OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

16352

Distr.
LIMITED

PPD.39
3 July 1987

ENGLISH

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

PERSONNEL REQUIREMENTS IN IRON AND STEEL: TESTING A METHODOLOGY FOR DETERMINING MANPOWER NEEDS

Sectoral Working Paper Series

No. 57

SECTORAL STUDIES BRANCH
STUDIES AND RESEARCH DIVISION

V.87-87263

SECTORAL WORKING PAPERS

In the course of the work on major sectoral studies carried out by UNIDO, Studies and Research Division, several working papers are produced by the secretariat and by outside experts. Selected papers that are believed to be of interest to a wider audience are presented in the Sectoral Working Papers series. These papers are more exploratory and tentative than the sectoral studies. They are therefore subject to revision and modification before being incorporated into the sectoral studies.

Preface

This study presents the results of a test of a method for determining manpower requirements for two different types of metallurgical enterprises, viz. integrated iron and steel works and mini-steel mill. The method has been elaborated and the testing done by Professor V.A. Romenets, Dr. N.I. Perlov and Dr. L.V. Kovalenko of the Union of Soviet Socialist Republics as consultants to UNIDO.

The methodology has been described in detail in the following UNIDO publications: "Manpower and training requirements in industry: a methodology with an application to the iron and steel sector", Sectoral Working Paper Series No. 32, UNIDO/IS.544, 24 September 1984 and "Personnel and training needs in iron and steel", Sectoral Studies Series No.23, UNIDO/IS.621, 27 March 1986.

The terms "total input", "total labour requirements" and "direct labour requirements" in this study replace the terms "complex or total expenditure", "complex or total labour expenditure" and "direct labour expenditure", respectively, which were used in the two basic studies mentioned above.

CONTENTS

TABLES

TABLES

1. INTRODUCTION

The aim of this study is to demonstrate in an application to the iron and steel industry, how the methodology for determining personnel needs described in several UNIDO publications could serve as a useful and rather simple tool for manpower planning in developing countries at a sectoral level. The methodology was elaborated directly for the use in the iron and steel sector, but could also be applied to other industrial sectors.

In order to show the broad possibilities of the methodology in question it has been applied for determining manpower requirements of various types of metallurgical enterprises. Operational works of the Tata Iron and Steel Company Limited (TISCO) in Jamshedur, India, and of the Zimbabwe Iron and Steel Company Limited (ZISCO) in Redcliff, Zimbabwe, were selected as examples of integrated iron and steel works. A steel works which was recently designed for the Mongolian People's Republic was chosen as an example of a mini-steel plant.

The procedure of determining personnel requirements needed for establishing and/or functioning of a metallurgical enterprise in accordence with the methodology in question includes the following main stages:

(a) Determining the total input of raw material, energy and semi-finished products required for the production of one ton of intermediate and final metallurgical products. This is done with the help of a modified input/output technique developed and described in the studies referred to in the preface.

(b) Computing the total labour requirements per ton to product. To compute this amount, the total input of raw material, materials, energy and semi-finished products are multiplied by coefficients of direct labour requirements.[1/]

(c) Computing total personnel requirements. This is done by multiplying the values of total labour requirements per ton of products by the output of final products. The values obtained are then divided by the annual working hours per person (2,000 hours) in order to calculate the number of persons required;

(d) Estimating an occupational staffing structure and dividing the required personnel into occupational categories such as engineers, technicians, clerical staff and workers of different skills (highly skilled, skilled, semi-

---

1/ The following coefficients of direct labour requirements in manhours per ton, thousand cu.m. Gigacal or thousand Kwh respectively, were used in the study: coking-coal mining 1,8; coke and by-product 1,9; fuel 0,285-0,269; outside electric energy 1,555; thermal energy 0,136; oxygen 0,322; blast furnace blast 0,198; iron ore 1,1; sinter 0,565; pellets 0.5; prereduced pellets 2,0; iron 0,759; open-hearth (OH) steel 3,5; basic oxygen furnace (BOF) steel 1,6; electric arc furnace (EAF) steel 2,7; heavy-section rolled products 2,6-3,1; medium-section rolled products 2,5; light-section rolled products 2,45; plates 3,9; sheets 2,1; cold-rolled sheets 8,2; section-structural alloyed steel 8,0; scrap preparation 0,7; refractories 5,1; lime 1,05. (Based on experience from developing countries; see UNIDO/IS.544, page 9, for further explanation.)

and unskilled). This estimate is usually based on percentage proportions of different occupational categories based on staffing patterns from plants in developing countries.

Calculations carried out in accordance with this scheme have permitted the determination of manpower requirements for all the studied metallurgical enterprises.

As a result of these calculations the following information on manpower requirements was obtained:

(a) The total number of employees needed for functioning the enterprises;

(b) Data on the requirements of the enterprises for employees of different occupational categories; and

(c) Data on the needs of the enterprises for workers of different skills.

Analysis of the results of the estimations of manpower requirements made in this study and a comparison with an empirical information on the same enterprises proved that the methodology in question could be used for a reliable determination of manpower needs.

2. DETERMINING MANPOWER REQUIREMENTS FOR THE WORKS OF THE TATA IRON AND STEEL COMPANY LIMITED IN JAMSHEDPUR

The integrated iron and steel works of the Tata Iron and Steel Company Limited in Jamshedpur is now being modernized with the view to widen the range of rolled products, to renew production units (equipment) and to improve their efficiency. At present the works have the following annual production capacities: pig iron 2,000,000 tons; raw steel 2,160,000 tons and rolled products 1,740,000 tons.

The modernization programme consists of two phases. Phase 1, which has been basically completed, envisaged the replacement of the old Duplex open-hearth furnace by the modern basic-oxygen furnaces of a 1.1 million tons annual steel capacity with continuous casting and vacuum-arc degassing facilities, the commission of oxygen plants, lime and dolomite kilns.

Phase 2 of the modernization envisages the renovation of some facilities for finishing the products, the strengthening of the infrastructural facilities used for electric power generation, the improvement of blast-furnace operation efficiency, the modernization and expansion of the capacities for the increase of output of finished rolled products by 400,000 tons.

After the completion of phase 2 of the modernization the annual output (or at least the annual capacity) of finished rolled products of the Jamshedpur works will reach the level of 2,140,000 tons. This level was accepted as a basis for determining manpower requirements of this works. It was assumed that this annual output would comprise 650,000 tons of heavy-section rolled products and billets, 100,000 tons of medium-section rolled products, 300,000 tons of light-section rolled products, 150,000 tons of plates, 200,000 tons of sheets, 140,000 tons of cold-rolled sheets, 600,000 tons of section-structural alloyed steel. It was also accepted that 500,000 tons of heavy-section rolled products, 100,000 tons of medium-section rolled products and 300,000 tons of light-section rolled products would be produced in blooming and slabbing mills from ingots of OH steel; 150,000 tons of plates, 200,000 tons of sheets and 140,000 tons of cold-rolled sheets would be produced from BOF steel; 300,000 tons of section-structural alloyed BOF steel on the basis of sponge iron and 300,000 tons of section-structural alloyed EAF steel would be produced with the use of continuous casting.

Table 1 contains the values of total input of raw material, energy and semi-finished products required for the production of one ton of intermediate and final products in Jamshedpur works of TISCO. To determine these values, the data on the present actual consumption of raw materials, material, fuel, energy, semi- and intermediate products in the works for manufacturing its products were used.

Table 2 presents the results of the determination of total labour requirements for the manufacture of nine different rolled products and of continuously-cast section-structural alloyed steels.

Table 1. Total input of raw material, energy and semi-finished products for manufacturing 1 ton of products in Jamshedpur works of TISCO

Input	Unit of measurement	Ingot cast steelmaking of:							Production of continuously-cast section structural alloyed steel	
		OH steel			BOF steel					
		Heavy-section rolled products	Medium-section rolled products	Light-section rolled products	Heavy-section rolled products	Plates	Sheets	Cold-rolled sheets	EAF steel on the basis of sponge iron	BOF steel
Coking coal	t	0.912	0.906	0.861	1.313	1.410	1.634	1.726	-	1.171
Coke and by-products	t	0.561	0.557	0.530	0.808	0.868	1.000	1.056	-	0.721
Outside electricity	thou.kWh	0.948	0.940	0.830	1.120	1.200	1.391	1.494	1.810	1.000
Thermal energy	G cal	0.450	0.438	0.381	0.532	0.571	0.657	0.705	0.277	0.475
Oxygen	thou.m^3	0.240	0.240	0.230	0.206	0.307	0.356	0.382	0.034	0.255
Blast-furnace blast	thou.of m^3	1.493	1.490	1.412	2.150	2.310	2.680	2.834	-	1.918
Iron ore	t	1.188	1.170	1.122	1.711	1.838	2.130	2.249	1.635	1.526
Sinter	t	0.488	0.480	0.462	0.665	0.714	0.825	0.871	-	0.593
Pellets	t	0.665	0.665	0.640	0.922	0.990	1.147	1.211	1.456	0.822
Prereduced pellets	t	-	-	-	-	-	-	-	1.120	-
Iron	t	0.696	0.697	0.662	0.982	1.055	1.223	1.291	-	0.876
OH steel	t	1.279	1.279	1.213	-	-	-	-	-	-
BOF steel	t	-	-	-	1.279	1.369	1.577	1.667	-	1.141
EAF steel	t	-	-	-	-	-	-	-	1.120	-
Heavy-section rolled products	t	1.000	-	-	1.000	-	-	-	-	-
Medium-section rolled products	t	-	1.000	-	-	-	-	-	-	-
Light-section rolled products	t	-	-	1.000	-	-	-	-	-	-
Plates	t	-	-	-	-	1.000	-	-	-	-
Sheets	t	-	-	-	-	-	1.000	1.000	-	-
Cold-rolled sheets	t	-	-	-	-	-	-	1.000	-	-
Section-structural alloyed steel	t	-	-	-	-	-	-	-	1.000	1.000
Scrap preparation	t	0.667	0.667	0.633	0.390	0.419	0.486	0.513	-	0.348
Refractories	t	0.040	0.040	0.040	0.025	0.027	0.031	0.033	0.070	0.022
Lime	t	0.200	0.200	0.200	0.150	0.160	0.185	0.196	0.123	0.133

Table 2. Total labour requirements for manufacturing different products in Jamshedpur works TISCO (man/hours per ton)

Production process	Ingot cast production of:							Production of continuously-cast section structural alloyed steel	
	OH steel			BOF steel					
	Heavy-section rolled products	Medium-section rolled products	Light-section rolled products	Heavy-section rolled products	Plates	Sheets	Cold-rolled sheets	EAF steel on the basis of sponge iron	BOF steel
Coking-coal mining	1.640	1.630	1.550	2.360	2.540	2.940	3.110	-	2.110
Coke and by-product process	1.066	0.058	1.007	1.374	1.649	1.900	2.006	-	1.370
Ore mining	1.307	1.287	1.234	1.782	2.022	2.343	2.474	1.799	1.679
Production of sinter	0.275	0.271	0.261	0.376	0.403	0.466	0.492	-	0.335
Production of pellets	0.333	0.328	0.320	0.461	0.495	0.574	0.606	0.728	0.411
Production of prereduced pellets	-	-	-	-	-	-	-	2.240	-
Blast-furnace ironmaking	0.536	0.536	0.509	0.755	0.811	0.940	0.993	-	0.674
OH steelmaking	4.477	4.477	4.246	-	-	-	-	-	-
BOF steelmaking	-	-	-	2.046	2.190	2.523	2.667	-	1.826
EAF steelmaking	-	-	-	-	-	-	-	3.024	-
Rolling	3.100	2.500	2.450	2.600	3.900	2.100	8.200	8.000	8.000
Scrap preparation	0.467	0.467	0.443	0.273	0.293	0.340	0.359	-	0.244
Production of refractories	0.204	0.204	0.204	0.127	0.138	0.158	0.168	0.357	0.112
Production of lime	0.210	0.210	0.210	0.158	0.168	0.194	0.206	0.129	0.140
Repair services	2.620	2.487	2.360	2.620	3.223	3.793	3.983	2.526	2.810
Energy facilities	2.318	2.299	2.079	2.817	3.062	3.502	3.752	3.069	2.514
Transport facilities	1.463	1.365	1.315	1.463	1.924	1.790	3.200	1.930	2.020
General works services	1.950	1.816	1.736	1.950	2.526	2.382	4.168	2.570	2.686
Total	21.965	20.935	19.924	21.262	25.344	25.945	36.384	26.372	26.931

The results of the computation of the number of persons required for manufacturing nine types of products in the works of TISCO in Jamshedpur are presented in table 3.

It follows from these data that after the completion of the modernization the Jamshedpur's works will need for manufacturing 2,140,000 tons of rolled products a year an industrial and production personnel comprising 26,156 people. The present works' staff, 30,182 people manufactures 1,740,000 tons of rolled products annually, i.e. 20 per cent less then the works will be able to manufacture after the modernization.

Table 4 contains the information on occupational structure of all categories of personnel for the Jamshedpur's works. The table shows that workers constitute the greatest part of the industrial and production personnel needed for functioning the Jamshedpur's works after its modernization - 21,880 people or 83.7 per cent, of a works' overall work force. The second place in occupational structure in quantitive terms belongs to engineers and technicians[2/] - 3,117 people or 12.1 per cent of total works' manpower requirements. Other occupational groupings take the intermediate position.

The data on occupational structure of requirements for workers are given in table 5. They indicate that the greatest number of working personnel needed are skilled workers. The works will require 12,645 workers of this category or 57.8 per cent of the total number of the workers needed. As far as other categories of workers are concerned, they will be required in the following quantitives: highly skilled 3,397 or 15.5 per cent; semi-skilled 2,127 or 9.7 per cent and unskilled 3,711 or 17.0 per cent.

2/ The following categories of specialists are included in this grouping: plant and department managers, section and shift supervisors, heads of services, managers and their deputies, general formen and foremen, controllers, steelmakers, rollers.

Table 3. Personnel requirements for the Jamshedpur works of TISCO (number of persons)

Production process	Ingot cast production of:							Production of continuously-cast section structural alloyed steel			
	OH steel			BOF steel							
	Heavy-section rolled products	Medium-section rolled products	Light-section rolled products	Heavy-section rolled products	Plates	Sheets	Cold-rolled sheets	EAF steel on the basis of sponge iron	BOF steel	sub-total	Percentage of total
Coking coal mining	410	82	233	177	191	294	218	-	317	1.922	7.3
Coke and by products process	267	57	151	103	124	190	140	-	205	1.233	4.7
Ore mining	326	64	185	141	152	234	173	267	252	1.794	6.8
Production of sinter	69	14	39	28	30	47	34	-	50	311	1.2
Production of pellets	83	16	48	35	37	57	42	109	62	489	1.9
Production of prereduced pellets	-	-	-	-	-	-	-	336	-	336	1.3
Blast-furnace ironmaking	134	27	76	57	61	94	70	-	101	620	2.4
OH steelmaking	1.119	224	637	-	-	-	-	-	-	1.980	7.6
BOF steelmaking	-	-	-	153	164	252	187	-	274	1.030	3.9
EAF steelmaking	-	-	-	-	-	-	-	454	-	454	1.7
Rolling	775	125	368	195	293	210	574	1.200	1.200	4.940	18.9
Scrap preparation	116	23	66	20	22	34	25	-	37	343	1.3
Production of refractories	51	10	31	9	10	16	12	54	17	210	0.8
Production of lime	53	10	33	12	13	19	14	19	21	194	0.7
Repair services	655	124	354	196	242	379	279	379	422	3.030	11.6
Energy facilities	579	115	310	211	230	350	263	460	377	2.895	11.1
Transport facilities	366	68	197	11	144	179	224	290	303	1.882	7.2
General works services	488	91	260	146	189	238	292	386	403	2.493	9.6
Total	5.491	1.046	2.988	1.594	1.902	2.593	2.547	3.954	4.041	26.156	100

Table 4. Occupational structure of personnel for the Jamshedpur works of TISCO

Production process	Total number of employees	Engineers and technicians	Percentage	Engineers	Percentage	Technicians	Percentage	Mechanics	Percentage	Electricians	Percentage	Clerical staff	Percentage	Workers	Percentage
Coking-coal mining and coke and by-products process	3.155	398	12.6	133	4.2	265	8.4	79	2.5	35	1.1	63	2.0	2.694	85.4
Ore mining and preparation for heat	2.594	200	7.7	65	2.5	135	5.2	36	1.4	29	1.1	54	2.1	2.340	90.2
Production of pre-reduced pellets	336	34	10.0	11	3.3	23	6.7	3	0.8	3	0.8	5	1.4	297	88.6
Blast-furnace ironmaking	620	62	10.0	21	3.4	41	6.6	5	0.8	5	0.8	9	1.4	549	88.6
OH steelmaking	1.980	158	8.0	59	3.0	99	5.0	14	0.7	14	0.7	24	1.2	1.798	90.8
BOF steelmaking	1.030	72	7.0	24	2.3	48	4.7	6	0.6	6	0.6	12	1.2	946	91.8
EAF steelmaking	454	45	10.0	15	3.3	30	6.7	4	1.0	4	1.0	6	1.2	403	88.8
Rolling	4.940	459	9.3	153	3.1	306	6.2	49	1.0	34	0.7	94	1.9	4.387	88.8
Scrap preparation	343	24	7.0	7	2.0	17	5.0	24	7.0	-	-	10	3.0	309	90.0
Production of refractories	210	15	7.0	6	3.0	9	4.0	1	0.6	1	0.5	5	2.4	190	90.6
Production of lime	194	13	7.0	6	3.0	7	4.0	1	0.6	1	0.5	5	2.4	176	90.6
Repair services	3.030	215	7.1	73	2.4	142	4.7	215	7.1	-	-	61	2.0	2.754	90.9
Energy facilities	2.895	579	20.0	191	6.6	368	13.4	-	-	203	7.0	58	2.0	2.258	78.0
Transport facilities	1.882	230	12.2	77	4.1	152	8.1	230	12.2	-	-	120	6.4	1.532	81.4
General works services	2.493	673	27.0	224	9.0	449	18.0	249	10.0	199	8.0	573	23.0	1.247	50.0
Total	26.156	3.177	12.1	1.065	4.1	2.112	8.0	916	3.5	534	2.0	1.099	4.2	21.880	83.7

Table 5. Occupational structure of workers for the Jamshedpur works

Production process	Total number of workers	Highly skilled		Skilled		Semi-skilled		Unskilled	
		Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
Coking-coal mining and coke and by-product process	2.694	401	14.9	1.447	53.7	380	14.1	466	17.3
Ore mining and preparation for heat	2.340	278	11.9	1.039	44.4	515	22.0	508	21.7
Production of prereduced pellets	297	45	15.0	163	55.0	30	10.0	59	20.0
Blast-furnace ironmaking	549	55	10.0	334	60.8	69	12.6	91	16.6
OH steelmaking	1.798	369	20.5	1.014	56.4	151	8.4	264	14.7
BOF steelmaking	946	194	20.5	534	56.4	79	8.4	139	14.7
EAF steelmaking	403	83	20.5	227	56.4	34	8.4	59	14.7
Rolling	4.387	671	15.3	2.720	62.0	426	9.7	570	13.0
Scrap preparation	309	18	5.8	222	71.9	18	5.8	51	16.5
Production of refractories	190	22	11.4	100	52.4	2	1.2	66	35.0
Production of lime	176	20	11.4	92	52.4	2	1.2	62	35.0
Repair services	2.754	226	8.2	2.085	75.7	30	1.1	413	15.0
Energy facilities	2.258	397	17.6	1.077	47.7	289	12.8	495	21.9
Transport facilities	1.532	306	20.0	843	55.0	77	5.0	306	20.0
General works services	1.247	312	25.0	748	60.0	25	2.0	162	13.0
Total	21.880	3.397	15.5	12.645	57.8	2.127	9.7	3.711	17.0

3. DETERMINING MANPOWER REQUIREMENTS FOR THE WORKS OF THE ZIMBABWE IRON AND STEEL COMPANY LIMITED

ZISCO's integrated iron and steel works produces both billets and finished rolled products by the classical technological route - coke producing - BF iron making - BOF steelmaking - rolling. The annual production capacities of the works are as follows: coke 582,000 tons; BF iron 871,000 tons; BOF steel 907,000 tons, including 870,000 tons of ingots and continuously casted billets; finished rolled products 747,000 tons, including 220,000 tons of continuous castings, 227,000 tons of heavy-section rolled products, 91,000 tons of medium-section rolled products and 209,000 tons of light-section rolled products.

The values of total input of raw material, energy and semi-finished products required for manufacturing one ton of products in the ZISCO works are presented in table 6. For the determination of these values the actual

Table 6. Total input of raw material, energy and semi-finished products for manufacturing 1 ton of products in the ZISCO works

Input	Unit of measurement	Production of:			
			With ingot casting		
		Continuously casted billets	Heavy-section rolled products	Medium-section rolled products	Light-section rolled products
Fuel	tce	1.316	1.445	1.419	1.414
incl. coke	t	0.592	0.651	0.638	0.636
Outside electricity	thou.kWh	0.830	0.913	0.895	0.892
Thermal energy	G.cal.	0.390	0.429	0.420	0.419
Oxygen	thou.m^3	0.250	0.275	0.270	0.269
Blast-furnace blast	thou.ef. m^3	1.800	1.960	1.940	1.930
Sinter	t	0.365	0.402	0.393	0.392
Iron	t	0.856	0.942	0.923	0.920
BOF steel	t	1.000	1.100	1.078	1.075
Heavy-section rolled products	t	-	1.000	-	-
Medium-section rolled products	t	-	-	1.000	-
Light-section rolled products	t	-	-	-	1.000
Scrap preparation	t	0.300	0.330	0.320	0.320
Refractories	t	0.021	0.022	0.022	0.022
Lime	t	0.100	0.110	0.108	0.107
Electric ferro-alloys	t	0.015	0.016	0.016	0.016

works' data on the consumption of coke, iron ore and sinter for producing iron and data on the consumption of iron for manufacturing continuously casted BOF steel were used. Other data necessary for the determination of the values of total expenditure, but not available, were derived from the actual data referred to above by multiplying them by coefficients reflecting the difference in consumption of steel for manufacturing rolled products from ingots and continuously casted billets.

Table 7 presents the results of the computation of total labour requirements for manufacturing continuously casted billets and three types of rolled products in the ZISCO works.

Table 7. Total labour requirements for manufacturing different products in ZISCO works (man-hours per ton)

Production process	Production of			
		With ingot casting		
	Continuously casted billets	Heavy-section rolled products	Medium-section rolled products	Light-section rolled products
Coke and by-product process	1.124	1.237	1.212	1.208
Production of sinter	0.206	0.227	0.222	0.221
Blast-furnace iron-making	0.658	0.724	0.710	0.707
BOF steelmaking	1.600	1.760	1.725	1.720
Rolling	-	3.100	2.900	2.850
Scrap preparation	0.210	0.230	0.220	0.220
Production of refractories	0.105	0.112	0.112	0.112
Production of lime	0.105	0.116	0.113	0.112
Repair services	1.955	2.150	2.040	2.046
Energy facilities	2.282	2.510	2.460	2.453
Transport facilities	1.200	1.320	1.294	1.290
General works services	1.600	1.760	1.725	1.720
Total	11.045	15.246	14.733	14.659

The data contained in table 7 made it possible to determine personnel requirements for the works. The results of this determination are presented in table 8. According to these results, the works needs for its normal functioning a workforce comprising 5,147 persons.

Table 8. Personnel requirements for the ZISCO works (number of persons)

Production process	Production of:					
	With ingot casting					
	Continuously cast billets	Heavy-section rolled products	Medium-section rolled products	Light-section rolled products	Sub-total	Percentage of total
Coke and by-products process	124	140	55	126	445	8.6
Production of sinter	23	26	10	23	82	1.6
Blast-furnace ironmaking	72	82	32	74	260	5.1
BOF steelmaking	176	200	78	180	634	12.3
Rolling	-	352	132	298	782	15.2
Scrap preparation	23	26	10	23	82	1.6
Production of refractories	12	12	5	12	41	0.8
Production of lime	12	13	5	12	42	0.8
Repair services	215	244	93	214	766	14.9
Energy facilities	251	285	112	256	904	17.6
Transport facilities	132	150	59	134	475	9.2
General works services	176	200	79	180	635	12.3
Total	1.216	1.730	670	1.532	5.148	100.0

The number of persons presently employed at the ZISCO works is 5,205, which indicates that the calculated and ZISCO's data are in a good agreement.

The information on occupational structure of all categories of the ZISCO works' personnel is contained in table 9. Similar information relating to workers is presented in table 10. On the whole the data contained in these two tables are also in the agreement with the ZISCO works' data on its occupational structure. The only essencial difference between two types of data on the occupational structure is the difference in the number of engineers and technicians - according to data of this study, the ZISCO works needs one and a half as much specialists of these two categories then it employs presently.

Table 9. Occupational structure of personnel for the ZISCO works

Production process	Total number of employees	Engineers and technicians	Percentage	Engineers	Percentage	Technicians	Percentage	Mechanics	Percentage	Electricians	Percentage	Clerical staff	Percentage	Workers	Percentage
Coke and by-product process	445	56	12.6	19	4.2	37	8.4	11	2.5	5	1.1	9	2.0	364	81.8
Production of sinter	82	6	7.3	2	2.4	4	4.9	2	2.4	1	1.2	2	2.4	71	86.7
Blast-furnace ironmaking	260	26	10.0	9	3.4	17	6.6	2	0.8	2	0.8	4	1.4	226	87.0
BOF steelmaking	634	44	6.9	14	2.3	30	4.6	4	0.6	4	0.6	8	1.3	574	90.6
Rolling	782	73	9.3	25	3.1	48	6.2	8	1.0	5	0.7	15	1.9	681	87.1
Scrap preparation	82	6	7.0	2	2.0	4	5.0	6	7.0	-	-	2	3.0	68	83.0
Production of refractories	41	3	7.3	1	2.4	2	4.9	1	2.4	1	2.4	1	2.4	35	85.5
Production of lime	42	3	7.2	1	2.4	2	4.8	1	2.4	1	2.4	1	2.4	35	85.6
Repair services	766	54	7.1	18	2.4	36	4.7	54	7.1	-	-	15	1.9	643	83.9
Energy facilities	904	181	20.0	60	6.6	121	13.4	-	-	63	7.0	18	2.0	642	71.0
Transport facilities	475	58	12.2	19	4.1	39	8.1	58	12.2	-	-	30	6.4	329	69.3
General works services	635	171	27.0	57	9.0	114	18.0	63	10.0	51	8.0	146	23.0	204	32.1
Total	5,148	681	13.2	227	4.4	454	8.8	210	4.1	133	2.6	251	4.9	3,874	75.2

Table 10. Occupational structure of workers for the ZISCO works

Production process	Total number of workers	Highly skilled		Skilled		Semi-skilled		Unskilled	
		Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
Coke and by-product process	384	54	14.9	195	53.7	51	14.1	63	17.3
Production of sinter	71	8	11.9	32	44.4	16	22.0	15	21.7
Blast-furnace ironmaking	226	23	10.0	137	60.8	28	12.6	38	16.6
BOF steelmaking	574	118	20.5	324	56.4	48	8.4	84	14.7
Rolling	681	104	15.3	422	62.0	66	9.7	89	13.0
Scrap preparation	68	4	5.8	49	71.9	4	5.8	11	16.5
Production of refractories	35	4	11.4	18	52.4	1	1.2	12	35.0
Production of lime	36	4	11.4	19	52.4	1	1.2	12	35.0
Repair services	643	53	8.2	487	75.8	7	1.1	96	15.0
Energy facilities	642	113	17.6	306	47.7	82	12.8	141	21.9
Transport facilities	329	66	20.0	181	55.0	16	5.0	66	20.0
General works services	204	51	25.0	122	60.0	4	2.0	27	13.0
Total	3,874	602	16.9	2,294	59.2	324	8.4	654	16.9

4. DETERMINING MANPOWER REQUIREMENTS FOR A MINI-STEEL PLANT IN THE MONGOLIAN PEOPLE'S REPUBLIC

For determining manpower requirements for a mini-steel plant to be constructed in the Mongolian People's Republic (MPR) according to a government decision, the following levels of plant capacity were used:

Liquid steel (to be produced from scrap in electric arc furnaces with the use of continuous casting) - 112,000 tons;

Finished steel products (50 per cent of light-section and 50 per cent of medium-section rolled products) - 100,000 tons.

These levels were established by the Dastur Engineering International Gmbh (DEI)[3/] - the company which was commissioned by UNIDO to prepare a project report for the establishment of a mini-steel plant in the MPR on the basis of the country's requirements of steel and its products according to the targets set-up in the Seventh Five Year Plan.

Table 11 contains the values of total input of raw material, energy and semi-finished products for manufacturing one ton of products in the plant for the process route involving EAF steelmaking on the basis of scrap and continuous casting.

Table 11. Total input of raw material, energy and semi-finished products for manufacturing 1 ton of products in the mini-steel plant in Mongolian People's Republic

Input	Unit of measurement	Production of: Medium-section rolled products	Production of: Light-section rolled products
Fuel	tce	0.100	0.100
incl. fuel oil	t	0.051	0.051
Outside electricity	thou.Kwh	0.940	0.940
Thermal energy	G cal	0.060	0.059
Scrap	t	1.100	1.100
EAF steel	t	0.062	1.065
Medium-section rolled products	t	1.000	-
Light-section rolled products	t	-	1.000

3/ Detailed Project Report for Establishment of a Mini Steel Plant in Mongolian People's Republic, Dastur Engineering International Gmbh, Dusseldorf, May 1985.

These values and the data on direct labour requirements mentioned in the introduction of this study made it possible to calculate the total labour requirements for manufacturing one ton of products. The results of this calculation are presented in table 12. It should be noted that the table does not contain any data on labour requirements for scrap preparation. The reason for this is that the scrap will be delivered to the plant from another enterprise in the condition ready for the use. Due to this fact total labour requirements on repair, transport facilities and general work services at this plant are smaller than at the TISCO and ZISCO works.

Table 12. Total labour requirements for manufacturing different products in the mini-steel plant in Mongolian People's Republic (man-hours per ton)

Production process	Production of	
	Medium-section rolled products	Light-section rolled products
EAF steelmaking	2.867	2.878
Rolling	2.000	1.950
Repair services	0.698	0.702
Energy facilities	1.256	1.271
Transport facilities	0.415	0.415
General works services	0.550	0.550
Total	7.786	7.766

The results of the computation of personnel requirements for the Mongolian mini-steel plant are shown in table 13. These results indicate that the plant will require for its functioning a workforce comprising 389 persons. According to the DEI's report, manpower requirements for the plant are somewhat smaller - 336 people. This difference is explained by the different results of estimations of manpower requirements for the implementation of the main manufacturing processes - steelmaking and rolling - in this study and in the DEI's report. In accordance with the results of the calculation made in this study manpower requirements for steelmaking and rolling are 144 and 99 persons, respectively; according to the DEI's reports these figures are 102 and 87 persons, respectively.

The information on the occupational structure of all the categories of personnel required for the plant is contained in table 14; the same information for workers is presented in table 15. This information shows that workers constitute the biggest group of personnel needed for functioning the plant - 326 people or 83.8 per cent of total plant's manpower requirements. The second place in the occupational structure of the plant belongs to engineers and technicians. The plant needs them in the quantity of 50 persons

(12.9 per cent of total plant's requirements in personnel). The most needed category of workers, as it follows from table 15, are skilled workers - 108 persons or 58.3 per cent of a total number of workers.

Table 13. Personnel requirements for the mini-steel plant in the Mongolian People's Republic (number of persons)

Production process	Production			
	Medium-section rolled products (50,000t)	Light-section rolled products (50,000t)	Sub-total	Percentage of total
EAF steelmaking	72	72	144	37.0
Rolling	50	49	99	25.5
Repair services	17	18	35	9.0
Energy facilities	31	32	63	16.2
Transport facilities	10	10	20	5.1
General works services	14	14	28	7.2
Total	194	195	389	100.0

It was noted earlier that there is a difference in quantitive terms between manpower requirements determined in this study and suggested in the DEI's report. A difference exists also between the occupational structures proposed for the plant in this study and in DEI's report. The most essential is a difference of a qualitive character - the occupational structure suggested by DEI does not include such professional categories of personnel as engineers and technicians.

These categories of personnel in the DEI's occupational structure are replaced by managerial and supervisory personnel. It would appear that the occupational structure based on professional qualification proposed in this study better reflects production requirements.

Table 14. Occupational structure of personnel for the mini-steel mill in the Mongolian People's Republic

Production process	Total number of employees	Engineers and technicians	Percentage	Engineers	Percentage	Technicians	Percentage	Mechanics	Percentage	Electricians	Percentage	Clerical staff	Percentage	Workers	Percentage
EAF steelmaking	144	14	10.0	5	3.3	9	6.7	2	1.0	2	1.0	2	1.2	128	88.8
Rolling	99	9	9.3	3	3.1	6	6.2	1	1.0	1	0.7	2	1.9	88	88.8
Repair services	35	3	7.1	1	2.4	2	4.7	3	7.1	-	-	1	2.0	31	90.0
Energy facilities	63	13	20.0	4	6.7	9	13.3	-	-	4	7.0	1	1.0	49	77.8
Transport facilities	20	3	12.2	1	4.1	2	8.1	3	12.2	-	-	1	6.4	16	81.4
General works services	28	8	27.0	3	9.0	5	18.0	3	10.0	2	8.0	2	23.0	14	50.0
Total	389	50	12.9	17	4.4	33	8.5	12	3.1	9	2.3	13	3.3	326	83.8

Table 15. Occupational structure of workers for the mini-steel mill of the Mongolian People's Republic

Production process	Total number of workers	Highly skilled		Skilled		Semi-skilled		Unskilled	
		Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
EAF steelmaking	128	26	20.5	72	56.4	11	8.4	19	14.7
Rolling	88	13	15.3	55	62.0	9	9.7	11	13.0
Repair services	31	3	8.2	23	75.7	1	1.1	4	15.0
Energy facilities	49	9	17.9	23	47.7	6	12.8	11	21.9
Transport facilities	16	2	20.0	9	55.0	1	5.0	3	20.0
General works services	14	4	25.0	8	60.0	-	2.0	2	13.0
Total	326	58	17.8	108	58.3	28	8.6	50	15.3

5. CONCLUSIONS

A methodology for determining manpower requirements in the iron and steel industry based on input-output analysis was applied for the estimation of personnel needs of two types of metallurgical enterprises:

(a) integrated iron and steel works using the classical manufacturing scheme - coke producing - blast furnace ironmaking - steelmaking - rolling; and

(b) mini-steel plant using a manufacturing scheme consisting of two major processes - electric arc furnace steelmaking and rolling.

As examples of the first type of enterprise the operational works of the Tata Iron and Steel Company Limited in Jamshedur, India and the Zimbabwe Iron and Steel Company Limited in Redcliff, Zimbabwe, were selected. As an example of the second type of enterprise a mini-steel plant to be constructed in the Mongolian People's Republic was chosen.

The computations made gave the possibility to receive for all the analysed enterprises the information on industrial and personnel requirements and on occupational staffing structure needed for functioning these enterprises.

Some results of these computations as well as the data on the personnel presently employed by the TISCO and ZISCO works and on the manpower requirements for the Mongolian mini-steel plant suggested by the Dastur Engineering International Gmbh are presented in table 16.

Table 16. Comparison of the data on manpower requirements of different origin

Type of data	Title of an enterprise		
	TISCO works	ZISCO works	Mongolian mini-steel plants
Number of employees required by an enterprise according to this study	26,156	5,148	389
Number of persons presently employed by an enterprise or suggested for employment by other organizations	30,182	5,205	336
Difference between the above types of data, percentage	13.3	1.1	13.4

Analysis of the information contained in the table leads to a conclusion that in quantitive terms the data of this study and the analogous data of TISCO, ZISCO and DEI are in rather good agreement.

It should be noticed that the data on personnel requirements for the TISCO works found in this study correspond to the works' needs after its full modernization when it would produce 2,14 million tons of rolled products instead of 1,74 million tons being produced presently. For this reason the actual difference between ZISCO's and this study's data will be greater - up to 18 per cent, according to the estimation made. It is difficult to expect, however, that in such a field as manpower requirements the results found theoretically and empirically should completely coincide. If theoretical methods of determining manpower needs usually take into account only the satisfaction of technological requirements, empirical ones are also often influenced by social factors such as the necessity to increase employment.

The difference between the data on the Mongolian mini-steel plant is explained, as pointed out above, by the different opinions of DEI and this study with respect to manpower requirements for the implementation of the major manufacturing processes - steelmaking and rolling.

As far as occupational structure of personnel is concerned, the data of this study and TISCO, ZISCO and DEI are similar. However, according to the estimates of the study the analysed enterprises would need more personnel of such professional categories as engineers and technicians.

The analysis of the estimated data and a comparison with other available data of a similar character on the studied enterprises have confirmed that the methodology under study can be used as an efficient means of calculating manpower requirements for industrial enterprises. Given the general characteristics of the methodology it should be possible to use it for determining personnel requirements in manpower planning in different sectors.

SOMMAIRE

Cette étude décrit la mise à l'essai d'une méthode servant à déterminer les besoins en main-d'oeuvre dans l'industrie sidérurgique.

La méthode avait été élaborée au départ par le Professeur V.A. Romenets et les Drs N.I. Perlov et L.V. Kovalenko de l'Union des Républiques socialistes soviétiques et les travaux d'essai ont également été dirigés par ces mêmes spécialistes à titre de consultants de l'ONUDI.

La méthode fut appliquée pour calculer les besoins en personnel dans deux types différents d'entreprises métallurgiques: (i) manufacture intégrée utilisant la voie de fabrication classique: fabrication de coke, de fer par hauts fourneaux, d'acier et laminage; (ii) petite fabrique consacrée à la manufacture et au laminage de l'acier dans des fournaises à arc électrique.

Les calculs effectués ont permis de déterminer les besoins en personnel pour les genres d'entreprises à l'étude et d'en évaluer les structures occupationnelles.

L'analyse des données calculées et une comparaison de ces mêmes données avec l'information empirique disponible sur les entreprises à l'étude ont confirmé que la méthode peut être utilisée efficacement comme moyen de calculer les besoins en main d'oeuvre dans les entreprises industrielles. Etant donné les caractéristiques générales de la méthode, il devrait être possible de l'utiliser aussi pour déterminer les besoins en main d'oeuvre lors de la planification dans d'autres secteurs.

EXTRACTO

El estudio presenta los resultados de un exámen para verificar una metodología utilizada para determinar las necesidades de mano de obra en la industria del hierro y del acero. La metodología fué originalmente elaborada por el Prof. V.A. Romenets, el Dr. N.I. Perlov y el Dr. L.V. Kovalenko de la Unión Soviética como consultores de la ONUDI. Ellos también llevaron a cabo este exámen.

La metodología se aplicó para calcular el personal necesario para dos tipos de empresas metalúrgicas:

(a) Plantas integradas de hierro y acero utilizando la ruta clásica de producción: producción de coke, producción de hierro en altos hornos, producción de acero, laminado, y

(b) Mini-planta de acero con una ruta de producción con arcos eléctricos y laminado.

Los cálculos efectuados permitieron determinar el personal necesario para las empresas estudiadas además de poder estimar la estructura ocupacional.

El análisis de las cifras calculadas y una comparación de estas cifras con información empírica disponible sobre las empresas estudiadas, ha confirmado que la metodología puede usarse como un medio eficiente para calcular las necesidades de mano de obra en empresas industriales. Dadas las características generales de la metodología debería ser posible utilizarla para determinar requerimientos para personal al planear la mano de obra necesaria en distintos sectores.

РЕЗЮМЕ

Исследование посвящено опробированию методики определения потребности металлургических предприятий в кадрах. Проверка методики осуществлялась ее авторами, консультантами из Советского Союза проф. В.А.Роменцом и кандидатами наук Н.И.Перловым и Л.В.Коваленко.

В качестве объектов для проверки методики были выбраны два типа предприятий - металлургические заводы полного цикла и минизавод, использующий два основных процесса - выплавку стали и прокатку.

Проведенные расчеты позволили определить потребности в кадрах обоих типов предприятий и квалифицированную структуру этих кадров.

Анализ полученных в исследовании данных и их сопоставление с эмпирической информацией о кадрах изученных предприятий позволяют сделать заключение, что методология может быть использована в качестве эффективного инструмента для определения потребности в кадрах предприятий металлургической и других отраслей промышленности.

For the guidance of our publications programme in order to assist in our publication activities, we would appreciate your completing the questionnaire below and returning it to UNIDO, Studies and Research Division, Sectoral Studies Branch, D-2073, P.O. Box 300, A-1400 Vienna, Austria

---

Q U E S T I O N N A I R E

Personnel requirements in iron and steel: testing a methodology for determining manpower needs

		(please check appropriate box) yes	no
(1)	Were the data contained in the study useful?	/_/	/_/
(2)	Was the analysis sound?	/_/	/_/
(3)	Was the information provided new?	/_/	/_/
(4)	Did you agree with the conclusion?	/_/	/_/
(5)	Did you find the recommendations sound?	/_/	/_/
(6)	Were the format and style easy to read?	/_/	/_/
(7)	Do you wish to be put on our documents mailing list?	/_/	/_/
		If yes, please specify subjects of interest	
(8)	Do you wish to receive the latest list of documents prepared by the Sectoral Studies Branch?	/_/	/_/
(9)	Any other comments?		

Name:
(in capitals) .....

Institution:
(please give full address) .....

Date: .....