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Scale of Collieries and their Top-Level Management Capability in the Polish Coal Mining Industry: Recent Results

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SCALE OF COLLIERIES AND THEIR TOP-LEVEL MANAGEMENT CAPABILITY IN THE POLISH COAL MINING INDUSTRY: RECENT RESULTS

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ABSTRACT

In this paper the following topics are considered:

-- retrospective research into the effect of coal mine scale on its effectiveness,

-- research results on the effect of the "system size" (coal mine) on the top-level management capability,

-- problem specifications for further research work in this area.

The research results presented in this paper are part of the work accomplished within the IIASA project called "Coal--Issues for the Eighties".

Among others, elements of the IIASA concept "S-IOT" have been used.

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J. Bendkowski, J. Stachowicz, and
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INTRODUCTION

This paper contains the results of the first stage of research work carried out by Polish research institutions within the framework of the IIASA study entitled "Coal--Issues for the Eighties". The aim of our work within this study related especially to organizational aspects of coal mining development, is to carry out complex investigations concerning managerial systems on various levels of economic organization in the mining industry, determining modernization trends and designing management organizations in this branch of industry--essential for our national economy.

An important part in the research work includes the work concerning quantitative and qualitative conditions of the management system at the level of mining divisions, mines and areas resulting from differences in their size.

In our opinion, the results of the research will be of essential important for further improvement of management organizations in the coal mining industry.

WORK THESIS

Differences of mine size lead to differences in both the degree of difficulty of decision issues facing the management of these economic systems, and to differences in the situations in which decision-makers participate and fulfill individual managerial functions in the course of successive stages of the process of decision-making.

Recognizing these differences will give better references to the colliery designers. Actually, the applicable methods in majority focus on the technological and economic aspects of mine size. The application of these methods gives a relatively flat surface in the area of the optimum colliery size. Therefore, the systems analysis approach adds organizational and managerial variables to the technical, technological and economic ones and this could give a more precise recommendation for design activity in the mining industry.

THE TASK

To pursue the above thesis, it was assumed that the following tasks should be carried out:

(a) carrying out retrospective research work on the formation of coal mine sizes in Poland, with respect to their efficiency, since 1950;

(b) identification of some relationships between the mine size and the management capabilities.

In this paper, the results of research work concerning item (a) and preliminary results of work within the range of item (b) are presented in detail.

DEFINITION OF SIZE AND EFFICIENCY OF THE ECONOMIC SYSTEM

According to the standard formula, a definition is formed by quality and class difference (definitio fit per genus et differentiam specificam).

The issue of complete and explicit definition of the system size is a subject of numerous discussions and disputes.

It seems (from the authors' point of view) that the most convincing definition is that which describes a system's size in terms of its influence on the environment.

This definition is not perfect and it is not in accordance with the quoted rule. Disregarding the complicated conceptions and the linguistic ones of this category, it is essential for further understanding (at least heuristically) to consider the following:

-- separating the organizational system from its environment,

-- determining the quantitative criteria for size evaluation.*

* The issue of an economic system's size, the way of measuring this, and its influence upon other system features, is well described in the literature; some works in English: Malcher (1976); Coplowa (1957); Khandwall, P.N., "Design of Organizations". In Polish the works of A. Zawiślak, K. Doktór, W. Pańkow and others should be mentioned.

A mine as a socialist enterprise (Gliński 1977) is characterized by territorial, legal, financial and organizational separation from the environment.

If the issue of territorial, financial, legal and organizational separation seems to be precisely determined, the economic discrimination is a matter of dispute among different authors, concerning the close connection between economic separateness and decision independence.

Decision independence is also closely correlated with the problem of centralization and decentralization, relevant not only for a planned socialist economy, but also for a market environment.

No doubt within the same branch of industry there exists a variety of degrees of decision independence; this problem is also a subject of our work.

Nevertheless, for the purpose of this study, it has been assumed that differentiation of mines in this respect is not so relevant as far as the research results are concerned.

The above assumptions have been made on the grounds that there is great similarity between the underground mines assembled in one mining region, and such mines have been the main object of our analyses. This similarity has been previously confirmed by many decision-makers.

For the purposes of this analysis, it has been assumed that the size of mines should be determined by means of the following indicators:

-- output quantity,
-- total employment,
-- total length of mining excavations and number of shafts;

whereas the efficiency of mines has been defined by means of:

-- overall output,
-- underground output,
-- general labor intensity,
-- total electric power consumption,
-- production costs.

THE RESULTS OF RETROSPECTIVE AND COMPARATIVE INVESTIGATIONS

The mining industry in Poland, with respect to its particularly dominant importance on our national economy from 1945 to 1979, has been developing very intensively.

Coal output in Poland has shown a systematically increasing trend through the post-war period. During the period 1970 to 1977, coal output increased from 140 million tons to 186 million tons per year.

The average annual increment of coal output amounts to 6.6 million tons. The forecast for coal mining development in Poland anticipates further increase of coal output. In 1980 the coal output will exceed 210 million tons, and in 1985 the forecast level is 240 million tons per year.

The considerable output increase in Poland is being achieved in spite of a continuous deterioration in mining-geological conditions. It is expected that this deterioration will continue in the future. As the exploitation depth increases up to 1000 m., the problems of mine air-conditioning, rock burst, etc., will often occur.

The planned increase in output will be achieved even though the increase in employment is limited. At present 380 thousand people are employed in the mining industry.

At present the Polish coal industry has about 65 mines. The mines are grouped in seven areas. Six groups including ten mines each are located in the Upper Silesian Coal Basin. The seventh group is in the Lower Silesian Coal Basin.

Increased production is observed in the Polish coal mines. The number of mines whose daily output exceeds 15,000 tons continuously increases. These include both new mines, and older ones under reconstruction. Good results have been achieved by combining old mines in larger production units.

The output from a single face has considerably increased. While in 1970 the average daily output from longwall with caving amounted to about 600 tons, in 1977 it reached 1,000 tons. The output from one production level increased in this period from 2,300 tons per day to 4,000 tons per day.

The degree of mechanization of the mining production processes at the faces (particularly in longwall faces) has reached the level of 95 percent of total coal industry output.

The continuous development of output in the Polish coal industry is supported by several service and auxiliary enterprises as well as by the scientific research and design base.

About twenty factories producing mining machinery and devices, grouped in one mining machinery union, ensure the modern equipment indispensable for achieving our high level of coal output. The investment activity of the whole coal industry is undertaken by specialized enterprises grouped in the mine construction union and the coal industry building-assembly union.

As a result of service concentration and specialization the following centralized activities for the whole industry are performed:

- -- sale of coal,
- -- mine timber supply,
- -- exploitation and supply of stowing sand to the mines,
- -- other materials supply.

As has already been stated, together with the growth of output, intensive technological progress has taken place. It was followed by progress in the field of project-planning and investigation of new mines, and organizational progress; the latter is mainly concerned with organization of production.

However, as far as progress in the field of management organization is concerned, it is not fully satisfactory yet. IIASA research workers G. Dobrov, M. McManus and A. Straszak (1979) have observed that the organizational progress is not keeping up with the level of technology.

In our opinion this approach is better for analysis of a technological system because it gives a simple basis for comparison and examination of different system components as a system whole. As a development of this approach one can divide a technological system into two major subsystems; a production subsystem which creates by production processes and a management subsystem which creates by decision-making and information processes.

One can distinguish three components, hardware, orgware and software in these subsystems. Moreover in a sphere of the system contact with its environment this is also possible. For our further examinations, these categories (i.e., hardware, orgware, and software) will be taken.

Taking the above remarks into consideration, one could define the present step of our study more precisely as an examination focused on management systems of a colliery and on its connection with the environment.

Tables 1, 2 and Figure 1 display the data used for defining the size and efficiency of a mine over an analyzed period of time in the Polish mining industry. At present 65 mines, of various sizes, are in operation. Six mines of 12-24,000 t.p.d. (Glanowski, 1979) output capacity are under construction.

The technological progress achieved (concerning the design of mines and the construction of mining machinery and equipment), organizational progress (manifested in constant realization of the principle of production concentration), and experience acquired in mine construction have led to the view that in the mining-geological conditions of Polish coal-basins it is advisable to design and consttuct large integrated mines of 15-20 thousand tons oc coal output per 24 hours. These mines, comprising elementary mining areas connected by means of common underground transport, are independent with respect to ventilation.

The optimum size of such a type of mine is determined on the basis of technological-economic criteria (e.g., minimization of total mining costs) assuming maximum usage of the technological means available.

Thus on one hand, technological progress offers the possibility of designing and constructing big mines; additionally, introducing modern and expensive technical equipment in mines requires

Table 1

No.	Index Name	Unit of Measurement	Year						
			1950	1955	1960	1965	1970	1975	1977
1	2	3	4	5	6	7	8	9	10
1	Output in total	million tons	78,0	94,5	104,4	118,2	140,1	171,6	186,1
2	General productivity	%	100,0	113,2	126,9	156,1	197,8	326,7	343,4
3	Underground productivity	%	100,0	127,1	135,4	161,8	231,5	286,9	300,9
4	Labor intensity in general	%	100,0	88,2	79,9	78,8	38,9	30,6	29,1
5	Underground labor intensity	%	100,0	78,6	73,8	73,2	43,2	34,8	33,2

Source: Mining Industry Statistic Data.

Table 2

No.	Index Name	Unit of Measurement	Year						
			1950	1955	1960	1965	1970	1975	1977
1	Number of mines		81	87	86	80	77	68	65
2	Number of mines with mining output over 10,000 tons/24 hours		-	-	-	2	7	13	14
3	Number of mines with mining output over 18,000 tons/24 hours		-	-	-	-	-	-	1
4	Mining output in total	million tons	78,0	94,5	104,4	118,2	140,1	171,6	186,1
5	Average output of one mine	thousand tons per year	963,0	1168,3	1287,3	1459,2	1819,5	2523,5	2863,0
6	Employment in general	thousand employees	296,0	318,1	331,7	482,2	526,8	341,2	343,9
7	Employment-industrial group	thousand employees	285,6	304,2	312,4	324,2	330,5	321,6	326,0
8	Face output	%	38,7	51,6	60,0	69,1	720,7	78,09	84,23

Source: Mining Industry Statistic Data

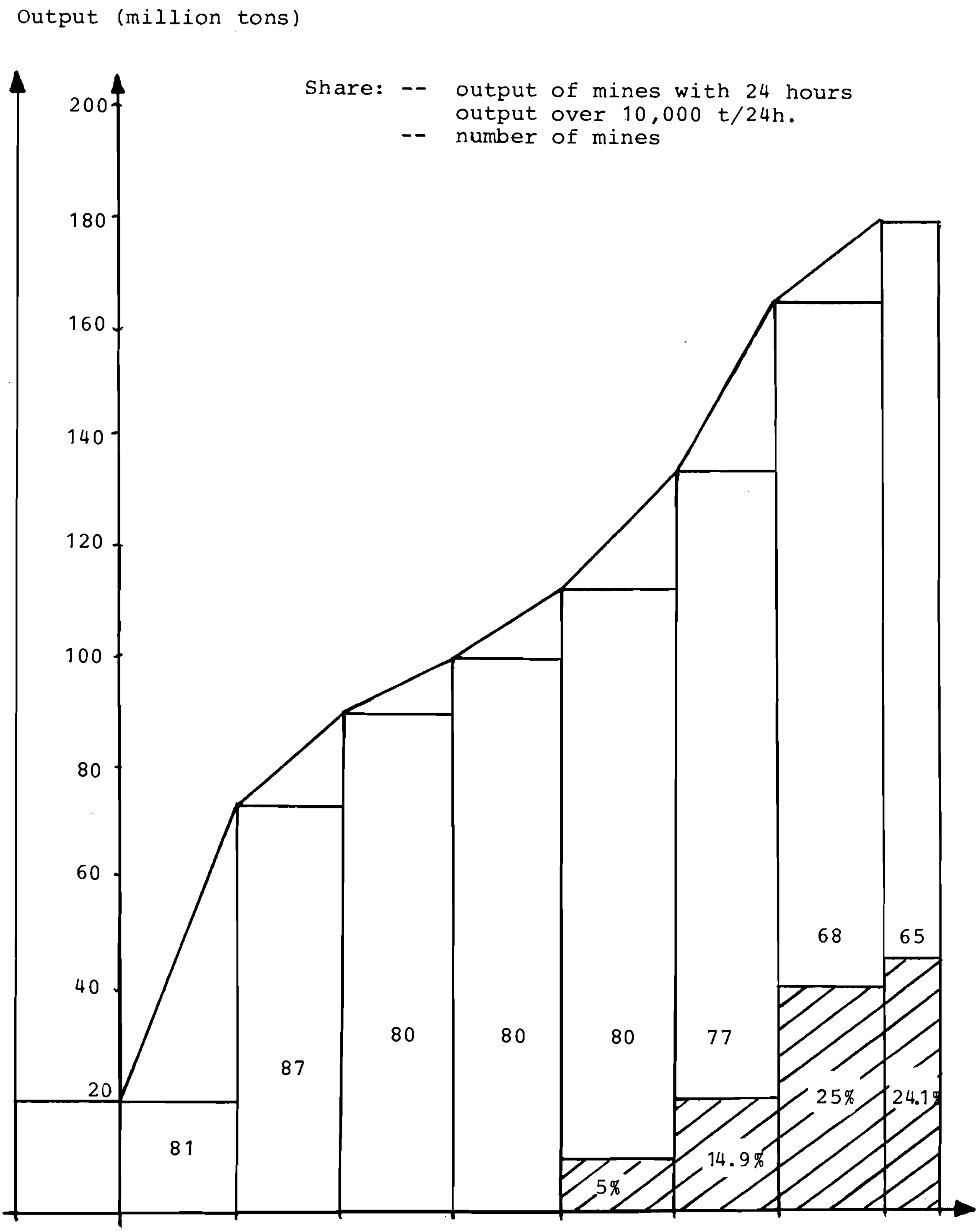

Figure 1

Source: Mining Industry Statistic Data

designing and constructing big mines, because high rates of mining, productivity and concentration are essential for achieving high efficiency of coal production; however on the other hand, new management and organization issues arise.

Table 3 shows present trends in the evolution of indicators of mine efficiency in three groups of mines classified by scale. For clarity of analysis those indicators have been included which determine to the greatest extent the size and efficiency of mines (and with which the previously mentioned indicators are correlated).

Conclusions

At the present stage of technological and organizational capability (hardware, software and orgware) in our mining industry, and in the conditions of our coal basin, the relationship between mines' efficiency growth and their size has been clearly demonstrated as follows:*

(1) Total productivity of mines with output over 18,000 t.p.d. is 17.94 percent higher than at those with output under 10,000 t.p.d.

(2) Underground output is 13.83 percent higher, respectively.

(3) Energy consumption per ton is 52.9 percent lower.

(4) Production costs per ton are 32.85 percent lower.

Nevertheless, the range of size of mines, rational with reference to their optimum efficiency, is at present quite wide, though we are not close to the threshold value (taking into consideration fixed costs, etc.); this range is distinctly different as far as other variables describing the system are concerned, including variables describing management capacity.

Studying this distinction enables us to view mine scale, not only in terms of its economic effects, but also in terms of its other important features forming the trend of proper, progressive integration of orgware, software and hardware.

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* A question may arise: Why the existing mines differ with regard to size? Hierarchy and sequence of activities in designing mining plants are different from the design activities for other industrial plants, because:

-- quantity of production cannot be established when the deposits are unknown, despite the known market needs, technological-economic, market and social potential.

-- quantity of output (yearly, daily) cannot be determined exclusively on the basis of having located a sufficient deposit, but only when mining development of a deposit is at least conceptually designed.

Table 3

No.	24 hours output	Productivity		Electric Power Consumption	Average Employment rate in a mine			Production costs				
		Underground	General		General	Industrial Group	Non-Industrial Group	Total	Labor	Materials	Depreciation	Power
-	tons/24 hours	%	%	%	%	%	%	%	%	%	%	%
1	18.000-24.000	100	100	100	100	86.56	4.44	100	100	100	100	100
2	16.001-18.000	89.58	91.8	63.51	100	86.58	4.46	113.18	112.92	114.91	85.31	97.1
3	14.001-16.000	94.43	96.5	67.89	100	86.01	4.98	127.85	120.84	147.70	96.23	111.01
4	12.001-14.000	94.76	94.91	74.50	100	85.76	5.24	126.52	122.91	123.14	95.42	109.54
5	10.000-12.000	90.05	90.83	84.20	100	85.80	5.30	128.82	128.54	128.35	99.37	113.52
6	below 10.000	82.06	86.17	152.9	100	86.13	4.90	132.85	137.78	133.20	100.21	116.04

Source: Mining Industry Statistic Data

INVESTIGATION OF MINE SIZE EFFECT ON MINE MANAGEMENT CAPABILITIES

The following studies have been conducted in order to explain more thoroughly the general belief, i.e., that differences between mines lead to differing degress of difficulty in the decision problems confronting decision-makers, and these variables exert an essential influence on their potential managerial capabilities.

1. On the basis of an inquiry with a group of decision-makers (general managers of mines and their deputy directors, chief engineer, deputy director for economic matters, deputy director for personnel, a list of difficult decision problems determining and influencing their managerial duties was prepared. A selection of these questions is included as an appendix. Twenty-five decision-makers were interviewed.

   When selecting the interviewed decision-makers we tried to cover in our questionnaire-surveys the managers who are widely experienced in managerial duties at mines of different size. These typical groups of sizes of mines have been accepted:

   -- Group I--mines with output of less than 10,000 t.p.d.,

   -- Group II--mines with output of 10-18,000 t.p.d.,

   -- Group III--mines with output of more than 18,000 t.p.d.

   These surveys have also provided information on frequency of difficult decision problems divided into single problems, rare problems and difficult decision problems of very frequent occurrence (routine). Moreover, using the scale of difficulty from 0 to 4 (0--not very difficult decision problems, 4--particularly difficult decision problems), information has been obtained concerning the degree of difficulty classified by size of mines.

   The list of all difficult decision problems mentioned and described by respondents covers 33 items. The set of these decisions was divided as follows:

   -- decision problems caused by the mine environment,

   -- decision problems, the substance of which lies in in hardware, software, or orgware, according to the classification proposed by IIASA research workers.

   In addition, difficult decision problems were classified by the role of decision-makers, i.e., in relation to the general manager and his deputy managers.

   Tables 4a and 4b show some examples of difficult decision problems especially influenced by the size of mines.

Table 4a. Some Hardware Decision Problems Associated with the Environment (0)

No.	Name of Problem	Group of Mines I		II		III	
		frequency	degree of difficulty	frequency	degree of difficulty	frequency	degree of difficulty
1	Change of the production plans during the year	3	3	3	4	3	4
2	Rational utilization of machines and equipment. Increase of breakdown of technical equipment due to shortage of spare parts and irregular supplies of machines, equipment and materials	3	4	4	3	4	3
3	Providing an appropriate social infrastructure	2	2	3	3	4	4

Table 4b. Some Hardware Decision Problems Connected with the System(s)

No.	Name of Problem	Group of Mines I		II		III	
		frequency	degree of difficulty	frequency	degree of difficulty	frequency	degree of difficulty
1	Probable failure of qualitative, quantitative plan as a whole and according to types and assortments	3	3	3	4	3	4
2	Serious worsening of mining and geological conditions at the level with the highest production capacity	2	2	3	3	3	3
3	Material procurement	2	2	3	3	4	4

2. Analysis of collected empirical material. The next stage of work described in paragraph 1 has confirmed the thesis that differentiation of mine size, similar in technique and technologies used, and which do not differ much as to the level of organization of production and organization system, results in differentiation of decisions, namely:

    -- in the class of decision problems caused by the mine environment--average indices of their difficulties are found in the group of small mines:

        average frequency of their occurrence--1.5;
        average degree of difficulty--1.8;
        in the group of medium mines--2.0 and 2.1 respectively;
        in the group of big mines--2.2 and 2.5 respectively.

    -- in the class of decision problems arising from the system:

        small mines--1.3 and 2.0;
        medium mines--2.3 and 2.2;
        big mines--2.6 and 2.3 respectively.

    In addition, deputy directors for personnel mentioned particularly difficult decisions resulting mainly from the size of mines.

3. The decision situation is connected, in the first place, with the substance of the decision problem, while the situations of the decision-maker are characterized by organizational circumstances and also by factors associated with the size of a system in which they occur.

    The degree of difficulties of situation of the decision-maker is determined by:

    -- substance of decision problem,
    -- kind of factors influencing a given situation,
    -- influence of particular factors,
    -- possibility of decision-makers to exert an influence on particular factors.

    Another feature of the situation of the decision-maker is his ability to exert an influence on a given factor and range of freedom of his activity; determined, in the first place, by subjective features of the decision-maker. (The reasoning mentioned was derived from the publication by M. Bartichi, "Method for Analysis of a Field of Force in Research of Decision-Making Processes. Problem of Organization ..."). At the further stage of work the factors limiting and facilitating situations of the decision-maker were listed.

    The objective of this work was to recognize the effect of particular factors on the situation of the decision-maker when solving difficult problems.

This research has been carried on as the next step of prepared interviews (Appendix 1). The results presented concern the preliminary stage of research. The set of factors was grouped according to three different sizes of mines. In addition, the factors were distinguished concerning technical and technological aspects of a technological system (hardware), organization aspects (orgware) and skills of personnel and organization climate (software).

A four-degree scale of influence of particular factors was used (0--slight influence, 4--particularly significant influence).

Tables 5a, b, c, and Tables 6a, b, c, contain the examples of typical factors facilitating and limiting the situation of the decision maker, and gives the degree of difficulty classified by size of mines.

A factor and multiclassification analysis was used for the synthesis of results.

4. Conclusions arising from the analysis made. At medium and large mines there is a marked increase on the influence of the factors limiting the situation of the decision-maker when solving difficult decision problems.

   (a) In the group of factors concerning hardware, the average influence of limiting factors by size of mines is as follows:

   -- small mines--1.7,
   -- medium mines--2.3,
   -- large mines--2.5.

   (b) In the group of factors associated with orgware, the influence of limiting factors is as follows:

   -- small mines--1.3,
   -- medium mines--2.5,
   -- large mines--2.8.

   (c) In the group of factors associated with software, the influence of limiting factors is as follows:

   -- small mines--1.9,
   -- medium mines--2.5,
   -- large mines--2.7.

   (d) Similarly, the average influence of facilitating factors is as follows:

   factors associated with hardware:
   -- small mines--2.0,
   -- medium mines--2.0,
   -- large mines--2.0.

Table 5a. Limiting Factors Associated with Hardware (Examples)

No.	Name of factor	Group of Mines I	II	III
		Degree of influence*		
1	Shortage of necessary material supplies	2	3	4
2	Increase in part of output from safety pillars in total output	4	2	1
3	Quantity and quality of hardware	1	3	4
4	Mechanization and automation of production process	1	2	3
5	Waste utilization	1	2	3

Table 5b. Limiting Factors Concerning Orgware (Examples)

No.	Name of factor	Group of Mines I	II	III
		Degree of influence*		
1	Inefficiency of computerized information systems	1	2	3
2	Inflexible organization of the unit imposed by the superior authorities	1	3	3
3	Lack of experienced staff sections	1	3	4
4	Non-adjustment of control systems	2	3	3
5	Frequent modifications of regulations and standards	1	1	1

Table 5c. Limiting Factors Concerning Software (Examples)

No.	Name of factor	Group of Mines I	II	III
		Degree of influence*		
1	Low skills of personnel	1	2	3
2	Short time horizon of the evaluation system used	1	2	3
3	Lack of self-dependence and initiative of:			
	-- staff	1	2	2
	-- workers	2	2	2
4	Operation of dispatching centres	2	3	4
5	Varying expectations of external authorities	3	4	4

* 0: slight influence; 4: particularly significant influence.

Table 6a. Facilitating Factors Concerning Hardware (Examples)

No.	Name of factor	Group of mines I	II	III
		Degree of influence*		
1	Relatively easy acquisition of additional material supplies	2	1	1
2	Relatively easy increase in production capacity of the working front	2	3	3
3	Quantity and quality of resources	1	2	3
4	Relatively easy acquisition of additional technical resources	2	1	1

Table 6b. Facilitating Factors Associated with Orgware (Examples)

No.	Name of factor	Group of mines I	II	III
		Degree of influence*		
1	Legality of activities	1	1	1
2	Engagement of the environment in accomplishment of the program the decision is pertinent to	1	2	2
3	Computerization of management	1	2	3
4	Proper measures of evaluation of work	3	3	4
5	Relatively easy distribution of resources and planning processes	2	3	4

Table 6c. Facilitating Factors Concerning Software (Examples)

No.	Name of factor	Group of mines I	II	III
		Degree of influence*		
1	Liability of the environment to requirements of mine management	1	2	3
2	Engagement of persons taking part in the decision-making process	3	3	3
3	Appreciation of the preliminary age of activities	2	3	4
4	Competence of decision-makers	2	3	4
5	Organization climate	1	2	3

* 0: slight influence; 4: particularly significant influence.

factors connected with orgware:
-- small mines--2.3,
-- medium mines--2.1,
-- large mines--1.7.

factors connected with software:
-- small mines--3.0,
-- medium mines--2.5,
-- large mines--1.9.

5. Although there is a marked increase of colliery efficiency along with their size increase, there is still an expressive trend of the increased influence of the factors limiting the decision-maker's situation as well as growth. The difficult decision problems and their frequency in the big collieries gives a validity to forecast that further growing of colliery size could bring about reduction of their efficiency. See Figure 2. Therefore a comprehensive study of technical and technological aspects of scale in the mining industry as well as organizational, managerial and environmental ones could help answer the questions:

   -- What size of colliery ought one to design and build in the eighties?

   -- How do we design an organization in the mining industry taking into consideration the different colliery sizes?

6. The following work is expected to be done in further stages:

   -- analysis of the influence of factors facilitating and limiting situations of the decision-maker for the whole set of difficult decisions distinguished, and for each decision individually, taking into account particular stages of the decision-making process;

   -- analysis of the ability of decision-makers to exert an influence on particular factors and their behavior in difficult decision situations;

   -- use of results of these investigations to determine guidelines for planning and modernization of the management system in the mining industry.

7. Data obtained as a result of the first stage of work are incomplete, therefore the conclusions presented should be treated as approximate findings confirming the accepted thesis and providing the basis for further more detailed studies.

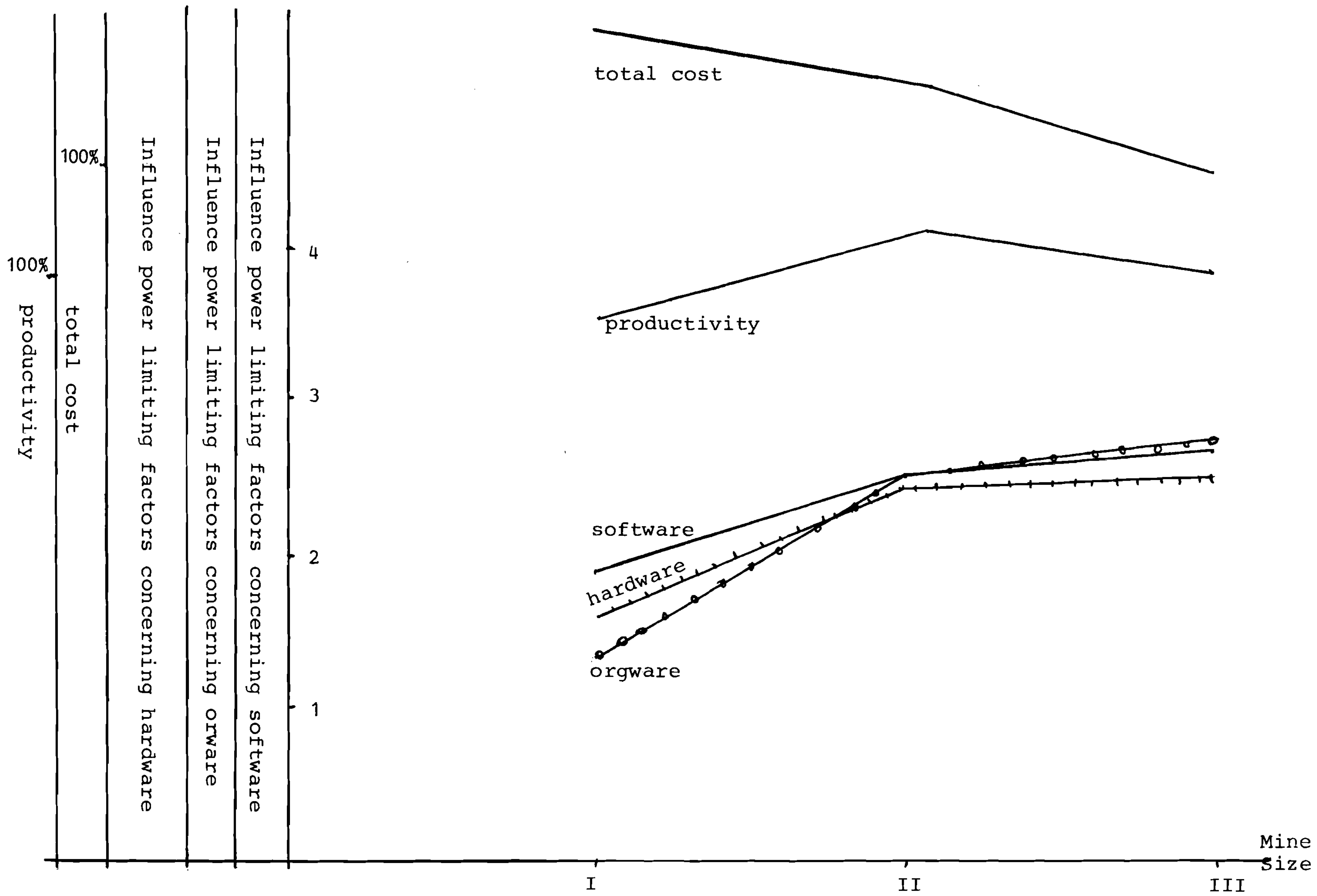
total cost
productivity
software
hardware
orgware
100%
100%
productivity
total cost
Influence power limiting factors concerning hardware
Influence power limiting factors concerning orware
Influence power limiting factors concerning software
4
3
2
1
I
II
III
Mine Size

Figure 2.

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APPENDIX 1

THE LIST OF THE QUESTIONS AS A SAMPLE OF THE INTERVIEW

I. The main colliery indicators; demographic and strategic colliery features.

Name of colliery ______________________

Name of area ______________________

*Colliery size indicators ______________________

Output quantity ______________________

Total employment ______________________

Total length of mining excavations and number of shafts ______________________

Other features describing the process of colliery development, in particular those connected with means, period, cause of the modernization and integration process (number of examined collieries which were integrated due to a technical and administrative combination of the mines)

**Colliery efficiency indicators.

Overall output (productivity) ______________________

Underground output (productivity) ______________________

General labor intensity ______________________

Total electric power consumption ______________________

Production costs ______________________

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* Most data related to point I we have obtained from our coal mining industry data bank.

**Appropriate data related to the last 12 months were taken.

II *Top management executive's questionnaire.

Your position in the colliery:

General manager--

Chief engineer--

Deputy Director for economic matters--

Deputy Director for worker's matters--

Your position in the mining industry during the last 10 years:

III Investigation of differentiation of difficulty in the decisional problems in different colliery size groups.

(1) Please make a list of these difficult operational decisional problems which occurred in the space of a month and a year that involved your activity in particular.

1.1 Using the scale of difficulty
0 = not very difficult decision problems
4 = particularly difficult decision problems

Please quantify the degree of those problems mentioned by you.

1.2 Using the scale of frequency of difficult decision problems

1 - single
2 - rare
3 - very frequent occurrence.

Please estimate the frequency of occurrence of the difficult problems over a years time.

(2) What is your opinion of the list of difficult decision problems mentioned by other managers from other collieries?

Do you think the difficult decision problems described by your colleagues relate to your managerial position in your colliery?**

If not, why?
If so, please supplement your list of difficult decision problems.

(3) You have managerial experience on different management levels and in different collieries, taking into account their different size. What is your opinion on the influence of colliеary size on the degree of difficulty of decision problems and their frequency?

* Most of the respondents are personally known by the authors.

**Only problems approved by most of the respondents were taken for further examination.

Please use the scale

0 - slight influence
4 - particularly significant influence

List of difficult decision problems	COLLIERY SIZE					
	I		II		III	
	degree of colliery size influence	rank frequency	degree	rank	degree	rank

IV Investigating decision-maker situations, in the course of their actions connected with solving difficult decision problems.

Please think of your decision activity when solving each problem from your list of difficult decision problems as described by you previously.

(1) What kind of factors impede and facilitate your activity. Please list a collection of factors limiting and facilitating your situations for each decision problem.

The difficult decision problem	The factors			
	Limiting	Degree of influence	Facilitating	Degree of influence
Name of the problem...				

1.1 What do you think of the factor list as mentioned by your colleagues? Please supplement your list of the factors.

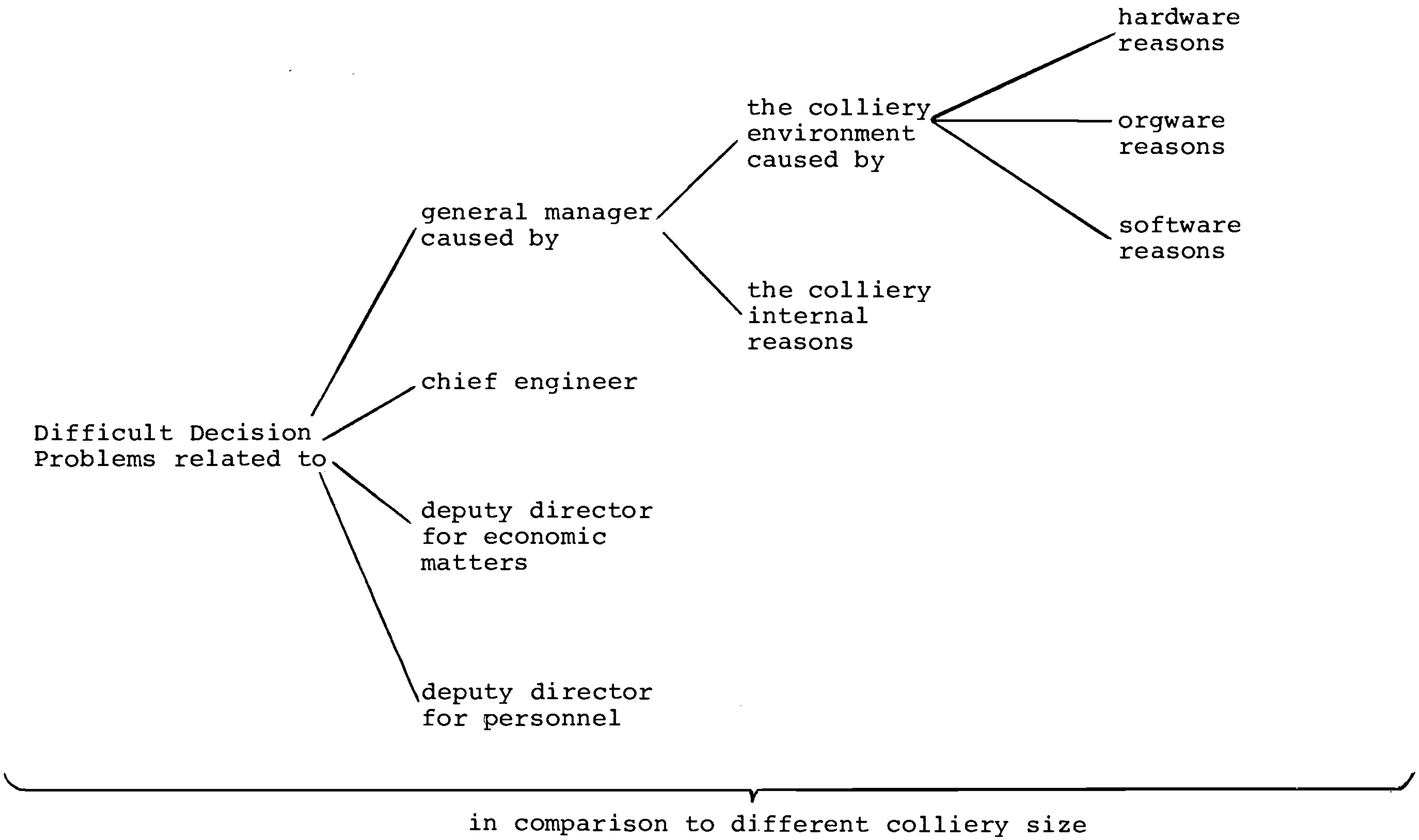
(2) Using a scale:

0 = slight degree of influence
4 = particularly significant influence

Assess the influence of the respective factors defining your decision situation for each decision problem by colliery size.

The factors	Colliery size		
	influence degree	influence degree	influence degree
Name of the factors			

DIFFICULT DECISION PROBLEMS TAXONOMY



LIMITING AND FACILITATING FACTORS TAXONOMY