production (materials, electricity used; capital, investment, number of employees, by some components, wages and salaries). All these data are available from the annual reports of the enterprises.

Table 3 shows 4 basic indicators (value added, persons employed, capital, investment) broken down according to public and private enterprises, Table 4 provides data on the three large cities of the country (Ankara, Istanbul Izmir) and the other localities. These data are also available from the current statistics.

The analysis of the sectors' development cannot be based, however, merely on available data at current prices. Table 5 should contain index numbers from data in physical units (as in case of electricity used and employment) or from data at constant prices (as in case of the capital stock) or calculated in a special way (as in case of the production index numbers). Most of these index numbers are not available now but, in addition to other data, are badly needed for productivity measurement and analysis. In order to fill these gaps of basic information on industrial development, efforts should be strengthened (see next section).

The product files according to Table 6 present simplified product balances: data on production, import, stock, export and domestic uses. The lack of consistency between the production and foreign trade figures should be rectified as soon as possible.

The suggested enterprise files (see Table 7) comprise the major data or output and factors of production (like Table 2 on sectors) and later on can be supplemented with other data on foreign trade, finance, etc.

For the management and the operational activities of the Industrial Department, beside the basic statistical data on the Turkish industry, data and information of other types are also needed. Establishment of an Information Unit in the Department - attached to one of the Sections (e.g. to IRI-Section) - is recommended in order to ensure completeness and better communication.

The first task of this Information Unit should be the registration of all documents with relevant information on industrial development in Turkey and abroad. All publications, interim reports and working materials are to be registered whether prepared in the Department and the Ministry or received from other institutions. After registration the documents can be kept in the receiving Section but the Information Unit should prepare and circulate each month an annotated list of these documents. The annotations should indicate the character of the documents and the types of information included.

The second task of the Information Unit is to collect all relevant documents. These should include:

- statistical bulletins, yearbooks, both Turkish and international (UN, ILO, UNESCO, ECE, ECAFE, OECD, EEC etc.),
- special statistical publications on industry (e.g. the series Growth of World Industry, the Profiles of Manufacturing series of the UNIDO);
- documents of the State Planning Office (annual programmes, medium - and long-term plans; annual and interim reports on the implementation of plans; opinion surveys of enterprises);
- reports, studies, analyses prepared by this or other Departments of the Ministry;
- surveys, reports, studies, analyses prepared by the State Planning Office, State Institute of Statistics, other national authorities as well as by international organizations (UN, UNIDO, ILO, UNESCO, ECE, ECAFE, OECD, EEC etc.).

The international organizations usually have and send free of charge cumulative lists of publications. These might help to complete the documents of the Unit retrospectively.

IMPROVEMENTS OF INDUSTRIAL STATISTICS AND ANALYSIS

In order to improve statistics and analysis of industrial development, the cooperation and the joint efforts of the Ministry, the State Planning Office and the State Institute of Statistics should be strengthened. Agreements of these institutions resulted in the elimination of a number of overlapping activities and in increasing the consistency of the statistical data from different sources. As far as basic statistics is concerned, at the present time further improvements are necessary in order to:

- to increase the coverage of the data reported;
- to increase the reliability of the data reported;
- to shorten the length of time needed for processing and editing the data;
- to provide production and other index numbers.

With the aim to increase the coverage of the annual reports of the enterprises, the obligatory use of the registration code-numbers in all official letters has been suggested in Chapter 3. This can help to identify and supplement the missing registrations.

In order to increase the reliability of the data reported by the enterprises, extensive training activities may be recommended for the statisticians of the enterprises. It is worthwhile to consider the introduction of a title "qualified statistician" for persons attending the courses and passing examination. This might stimulate participation.

The length of time needed for processing and editing the census data and the annual reports of the enterprises depends to large extent on the number and qualifications of staff engaged in this work, on the organization of work and the availability of computer facilities. According to the new arrangements the State Institute of Statistics takes responsibility for the whole procedure and they should be asked to make use of all possibilities of saving time regarding each of the factors mentioned above, in particular regarding availability of computer's capacity for industrial statistics.

The Industrial Division of the State Institute of Statistics as a rule prepares summary tables on the preliminary data of the census as well as those of the annual reports. Beside the State Planning Office these preliminary data should be provided to the Ministry(IRI Section of the Industrial Department) as well.

The Industrial Division of the State Institute of Statistics is making preparations to calculate quarterly production index numbers according to the recommendations of the U.N. Statistical Office. The Ministry should communicate officially its interest in and the importance attributed to this initiative and ask for speeding up the studies, experimental computations and the finalization of the methodology.

Further actions are needed to ensure the consistency with the labour input data enabling the measurement of changes in productivity. Taking into account the rapid changes in prices, increasing need is felt to disaggregate

the effects of volume and price changes by help of price index numbers on major groups of industrial projects. For the measurement of changes in capital intensity, capital/output and investment ratios, price and volume index numbers on stock and formation of capital are needed too.

Establishment of a permanent committee "Industrial Statistics and Analysis" seems to be useful. It should include representatives of the Ministry, the State Planning Office and the State Institute of Statistics. This Committee should set priorities and draft a programme, support and follow up the implementation regarding both the improvements in basic statistics as suggested above and the development of industrial analysis as outlined in the following few paragraphs.

The State Planning Office is now the place where most analyses on industrial development are being prepared. These studies serve as basis for evaluating the realization of previous plans, as well as for setting new targets on the growth of industry. The major conclusions of these studies will be published in the official documents on the annual programmes, medium- and long-term plans. Some studies will be sent to the other authorities as part of an exchange of working materials. This course should be pursued.

The State Planning Office often makes use of its special enterprise opinion surveys, primarily in the annual and interim reports. Enterprises will be asked regularly about the anticipated changes in the business cycle and the expected changes in output, employment, investment. This method could be extended to estimates on the actual changes of these indicators (as well as to some other questions of strategic importance). Since most probably the systematic calculation of production index numbers and different deflators by industrial branches will take some time, this simplified method (of course with some margin of error) might help to surmount the temporary difficulties of lack of data.

Both the State Institute of Statistics and the Ministry of Industry and Technology are going to increase their activities on industrial analysis. These are proper intentions since both institutions have special skills in the field and special needs for such analysis. At the same time some

coordination of these efforts is advisable. While the State Institute of Statistics could be more engaged in analysis requiring a wide data basis, connected with computerized processing of the enterprises' report, - analyses of technical progress, factors of growth, specialization, foreign relations etc. where knowledge on engineering and the actual situation of the factories, experience in monitoring industrial development are indispensible, should be more the concern of the Ministry of Industry and Technology. In the Industrial Department of the Ministry first of all the IRI Section, Sectoral Studies and the Information Unit are or could be prepared for such activities, with regard to their special field all Sections should be encouraged - and assisted by the Data Bank, the Information Unit and some training activities.

The situation of an economy at a given time, its development during the past period, the growth rate characteristic thereof and the structural changes can all be properly evaluated only on the basis of international comparisons. With respect to design and shape future development, the study of the situation, the structure, past records and projections of the more advanced countries seems to be similarly important. Naturally, national plans cannot be outlined merely on basis of international analogies. Planning consists, essentially, of finding where and how the country should deviate from general development trends due to the special endowments, environment. Nevertheless, international comparisons and analogies render significant contributions to adequate evaluation and planning of industrial development, and therefore, more actions are recommended in this direction.

First, rates of growth may be compared where the differences in methods of national statistics can generally be neglected. Secondly, comparisons of thepattern of the economy and the industry are suggested. The use of data in physical units is to be preferred but is rather limited. Though value indicators, as e.g. value added by branches characterizing the sectoral pattern of the industry, are influenced also by the relative prices different in the various countries they still can be compared and evaluated. Then, comparisons on the relative level of output, productivity, investment etc.

are suggested which usually require more sophisticated techniques. Experience of research institutes as well as of international organizations engaged in such activities (as e.g. ECE) can be of great help for starting this type of analyses.

As for the topics of analyses and studies, beside the usual general evaluation of industrial development, at least three overall themes, and sectoral studies might be recommended. The overall themes are as follows: concentration of the industry, sectoral pattern of the industry, factors of industrial growth.

The analysis of the concentration of the industry can be based partly on Table 1 of the branch files (See Annex III) with data by establishment size-classes, partly on the calculation of the shares of the 3 and 5 largest firms of the branches and on relative productivity, capital intensity and other indicators by size-classes. Also, comparative international data are available on a number of countries.

The sectoral pattern of the industry can be investigated first of all by the shares of branches in gross output, value added, employment, capital, investment, foreign trade etc. at different point of time. Then rates of growth and changes in pattern may be compared. Again, a number of studies with international comparisons (including UN studies) are available. These can serve as basis for evaluating the specific features of the Turkish industry against the "normal pattern" (corresponding to a given level of per capita GDP and size of population). Finally, analysis of the prospects and optimalization of the sectoral pattern of the Turkish industry may be initiated.

The growth factors studies may attempt to identify - qualitatively and quantitatively - the major factor contributions to the development of the Turkish industry. First, the role of increase in employment and labour productivity, in capital, capital intensity, total factor input and total factor productivity should be analyzed. Then the contributions of the different branches, of the changes in the pattern of the industry and of the economies of scale could be investigated. Finally, use of more sophisticated

econometrical methods and international comparisons are suggested.

The sectoral studies may cover the topics and use the methods suggested above but more attention should be paid in these cases to the analysis of market and demand as well as of level and progress of technology, - both not only in a national but also in international context.

ANNEX I

ORGANIZATIONAL UNITS AND MAIN ACTIVITIES OF THE INDUSTRIAL DEPARTMENT

vision, Section	Main activities at the present time Related to current work / Future - oriented
Enterprises and Foreign Trade	
11. Enterprises	- Surveying industrial development, advice coordination
12. Industrial Registration and Inventory (IRI)	- Registration of firms - Collecting, revising and processing of the firms' annual reports (SIS takes over). - Preparing files on the firms' data by localities
13. Foreign Trade	- Controlling imports (quotas, permits, customs exemptions) - Export of (some) industrial products
14. Industrial Products	- Import permits - Suggestions for developing domestic production
15. Iron and Steel	— Import permits - Research and studies on developing technology and production
16. Common Market	- Representation of the Ministry in, drafting reports for negotiations
Sectoral Development	
21. Automotive Industry	- Fostering import substitution (targets, regulations, control of implementation) - Development of the automotive industry
22. Foreign Relations	- Licence and know-how agreements
23. Sectoral Studies (to be developed)	- Studies of the current situation and development prospects of sectors, primarily those dealt with by Sections 21 and 22
24. State Economic Enterprises	- Supervision, advice, coordination
Finance and Administration (of the Department)	

ANNEX II

STANDARDIZED FORMS OF REPORTS FOR THE SECTIONS OF THE INDUSTRIAL DEPARTMENT

Form No. 1	Report on Registrations
Form No. 2	Report on Import Quotas and Permits
Form No. 3	Report on Import Permits on List 2
Form No. 4	Report on Import Applications
Form No. 5	Annual Development of Sectors
Form No. 6	Comparative Data of the Firms of the Sector
Form No. 7	Report on Licence and Know-how Agreements
Form No. 8	Annual Report on Licence and Know-how Agreements
Form No. 9	Production of the SEE's
Form No. 10	Report on the Investment of the SEE's
Form No.R/ 2	Registration of Import Quotas and Permits
Form No.R/ 3	Registration of Import Permits on List 2

Form No. 1

Section: IRI

Report on Registrations in the Year 1973

Sector	Number of firms				From the new registrations, firms				
	Registered at the beginning of the Year	Newly registered in 1973	Cancelled in 1973	Registered at the end of the Year	in Ankara	in Istanbul	in Izmir	with employees more than 50	with employees more than 200
Total									

Form No. 2

Section: Report on Import Quotas and Permits Period: 1974 ..... Quarter

Code No.	Name of the Quota	Unit	The amount of the Quota				The amount given			Percentage use of the share 1974	
			1973	1974	Proportional Share 1974		1973	in the period reported	from the beginning of the year	in the period reported	From the beginning of the year
					For the period reported	From the beginning of the year					
	T o t a l	1 000 $									

On Quarter IV (and the total year) all products, on Quarters I, II and III only those should be listed, where the difference between the proportional share of the quota and the amount given (either in the period reported or from the beginning of the year) exceeds 20 per cent.

Form No.3

Section:

Report on Import Permits on List 2

Period: 1974 ..... Quarter

Code No.	Name of the Product	Unit	1973	1974		Percentage use of the amount given in 1973	
				The period reported	From the beginning of the year	In the period reported	From the beginning of the year 1974
	T o t a l	1 000 $					

On Quarter II (and the total year) all products, on Quarters I, II and III only those should be listed where the difference between the proportional share of the amount used in 1973 and the amount given (either in the period reported or from the beginning of the year) exceeds 20 per cent.

Form No. 4

Section: Industrial Products

Period: 1974 .....Quart

Report on Import Applications

Sector		Number of Applications		Expertise given	
		came in	went out	positive	negative
	A				
	B				
	A				
	B				
Total	A				
	B				
	C				

A = in the quarter reported; B = from the beginning of the year;
C = in the previous year.

Form No. 5

Section:

Annual Development of the Sector ..... Period: 1974

Name of the Firm	Gross Value of Output		Value added		Capital		Investment		Number of Employees		Salaries paid		Share of exports in sales (%)		Import content of the production (%)	
	1000 TL.	+/ %	1000 TL.	+/ %	mill. TL.	+/ %	mill. TL.	+/ %	Number	+/ %	1000 TL.	+/ %	1973	1974	1973	1974
Total																

+/ % of the previous year.

Form No.6

Section: Comparative Data of the Firms of the Sector ..... Period: 1974

Name of the Firm	Percentage share of the firm in					Value added/ Capital	Fixed assets/ Capital	Value added/ Employees	Workers/ Employees	Salaries/ Employees
	Gross Value of output	Value added	Capital	Investment	Number of employees	as percentage of the average ratio of the sector				

Report on License and Know-how Agreements

Period: 1974 .... Quarter

dress irm	Sector, Sub-Sector	Share of foreign capital (%)	Character of the agreement		The agreement concerns production		Period covered (years)	Cost of transfer (1000$)		Date of the Application		Date of approval
			new	exten-sion	on-going	to be developed		Initial	Annual	Came in	Went out	
d all ons	A											
	B											

e quarter reported; B = from the beginning of the year.

Form No.6

Section: **Comparative Data of the Firms of the Sector .....** Period: 1974

Name of the firm	Percentage share of the firm in					Value added/ Capital	Fixed assets/ Capital	Value added/ Employees	workers/ Employees	Salaries/ Employees
	Gross Value of output	Value added	Capital	Investment	Number of employees	as percentage of the average ratio of the sector				

Form No. 7

Section: Report on License and Know-how Agreements Period: 1974 .... Quarter

File No.	Name and address of the firm		Sector, Sub-Sector	Share of foreign capital (%)	Character of the agreement		The agreement concerns production		Period covered (years)	Cost of transfer (1000 $)		Date of the Application		Date of approval
					new	extension	on-going	to be developed		Initial	Annual	Came in	Went out	
	Number and amount of all applications	A												
		B												

A = in the quarter reported; B = from the beginning of the year.

Form No.8

Section:

Period: 1974

Annual Report on License and Know-how Agreements

	Sector...	Sector...	Sector...	Sector...	T o t a l
Number of applications coming in went out approved					
Number of applications when the share of foreign capital was: 0 1 - 25 26 - 49 50 -					
Number of applications concerning - on-going production - production to be developed					
New agreement applications Agreement extension applications					
Applications by period covered 3 years 4 - 5 " 6 - 10 " 11 - "					
Costs of transfer according to the agreements (1000$) a) Know-how - initial - annual b) Royalty - initial - annual					

Form No.9
Section: SEE

Production of the SEE's

Period: 1974.....Quarter

Enterprise, product	Unit	Production			Stocks at the end the end	Sales in the	Production	
		in the previous year	in the quarter reported	from the beginning of the year	quarter reported		in the quarter reported	from the beginning of the year
							in % of the production of the previous year	

Form No. 10

Section: SEE

Report on the Investments of the SEE's

Period: 1974 ..... Quarter

Enterprise, project	Planned		Planned costs (mil.TL.) for 1974	Actual expenditures (mil.TL.)		Actual expenditures in % of total planned costs	
	date of implementation	costs (mil.TL.)		in the quarter reported	from the beginning of the year	in 1974	total
Total							

Form No. R/2

Section: Registration of Import Quotas and Permits Year: 1974

Code No.	Name of the Quota	Unit	The Amount of the Quota					The Amount given 1974							
			1973	1974	Proportional Share			1973	I.Q.	II.Q.	III.Q.	IV.Q.	I+II.Q.	I+II+III Q.	Total Year
					I.Q.	I+II.Q.	I+II+III.Q.								
Total		1000 $													

Form No.R/3

Section: Registration of Import Permits on List 2 Year: 1974

Code No.	Name of the Product	Unit	1973	Quarters of 1974				From the beginning of 1974		
				I.	II.	III.	IV.	I + II	I+II+III	Total Year
		$								
		$								
		t								
		$								
T o t a l		1000 $								

ANNEX III

Basic Elements of the Data Bank

Table 1 Number of establishments, persons employed and value added by establishment-sizes.

Table 2 Output and factors of production.

Table 3 Public and private enterprises.

Table 4 Regional data.

Table 5 Index numbers of sectoral development.

Table 6 Data on major products.

Table 7 Data on major enterprises.

Table 1

Sector:

Number of establishments, persons employed and value added by establishment-sizes

Year	Number of Establishments					Number of persons employed (in thousands) in establishments					Value added of establishments (in million TL.)				
	with employees				Total	with employees				Total	with employees				Total
	-50	51-200	201-1000	1001-		-50	51-200	201-1000	1001-		-50	51-200	201-1000	1001-	

Sector:

Table 2.

Output and factors of production

Year	Gross Value of Output (mil.TL)	Value added (mil.TL)	Materials used (mil.TL)	Electricity used (mil.TL)	Capital (mil.TL.)			Investment (mil.TL.)		Number of persons employed			Wages and Salaries
					Fixed assets	Working capital	Total	Buildings	Machinery and Others	Workers		Total	
										Male	Female		

Sector:

Table 3.

Public and Private Enterprises

Year	Value added (mil.TL)		Persons employed (1000's)		Capital (mil.TL)		Investment (mil.TL)		% share of public enterprises			
	Public	Private	Public	Private	Public	Private	Public	Private	Value added	Persons empl.	Capital	Invest-ment

Sectors

Table 4

Regional Data

Year	Locality	Value added		Persons employed		Capital		Investment	
		mil.TL.	%	number	%	mil.TL.	%	mil.TL.	%
	Ankara								
	Istanbul								
	Izmir								
	Others								
	Ankara								
	Istanbul								
	Izmir								
	Others								

Sector:

Table 5

Index numbers of sectoral development

Year	Production	Persons employed		Wages and Salaries	Capital (at constant prices)			Electricity used	Production/ persons employed	Production/ fixed assets	Production/ Capital	Production/ Electricity used
		Worker	Total		Machinery	Fixed Assets	Total					

Product: 1

Table 6

Data on major products

Year	Unit	Production		Import		Domestic Use	Stock at the end of the year	Export	
		Public Enterprises	Total	from EEC countries	Total			to EEC countries	Total

Name of the enterprise:
Address:
Year of foundation:

Table 7

Data on major enterprises

Year	Gross Value of Output (mil.TL)	Value added (mil.TL)	Materials used (mil.TL)	Electricity used (mil.TL)	Capital (mil.TL)			Investment (mil.TL)		Numbers of persons employed			Wages and Salaries
					Fixed Assets	Working Capital	Total	Buildings	Machinery and Others	Workers			
										Male	Female	Total	

APPENDIX I

Production Planning System

The following refers to a production planning system. It should not, however, be regarded as a recommendation for immediate implementation by the Ministry. Rather this or a similar system may be considered for eventual implementation following progress along the lines recommended in the body of this report.

The Production Planning System should be run by the planners of Production Section and new POMIS - Section which will be proposed in chapter 7. The system is divided in this report into four parts:

1) estimation of regional or provincial demands
2) allocation of production targets for plants
3) plan monthly targets for imports and usage of the most important raw materials or products like iron and steel
4) study the capacity requirements for following years

Tasks 1 and 2 would be preformed once a year, for example in September. The yearly production targets would be delivered to firms, which make monthly production plans based on yearly targets of Ministry and send to Production Section. Subsequently, task three could be performed and task four at some later date in the spring. The demand of final or consumer products in the whole country should be equal to that in the plans of SPO. Its regional distribution can be calculated using statistical estimates of the distributions of previous year. The regional demand of semi-finished products and raw materials depends on the regional allocation of production of final consumer products. The allocation of production targets for plants or firms can be made manually or by a linear programming model. The idea is that we use those plants and firms whose production and transportation costs are smallest, taking into account the regional distribution of demand, import and export targets of SPO and capacity constraints of plants. It can be defined as the minimum amount of production for plants of undeveloped provinces in order to maintain a sufficient level of employment.

The planners should know how much semi-finished products and raw materials are needed in an average plant in order to produce a unit of final product. Using these co-efficients and regional allocation of final products found above, the planners can calculate by computer the regional demand of semi-finished products and raw materials. Import and export targets are sought once again from the plans of SPO. Then, the production of semi-finished products and raw materials in plants can be planned using linear programming as mentioned in connection with production planning of final products above.

After receiving their yearly production targets of final, semi-finished products and raw materials from Production Section the firms may set their monthly production targets using the data for previous years. They send these monthly plans to the Production Section using uniform reports. These reports also contain data about capacity and production costs which are needed in planning. The firms may also comment, if it is impossible that the yearly targets can be reached.

Planners of the Ministry may make some adjustments to the allocation of production according to these notes. These plans of firms should be checked and then reports calculated for monthly requirements of

- imports
- iron and steel
- fuels
- energy
- other critical resources and
- raw materials.

The Ministry receives by these reports early indications of future troubles. On this basis they may plan how these requirements can be satisfied most economically.

Through to the five year plan of SPO, the Ministry knows future production requirements. It is useful to study when and where the new production capacity will be needed. This can be estimated in the same way as the yearly production targets of the firms, which are described above.

There are estimated regional demands of products, taking into account export and import targets. By using an allocation model, capacities can be studied to determined th necessary levels and location in order to satisfy the demand as cheaply as possible. This study can be carried out for one or more periods in the future. It helps to locate requirements of investments in the industry and tells where and when the demand of products and raw materials created by these investments will exist. These investments may be realized by private or public sectors. It is useful also to private firms to know the official estimates of future need of investments in production.

Production Controlling System

If every firm produces as much as they have promised then the whole national economy would reach the targets of SPO and no more control is needed. But for many reasons the firms are not able to realize their targets, so they should inform the Government as early as possible about delays and other deviations. They should send to the Production Section:

- change announcements concerning their monthly plans or
- regular reports on how much they have produced and other data defined in the pr duction report.

Change announcements should be made only if the changes are very large compared with the plans. In these cases the production plan should be revised. Corresponding changes would be made in the files of Data Bank. Realised production reports should be made approximately four times a year including data from the last three months.

Using these data, planners could make monitoring lists by computer of production for all products and raw materials which are taken into this monitoring system. These monitoring lists consist of the following data

- monthly production of two previous years
- monthly production plan of this year
- realized monthly production from the beginning of this year
- realized monthly sales, purchased and own consumption from the beginning of this year.

All these data are gradually introduced into the plans and realized production reports and saved in the files of computer or Data Bank.

Monitoring reports are conducted quarterly by summing up the data of monitoring lists. The reports concern every finished product, semi-finished product and raw material which belong to this system. The data are

- the original monthly production plan
- the plan after changes
- the realized production from the beginning of this year
- estimates for the future monthly production to the end of the year
- the yearly production target of SPO and the estimate of its realization.

The estimates for future monthly production can be based on the previous year production and production in the first parts of the current year. This kind of report would also include important exports, information needed by SPO and the Ministry.

Planning and Control Reports of Firms

Previously it was mentioned that firms should make an annual production planning report and a quarterly report of realised production. The contents of these reports are divided into three parts:

- capacity sheets
- production sheets
- raw materials, fuels and energy sheets.

Data for the capacity sheet is yearly concerning five years ahead. In all other sheets monthly data concerning activities only next year is requested. The energy section of that sheet may be deleted because its information concerns the Ministry of Energy and Natural Resources. However, it is more practical if the Ministry of Industry collects this data and sends the appropriate reports to the Ministry of Energy and Natural Resources.

The capacity sheet consists of the following data about each product for the next five years:

- upper bound of production
- lower bound of production
- production costs per unit.

The upper bound of production tells what the maximum capacity will be in the future. The lower bound of production is the firm's estimate of the minimal level of activity to avoid bankruptcy. Production costs include the costs of raw materials, machines, electricity and wages of production workers. Data in this sheet are needed by planners in the Ministry for their allocation model.

Production sheet consists of the following monthly estimates about each product:

- stock in the beginning of the month
- production
- deliveries
    - own usage
    - domestic sales
    - exports and finally
- stock at the end of the next year.

The raw materials, fuels and energy sheet includes:

- stock in the beginning of the month
- supplements of the sotck
    - own production
    - domestic purchases
    - imports

- own consumption and finally
- stock at the end of the next year.

The report of realized production has two parts:

- the production sheet and
- the raw materials, fuels and energy sheet.

Data concerns only realized figures from their last morths corresponding to the planning phase. It is useful that the plants and firms make these kinds of budgets and their control reports for their own management. It is a small extra job to send similar report to the Ministry of Industry. Planning by the Ministry based on this data would eliminate bottle-necks of production and increase effectiveness.

Allocation Model

The purpose of the Allocation Model is to assist in production planning. Its optimal solution would deal with each product separately. Production and transportation costs can be minimized, taking into account distribution of demand, targets for exports and imports, and plant capacity.

If required, the plans made by planners may differ from the optimal solution, but then it is easy to calculate the cost of the difference and judge its cost-benefit ratio. The solution of Allocation Model concerning a product includes

- amount of production in each plant
- amount of imports or exports in each harbour
- transportation plans from
    - plants to provinces and harbours
    - harbours to provinces
- costs of production and transportation.

From this data planned production is the most important information required. It indicates how production targets established by SPO for the whole country should be allocated for plants and firms. For this reason the model is referred to as an Allocation Model. The transportation plan found is a secondary result of the model. It is not used in the planning system but we cannot allocate production targets without calculating it. Another important result involves the shadow-prices of production bounds of the plants. Where the shadow-prices against upper bounds are high, the capacity of the plant should be increased and if they are close to the lower bounds of production then these bounds should be deleted if possible.

The Allocation Model needs the following input data:

- demand in each province
- targets of imports or exports
- upper and lower bounds of production in plants
- production costs in plants per unit
- transportation costs between plants, centres of provinces and harbours
- stevedoring costs in harbours.

The method for estimating demand has already been described. Import and export targets are received from SPO and upper and lower bounds are set from the firms' capacity sheets as are production costs. Transportation and stevedoring costs should be estimated by the planners in the Ministry. This is a transportation type of linear programming model. It can be solved by general purpose linear programming code or a fast special alorithm can be devised for this problem.

The new computer of the Middle East Technical University will be suitable for solving this model. It is advisable to make a programme consisting of

- an input programme (Fortran)
- a solution programme (Simplex code)
- an output programme (Fortran)

by which allocation problems of all important products can be solved in turn without any extra programming.

Sometimes, the optimal solution of the model cannot be found. The reason might be that the firms have proposed lower bounds of production which are too high in order to receive enough work. The planners may then study the shadow-prices of lower bounds and delete those bounds which are highest. Then optimal solution may be reached.

Operations Research Projects of the Groups of Industry

The former allocation model was designed to be as simple as possible so that the data requirements will be small and solution time short. The most important simplification was that models of different products have been separated from each other. Therefore, the results of the Allocation Model may be too optimistic. There are many constraints in plant capacities and supplements of semi-finished products and raw materials, which are not taken into account. The planners should know industrial firms, so well that they can correct constraints of the Model and solve it again if the proposals are unrealistic. The above explanation is one reason for development of mathematical models for groups of industry. Other reasons are that the proposals found by operations research models will be valuable:

- in advising the management of firms how they should run their plants in order to be efficient
- in designing rationalization of plants by showing which factories are profitable and which not
- in seeking the most economical product mix of the plants, and
- in planning investments of the groups of industry.

The models of each industry group will be unique. Individual models should be developed for textiles, iron and steel, petroleum refining, mining etc. These should be built into a programme package consisting of:

- an input programme
- a linear programming solution algorithem
- an output programme

which can be used repeatedly in different kinds of operations research and planning problems of industry.

A detailed description of these models cannot be given because they differ from each other (one example is included). But the main result of their optimal solution should consist of, for example, the following yearly data:

- sales of final and semi-finished products
- their stocks and production amounts
- requirements of raw materials
- the usage hours of different factories
- free capacities of factories, and
- total production costs.

In investment planning, a model is defined, according to each main investment alternative concerning the size and location of a new factory. Then the models are solved and the most economical alternative is selected (where the production costs estimated by the model and annuity of investment costs summed up are smallest). In these linear programming models of the industry groups are needed e.g. the following type of input data:

- forecasts of sales concerning every product
- production costs per unit in every factory
- transportation costs
- prices of products and raw materials
- need of raw materials to produce one unit of final product
- velocities of production in factories
- number of working hours in factories, and
- bounds in supply of raw materials.

The objective function which should be maximised consists of the value of sales less the costs of production, transportation and raw materials.

Data requirements are large and therefore working committees should be established, including planners or operations researchers and industry representatives. The representatives of firms are the main source of input information and they may later on advise their own company on how to develop a model for their firm.

APPENDIX II

Mathematical Description of Allocation Model

This allocation model concerns import, export, production and sales of only one product in turns taking into account all significant plants, harbours and consumption areas in Turkey.

1. Indexes

i = plant or factory ($i = 1,\ldots,I$)

j = harbour ($j = 1,\ldots,J$)

n = consumption area or province ($n = 1,\ldots,N$)

2. Decision Variables

x_i = production and delivery from stock in plant i

u_j = imports into harbour j

v_j = exports through harbour j

y_{ij} = transportation from plant i to harbour j

y_{in} = transportation from plant i to province n

y_{jn} = transportation from harbour j to province n

z = total costs

3. Input Data

d_n = demand of product in province n

$\underline{b}_i, \overline{b}_i$ = lower and upper limits of production capacity and stocks in plant i

a = target volume of imports

e = target volume of exports

f_i = production costs in plant i

g_j = import costs in harbour j

h_j = export costs in harbour j

c_{ij} = transportation costs from plant i to harbour j

c_{in} = transportation costs from plant i to province n

c_{jn} = transportation costs from harbour j to province n

Comment: The following inequatives should be satisfied in this model:

$$\sum_{i=1}^{I} b_i \leq \sum_{n=1}^{N} d_n + e - a \leq \sum_{i=1}^{N} \bar{b}_i$$

4. Formula of Allocation Model

4.1. Objective function to be minimized

$$\min z = \sum_{i=1}^{I} f_i x_i + \sum_{j=1}^{J} g_j u_j + \sum_{j=1}^{J} h_j v_j + \sum_{i=1}^{I} \sum_{j=1}^{J} c_{ij} y_{ij}$$

$$\sum_{i=1}^{I} \sum_{n=1}^{N} c_{in} y_{in} + \sum_{j=1}^{J} \sum_{n=1}^{N} c_{jn} y_{jn}$$

4.2. Demand equations

$$\sum_{i=1}^{I} y_{in} + \sum_{j=1}^{N} y_{jn} = d_n \qquad ,n = 1,\ldots,N$$

4.3. Export equations

$$\sum_{i=1}^{I} y_{ij} = v_j, \; j = 1,\ldots,J \text{ and}$$

$$\sum_{j=1}^{J} v_j = e$$

4.4. Import equations

$$\sum_{n=1}^{N} y_{jn} = u_j \; , \; j = 1,\ldots,J \text{ and}$$

$$\sum_{j=1}^{J} u_j = a$$

4.5. Production and stock equations

$$\sum_{j=1}^{J} y_{ij} + \sum_{n=1}^{N} y_{in} = x_i, \quad i = 1,\ldots, I$$

4.6. Capacity and stock bounds

$$a_i \leq x_i \leq b_i \quad , i = 1,\ldots I$$

4.7. Solving the model

The model is easily solvable by the new machine of M.E.T.U. if the following total $I + 2J + N \leq 1000$.

APPENDIX III

Iron Mining Model

1. Indexes

i = sources or mines $(i = 1,\ldots, I)$ $(I = 17)$
j = factories $(j = 1,\ldots, J)$ $(J = 3)$
n = impurities $(n = 1,\ldots, N)$ $(N = 11)$

2. Decision variables

x_{ij} = transportation amount of iron ore (≥ 0)

y_i = amount of mining of iron ore (≥ 0)

z_j = production of pure iron (≥ 0)

w_{nj} = permitted amount of impurities (≤ 0)

u = value added of iron production

3. Input data

d_j = maximum production capacity of iron (t)

s_i = supplies of iron ores (t)

c_{ij} = transportation costs of iron ores (TL/t)

a_i = contents of iron in iron ores (% per 100)

b_{in} = contents of impurities in iron ores (% per 100)

e_n = upper limit of impurities compared with production of iron (% per 100)

f_j = net selling prices of iron (TL/t) and

q_i = mining costs (TL/t)

4. Formula

4.1. Objective function

$$\max u = \sum_{j=1}^{J} p_j z_j = \sum_{i=1}^{I} \sum_{j=1}^{J} c_{ij} x_{ij} - \sum_{i=1}^{I} q_i y_i$$

4.2. Equations of sources

$$\sum_{j=1}^{J} x_{ij} - y_i \quad , \quad i = 1,\ldots, I$$

4.3. Equations of factories

4.3.1. Amount of Iron

$$\sum_{i=1}^{I} a_i \, x_{ij} = z_j \quad , \quad j = 1,\ldots, J$$

4.3.2. Amount of permitted impurities

$$a_n \, z_j - \sum_{i=1}^{I} b_{in} \, x_{ij} = w_{nj} \quad , \quad \begin{matrix} j = 1,\ldots, J \\ n = 1,\ldots, N \end{matrix}$$

4.4. Bounds

4.4.1. Bounds of sources

$$y_i \leq s_i \quad , \quad i = 1,\ldots, I$$

4.4.2. Bounds of factories

$$z_j = d_j \quad , \quad j = 1,\ldots, J$$

5. Acknowledgement:

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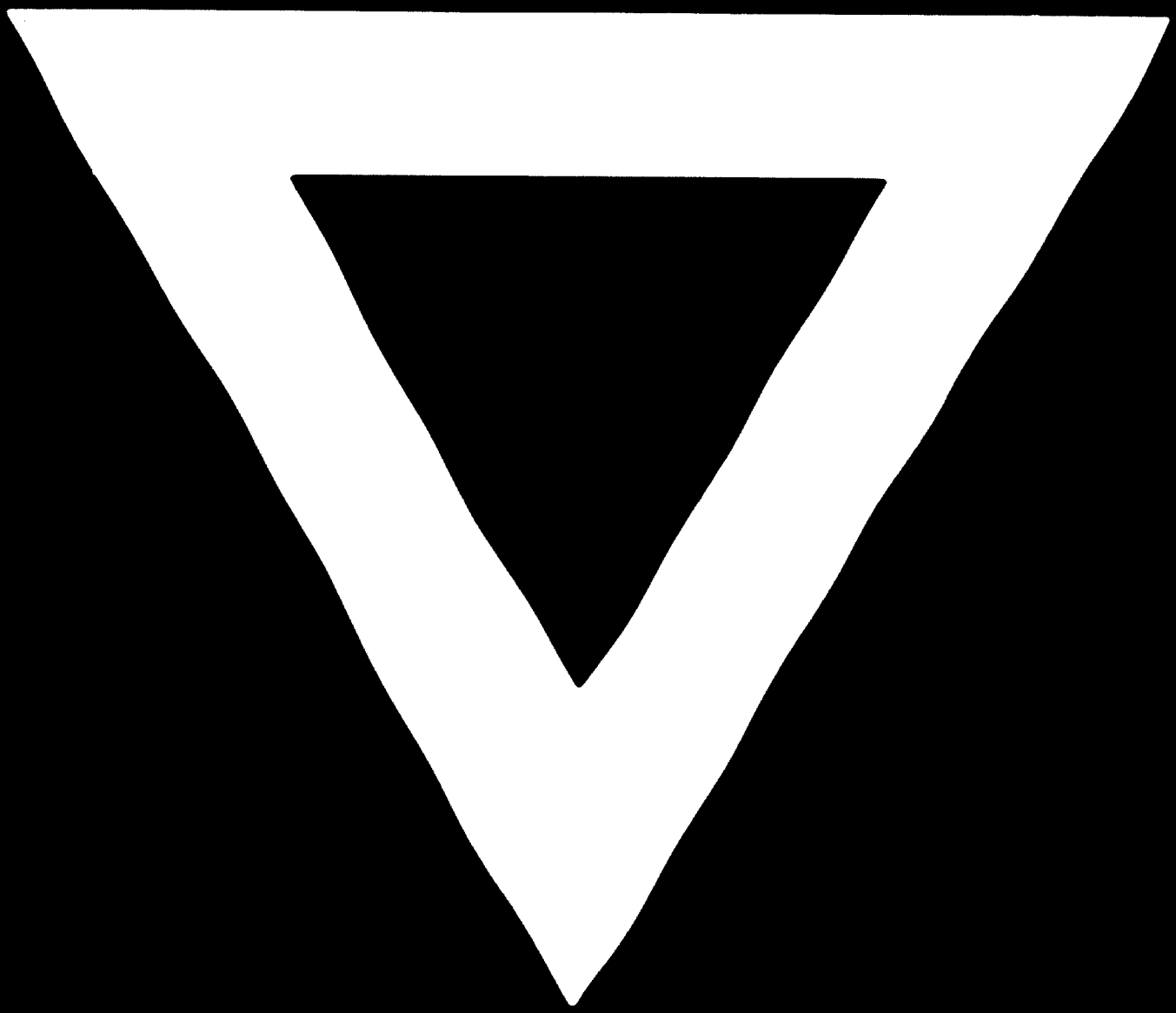
[redacted]



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