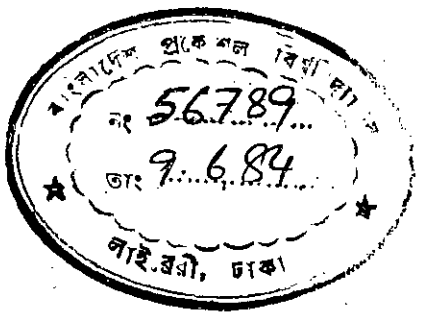
EVALUATION OF WORKERS' JOB PERFORMANCE AND ITS RELATION WITH THE LABOUR PRODUCTIVITY IN MANUFACTURING UNITS

A Thesis
by
MD. SHARAFAT ALI



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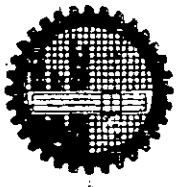

November, 1983
BANGLADESH UNIVERSITY OF ENGINEERING & TECHNOLOGY, DHAKA.

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Approved as to the style and content by:

M. M. Rahman 19.1.84.

DR. MD. MIZANUR RAHMAN — Chairman
Professor,
Department of Industrial
& Production Engineering
BUET, Dhaka.

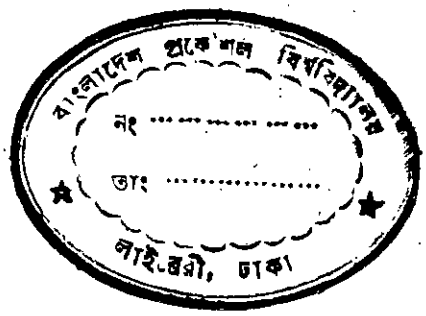
Anwarul Haque

DR. A.F.M. ANWARUL HAQUE — Member
Professor and Head,
Department of Industrial
& Production Engineering
BUET, Dhaka.

DR. M. ANWARUL AZIM — Member
Professor and Dean,
Faculty of Mechanical
Engineering, BUET, Dhaka.

A.B.M. Zohrul Kabir

Dr. A.B.M. ZOHRUL KABIR — Member
Assistant Professor,
Department of Industrial
& Production Engineering
BUET, Dhaka.



Mir Shahidul Islam

DR. MIR SHAHIDUL ISLAM — Member
Associate Professor,
Department of Urban and
Regional Planning,
BUET, Dhaka.

C E R T I F I C A T E

/This is to certify that this work has been done by me and it has not been submitted elsewhere for the award of any degree or diploma.

Countersigned

M. M. Khan
(SUPERVISOR)

M Shafat Ali.
SIGNATURE OF THE CANDIDATE

C O N T E N T S

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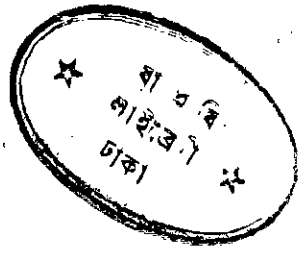
A B S T R A C T

A substantial improvement in productivity level in the industrial sector is an urgent need for the country. This has been observed that the workers performance level in this sector is far below compared to any standard. The possible reasons are ineffective policy monitoring and inappropriate and lack of basic research effort. Also there exists a "gap" in between proposed policies and the actual implementation and execution of these policies towards their achievements. The present research work was directed towards such an important aspect namely estimation of the labour productivity in some selected manufacturing units. Effort has been given to find out the factors influencing the labour performance.

A performance model has been proposed showing different factors which impede or impel the productivity of a worker. The relative importance of these factors has also been shown in the proposed model. A multiple regression analysis has been carried out using data as obtained through questionnaire surveys among both the management Executives and the workers in the shop floor. It has been observed that workers' job performance is highly correlated with "knowledge", "Skill", "Social Conditions","Individual Need","Physical Conditions" and "other related factors". It has also been observed that the quantitative values of these factors and their relevant and appropriate sub-factors as obtained through proposed quantification scales are sufficiently significant in estimating the labour performance indices in similar engineering plants.

LIST OF TABLES



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CHAPTER - 1

I N T R O D U C T I O N

The country, although is traditionally agrobased yet during the last decade a positive shift towards industrialization has been indicated. This also has been reflected in the country's Second Five-Year Plan(SFYP). In the plan a sectoral allocation for industries and minerals was set to Tk. 1390 crore(12.5% of the plan) with an anticipated annual growth rate of 8.4%. This compares to 5.4% of the overall growth rate. Though the industrial sector contributes only 8.8% of the G.D.P.(1), it plays a strong supportive role in the country's agriculture and infrastructural developments. For a country like Bangladesh with a low per capita income and a heavy population pressure and agrarian base, development of manufacturing holds the major long term hope for alleviating both poverty and guaranteeing high-level self-sustaining income growth. It was recognized that the symptom of the enterprise level problems is manifest in a general decline in labour productivity in the major sectors of the industries of the country which is shown in Table 1.1 below. But the labour productivity in the steel sector is shown to be encouraging.

TABLE 1.1

LABOUR PRODUCTIVITY INDICES
(1969-70=100)

	Industry	1972-73	1979-80
1.	Jute Textiles	101.50	56.40
2.	Cotton Textiles	74.50	32.70
3.	Paper	52.50	30.60
4.	Steel	84.60	128.60

During the last decade and a half, labour management relation has gone through strained phases, as a result there was a significant fall in overall industrial output and labour productivity. Compared to 1969/70 level productivity per worker in 1979/80 declined to 56.4 percent in the jute textile, 32.7 percent in the cotton textile and 30 percent in the paper industry. Labour productivity thus declined faster than real wage and in the end country lost valuable output and the workers lost their welfare. Though a larger number of factors contributed to this situation, it has also brought to the surface the basic fact that without an increase in labour productivity there cannot be real wage gain for labour also. Other related issues, such as "extent of workers participation in management, welfare facilities, skill development opportunities, factory environment etc. need to be kept under constant review". In the SFYP it is also emphasised that a continuous monitoring of the trends in labour productivity for all the sectors of economy is necessary. However like all other developing countries Bangladesh is no exception, where the shortage of skilled manpower has long been prevailed. This situation has further been aggravated where large scale exodus of this scarce resources has been taken place during the recent years. This is reflected in Tables 1.2 and 1.3. It can be seen in Table 1.2 that actual employment position in major industries has declined from 1979 in the engineering industries. Also in Table 1.3 estimates of employment in the industrial sector have to be adjusted accordingly.

TABLE 1.2

NO. OF WORKERS' IN MAJOR INDUSTRIES

Year	Engineering Industries	Total(including all types of Industries)
1975	41,000	3,46,450
1976	67,415	3,49,401
1977	89,639	3,94,552
1978	99,639	4,20,888
1979	99,639	4,28,552
1980	45,563	3,95,058
1981	48,711	4,43,919

Source : Bureau of Manpower, Employment and Training.

TABLE 1.3

ESTIMATES OF EMPLOYMENT IN THE INDUSTRIAL SECTOR
(Figures in million)

	1976	1976-77	1977-78	1978-79	1979-80	1980-81	1981-82
Employment in manufac-turing	1.300	1.500	1.500	1.500	1.500	1.600	1.600
a) Large Scale	0.400	0.400	0.400	0.410	0.440	0.470	0.490
b) Small Scale	0.900	1.100	1.100	1.090	1.060	1.090	1.120

Source : Bangladesh Bureau of Statistics (B.B.S.).

Thus the country is suffering in terms of production and productivity, plant utilization, development of skills , sustainance of sound industrial development and growth. This in turn has affected the overall economic growth significantly. Thus the industrial strategies and plans are colossally hampered; the vitally important strategy such as import substitution, manufacture of spares and components indigenously could not be achieved. This situation and due to some 'unveiled' reasons, the country has been pushed in resorting to unplanned import and thus positive increasing tendency of import dependence has been indicated.

But this situation should not let be continued. However, the scope and objective of the current research are not directed to find solutions to the above problems at macro level; rather a micro level study has been made in this thesis to assess the labour productivity in the manufacturing industry. The objective is to assess the productivity and its possible improvement by way of identifying few influencing variables and their control. This would thus help the management taking appropriate strategy to make best use of the available skills in the manufacturing units.

1.1 Labour Productivity and its measurement

The measurement and definition of labour productivity could be made from more than one considerations — it may

involve a comparison, in real terms between the output of a particular unit and the labour input required for its production. Thus to bring about such a comparison and measure productivity such data as total sales value (and derived gross output and value added), labour cost and other related costs should be needed in current figures. These values in a unit are subject to changes due to (i) price change, and (ii) change in numbers of units of output and input. Henceforth it has become necessary to separate the price and quantity components of the above items so that a separate analysis can be made with any change in the physical volume of output and labour input. This analysis of comparing the output with labour input which is termed as labour productivity has also been termed as "Labour Productivity Index"(LPI).

But measurement of the labour productivity index is not a very easy task while considering factors such as man, machine and management. This is because, in this situation interactions of all these factors take place simultaneously. These are the real values of machine tool utilization, workers' activities (manpower utilization-workers' performance), difference between planned timed and actual time of operation-corresponding to method and time study etc.

Productivity measurement and its control are necessary so that an improvement of man hours and machine hours spent on jobs

could be made. In this context the work content (i.e. standard man-hours required for a particular operation) per unit of output should be considered. It is therefore suffice to say that human resource factor is the single most influential among all other factors in a unit. Thus workers' performance would play the most vital role towards measuring the overall labour productivity index.

1.2 Relevance of the current study of LPI to the Country's need.

Bangladesh like all other developing countries has problems in areas such as proper utilization of imported technology (Technology transfer), technology development based on existing facilities, product design, method improvement, layout, product line balancing, inventory system and such other factors. Thus a comprehensive study to resolve these problems may become a necessity. But current focus is directed towards achieving a higher utilization of the production facilities involving man and machine.

The major industries in the country are mostly labour intensive where the productivity ratio of labour plays a very significant role in its economic development. This it has become necessary that efforts should be concentrated on workers' job performance (workers' efficiency). Although this efficiency based on effective hours available from workmen can be improved upto a certain level yet effort should be given to achieve maximum utilization of workers performance

within that level. And this is of prime importance from available human resource point of view. Regretably the workers performance level in the country is below from any standard level. Thus the whole of the industry is suffering. The possible effect of poor performance will result (i) an increase in direct labour cost, (ii) scheduling for in line production flow system cannot be maintained,(iii) the inprocess inventory will go up which will necessarily add to the cost of production and (iv) may create delivery schedule problems. Recognizing the importance and necessity of assessing labour productivity and its possible improvement, the scope and objectives of the thesis are laid down in the following article.

1.3 The scope and objectives of the present work:

Improvement in industrial productivity, specially in the labour sector, is considered to be an urgent need. Skill formation at the craftsman level and its optimum utilization represent one of the basic constituents of economic growth. It is now accepted that country's technology like in other developing countries is mostly labour intensive. So naturally scope is much more widened to concentrate the effort on expansion of labour employment. But every effort towards achieving this will be a waste if such a large community of labour is under-utilized. It has been observed throughout the whole country that in both agriculture and industrial sector manpower

is under-utilized. The utilization level is far below than those of other developing and developed countries. This is one of the important factors for which country has to pay penalty for lower productivity. With this view in perspective, the current research work is directed towards an important aspect such as productivity; emphasis would be given to find out a correlation between machine productivity and human productivity. As mentioned earlier the human productivity is the most influential factor to the overall productivity although other factors have positive influence. It is hypothesized that human performance in terms of effective man hours available from workmen, could be improved and attained to the highest possible level. This particular area of human management may be considered to be of great importance in the present day industrial situation and its context. Preliminary study on some selected manufacturing units such as Telephone Shilpa Sangstha (TSS), Metalex(Millat) industry, Bangladesh Machine Tools Factory(BMTF), Bangladesh Diesel Plant(BDP) and Bangladesh Industrial Technical Assistance Centre(BITAC) has revealed that clearly defined methodology on evaluation of worker's job performance from micro-level observations is absent. From management point of view this has a significant influence on the overall labour productivity.

Finally, there is a need for effective policy monitoring and appropriate research network to strengthen the development tools in order to draw up and execute appropriate plans

and programmes to promote the level of employment and labour productivity. Considering the importance of the productivity of labour, the measurement and control aspect at the floor levels of some selected manufacturing units has been chosen in the present work— the analysis of which would be a useful device to promote the labour productivity at national level.

The aims and objectives of the research work are as follows:

i. To identify the factors which influence workers' job performance.

ii. To develop a performance model by measuring the strenth of each identifiable variables-indicating their relative importance.

iii. To develop a scale for quantification of the qualitative factors.

iv. To establish a mathematical model using multiple regression analysis to find a relationship between workers' job performance and the quantifiable explanatory factors.

v. To find a relationship between workers' job performance and overall labour productivity index.

vi. To ascertain the causes of lower productivity.

CHAPTER - 2

LITERATURE SURVEY

Productivity-though it is a common term, yet it is not so easy to define in real sense. Moreover it can be defined in many ways taking different factors into consideration on different fields of respect viz. agriculture, manufacturing, firm level etc. But in every situation productivity plays a major role in the determination of profit as well as overall situation of the sector.

SUTERMEISTER[2] stated that increase in productivity depends upon or is determined by technical factors viz. technological development, raw materials, job layout and methods and human factors-mainly workers' or employees' job performance. Both of these should be considered simultaneously. After him productivity is defined as "output per man per hour, considering quality". The output per man per hour results not from man's effort along but results jointly from all the factors of production used such as labour, management, money, machines, raw materials etc. Productivity might also be expressed in terms of output per Taka value invested or output per unit input of raw material or output compared with any other input factor. The important points of Sutermeister's productivity model are given in Appendix I. In the model the activity weightage(in percentage or in any means) among the major factors were not given. Mention has only been made that the relative importance of each factor would probably

be different for different types of organization and they are subjected to change with time.

ARGYLE et al[3] gave a clear cut concept of productivity which is not determined solely by how hard and how well people work. The Technical Factors play a role, sometimes an overwhelmingly important one, sometimes a minor one.

CHANDY[4] viewed that productive capacity includes investments not only on reproducible tangible assets but also on human capital assets like health and sanitation, education and skill, research and training etc. The results of the analysis of 169 reports of National Productivity Council of India by CHANDY are presented in Table (A.2.1) in Appendix-II .From this study it revealed that the factors influencing productivity are human factor(36.34% weightage), communication and control process (27.05%), structure of organization(13.66%) , Machinery and equipment(9.02%) , Resources(7.92%) , socio-political and Market related (6.02%) . CHANDY viewed that to promote productivity increased number of persons should be trained in industrial skills under different training scheme within or outside the country as corporate target setting high degree of skills and favourable attitudes towards work are invariably the positive factors affecting the productivity. With reference to the input-output model of productivity the ratio in between them can be improved either by increasing the output or reducing the input whatever it may be.

In this context LIU[5] explained that "the input require-

ment of the modern production activities can be classified into physical input, which contains labour, capital and natural resources as well as invisible input which contains, motivation, knowledge, technology, management etc. Either the physical input or invisible input contains many complicated factors and involves the factor of human beings, which is probably the factors most hard to understand and most difficult to handle". He also pointed out a number of factors which are related to the performances of the productivity such as rationalization of organization and effective job procedures, basic education and training, wage system, mobility, new marketing channels, utilization of equipments, material improvement and substitutions, quality control, technology acquisition and absorption, R & D, national policy, environmental pollution control, socio-culture conditions, business cycle, weather , political situation etc.

AHMAD(6) analysed a country report on inter-industry differentials in productivity. The analysis was based on a large sample of manufacturing industries in Pakistan and on published information reported in the"Census of manufacturing Industries"(CMI) for 1966-67. In the study independent variable such as capital intensity, capital to labour ratio, ratio of net to gross capital stock, size of the establishment, number of reporting establishments, exports, import dependence, labour skills and quality, professional ratio, local versus foreign

firms etc. were used to regress with productivity differentials. Considering preliminary observations and correlation co-efficients productivity differentials appeared to be positively correlated with capacity utilization rates, average earnings, the size of establishments, capital intensity and foreign owned firms and negatively correlated with the degree of import dependence and number of establishments in each industry. Two correlations, productivity versus skills and the age of the capital stock, while significant, had the wrong sign.

AHMAD also focused on the results of a pilot opinion survey conducted by country Experts on productivity in some selected manufacturing establishments. The main objectives of the survey were to determine the factors which were presently hindering the achievement of high productivity levels as well as an identification of factors which were seen to be important in the determination of productivity levels in the future. It was seen from the detailed analysis for all manufacturing units that majority of the respondents claimed"labour indiscipline " as the most important factor limiting productivity(about 91.3%), 40.7% of the respondents reported" poor production planning" as being the second most important factor while 36.7% for power failures and 25.1% for out-dated plant and equipment.

On the other hand amongst the factors which were seen to be important of raising productivity (i.e. factors which

would help productivity) about 52.6% of the respondents said that restoring the right to management to hire and fire workers was the most important pre-requisite to raising productivity, 44% viewed that improvements in the quality of management were needed, while 35.8% of the respondents felt that making workers more productive and cost conscious and finally 35% gave their opinion on the importance of greater political stability.

NORMAN & BAHIRI[7] stated that engineers' measure of productivity was different from the traditional one. Accordingly productivity and effenciency are often regarded as synonymous. BAHIRI and MARTIN[8] claimed that most engineers have the same view that productivity is related to the efficiency of the producing activity and therefore implies an output/input relationship.

NORMAN and BAHIRI gave a scheme for measuring performance indices. This scheme based on work measurement principles provide a measure of performance(i.e. efficiency) against a standard by which both management and workers compare the effectiveness of their work, the basis of which is an operator (individual) or Group performance index i.e.

$$PI = \frac{\text{Standard Time for work done(measured)}}{\text{Actual time taken to do the work}} \times 100$$

where PI = Performance Index.

The standard time for a job is the sum of clock times required by a qualified workmen to:-

i) Carryout his task at the standard level of performance.

ii) Recover from the physical and mental strain imposed by his task.

iii) Compensate him for small contingent delays for which management are responsible. They claim that performance of worker has great influence on productivity. Management of all industrial enterprises should give stress on work measurement and method study, so that evaluation of workers job performance can be judged perfectly.

Considering productivity, DUDLEY[9] gave his strong argument on relaxation allowances- one of the vital factors of motion time analysis as well as the human factor analysis. According to him, relaxation allowance should be graded on the types and nature of the jobs considering fatigue and effort. An operative's working pace can be affected by factors such as attention required, concentration, confined working space, abnormal working conditions, special clothing and these obviously present an element of inconsistency in assessing the actual working pace relative to a standard.

Productivity, according to SHUNSAKU et al[10] may be affected by factors such as(a) Geographical, Sociological and climatic conditions(b) Cartels and other types of market

control of products and other market factors(c) Institutional conditions on taxation and legislation(d) Size of business plant or equipment(e) Wage system, hours of work intensity of labour in operation. Amongst these factors, (a), (b) and (c) are termed institutional factors,(d) is technological and capital dependent, (e) is the condition relating to workers. SHUNSAKU et al reported that according to a productivity survey report published by the Japanese Ministry of Labour, the important factors that affect productivity of the firm or industrial enterprise are (1) The placement of equipment and personnel(2) The skill of the workers (3) The quality of materials used in the production process (4) The ratio of operation.They expressed their view as though the quality of raw materials, the skill of labour and other factors influence labour productivity and determine the overall effect yet, the most fundamental factor which determines productivity is the relations between equipment and worker. The relationshipof the workers to each other and to management have also an importance towards labour peoductivity.

YOON-BAEGUH et al of Soong Jun University Team and DONG KYU CHOI et al of Korea Productive Centre Tem(11) worked jointly on productivity analysis condisering some selected industries of different nature viz, fertilizer, machinery and ceramics.The objectives of the study was to find out the factors which help or hinder productivity of these industries of Korea. The methodology followed was the statistical analysis of different types

of data obtained from questionnaire survey. From the analysis it was clear that employees' or workers' efficiency increased in the machinery industries when good human relations were maintained and wages increased. The research work also revealed some important points on productivity achievement. These along with other aspects are detailed in Appendix -III.

Research on human relations and productivity was carried out by MAYO(12) in his famous Hawthorne study. The significance of the study was in discovering the informal organization and its existance in all organizations. It demonstrated the importance to individuals of stable social relationships in the work situation. The impact of the study has been tremendous. It led to a fuller realization and understanding of the human factor in work situations. The work also led to an emphasis on the importance of an adequate communication system, particularly upwards from workers to management.

To discuss about the improvement of effectiveness and productivity one should know what management really is and how it really functions. From productivity point of view MUNDEL(13) defined management"as that of designing predicting the performance of and constraining the use of many integrated human group activities and the related physical resources and environ-

ment., for the purpose of producing the outputs selected for achieving the assigned objectives. The outputs may be either services, goods or a combination of both". Effectiveness and productivity are interrelated and the annual rise of productivity occurs mainly due to the persons who are directly or indirectly related to the production, other agencies and also due to management. A generalized set of terms known as " Work Unit" has been established when considering quantitative aspects of service outputs. The performance of a human motion is the Ist order work unit, the activity associated with the performance of part of a task is the 2nd order work unit and so on thus a large group of end products or completed services of the working group results on gross output-which is the 7th order work unit. If it is possible to divide the whole production scheme in such work units then invariably, productivity will be raised to a high extent.

MATSUMOTO(14) expressed that the workers in a major Japanese industrial concern are the heart of that industrial units in much the same manner that the shareholders are the nerves of a European or American Industrial organization. It seems that the workers' active participation has the direct bearing on the overall situation of an industry. From the management point of view, workers unlike other factors of production such as equipment, land and raw materials are irreplacable. Hence it is important that workers' potential and morale remain high. The following aspects regarding productivity

were given importance:-

(a) Improvements in production systems through suggestions and QC(Quality Control) circles. The QC, a statistical quality control system may be regarded as voluntary worker participation in product improvement. QC circles are small groups of workers who discuss and exchange ideas on product quality improvement.

(b) Workers' participation in management decision-making and

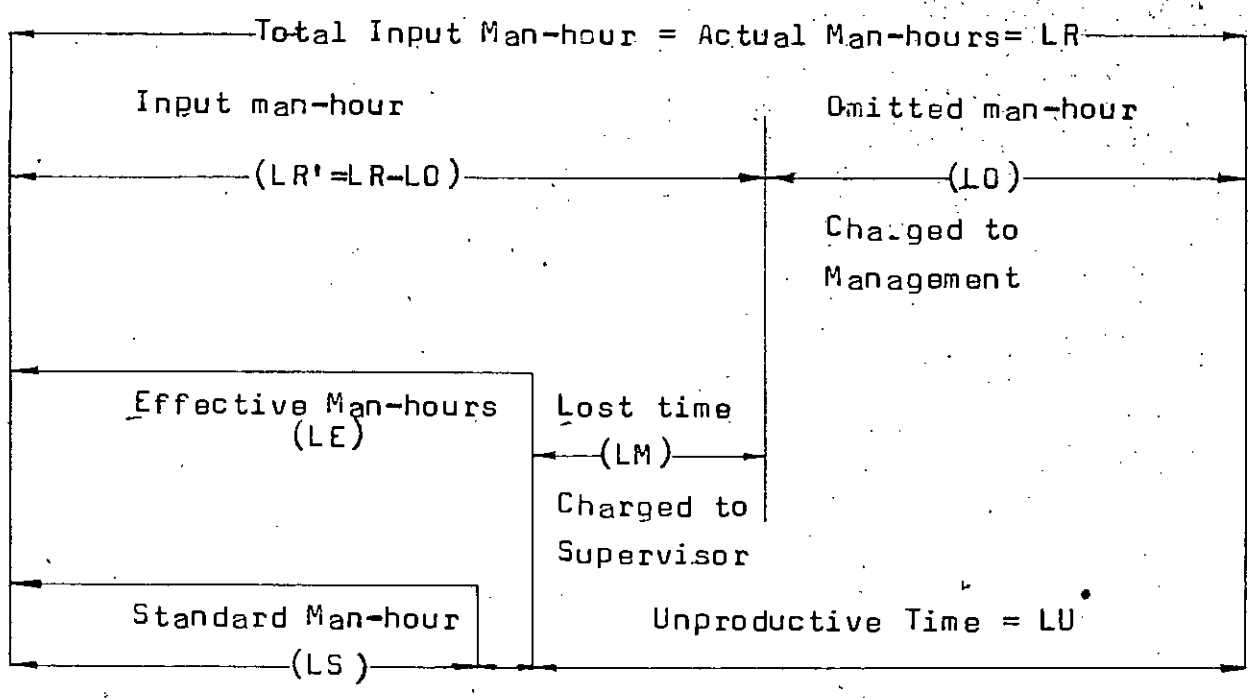
(c) Collective skill of the working team. It may be regarded as the grass roots foundation of industrial technology.

CHIN HOCK & TING[15] found from productivity analysis that there exists a positive correlation between labour productivity and average earnings per employee. The co-efficient of rank-correlation between these two variables was significant at the 5 per cent level of significance. Another feature of labour productivity in manufacturing sector was a positive correlation between labour productivity and the net value of fixed assets per worker. The labour productivity of both the manufacturing and the constructions sectors was still below the national average. To overcome this situation importance was given on greater efforts and further improvement in the techniques of production and organization, the skill and training of workers and capital endowment per worker on priority basis.

KUROSAWA[16] an APO (Asian productivity Organization) expert had carried out a study on productivity measurement and

control at a selected ship-building and ship-repairing workshop of India in mid 1977. The methodology was directed towards mainly the improvement of man-hours and machine-hours spent on jobs. Workers' performance or efficiency plays the key role towards productivity measurement and controls. SASMAL[17] was associated with KUROSAWA on the same research work. Both of them regarded productivity and workers performance as synonymous. But they differentiated positively in between overall labour productivity and workers' efficiency where overall labour productivity depends almost on workers' efficiency as well as some other factors also.

Methodologies adopted by KUROSAWA were mainly implemented in phases with modification in the research work of SASMAL. Their proposed overall labour productivity model based on labour utilisation and management in terms of man hour's(work content) can be defined as follows in the diagram:



The essential relationship between labour productivity and other related factors in which workers' efficiency plays an important role are:

Overall Labour Productivity of the organization	=	Standard Productivity (refers to Technology and organization factor)	X	Workers' efficiency	X	Ratio of effective Man-hour to input Man-hour	X	Ratio of Input Man-hour to Total Input Man-hour

i.e. $\frac{Q}{LR} = \frac{Q}{LS} \times \frac{LS}{LE} \times \frac{LE}{LR'} \times \frac{LR'}{LR}$

where Q = Output in physical units/equivalent tons or numbers etc.

All the above factors are mutually inter-related. The last two terms of the above equation can jointly be termed as "Contribution of Efficiency of labour Resources use". However this factor caused in improving labour productivity is associated with reduction i.e. the improvement of lost time and omitted time.

The research work emphasized that the workers performance (efficiency) is not only dependent on subjective factors like workers willingness, knowledge, skill, value judgement,

morale, working hours but also dependent on objective factors namely plant, machinery, work situation management etc.

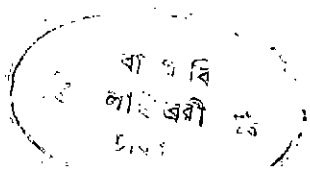
BARKAT et al[18] have defined production as the function of employment and productivity. They have proposed an efficiency model for agriculture planner in which it has been shown that efficiency is a function of ability, motivation, coordination, environment and also other unknown factors.

A case study conducted by AZIM[19] on a Engineering manufa turing unit in Chittagong, Bangladesh revealed that the existing machine utilization as well as manpower(labour) utilizatirn were not upto a satisfactory level. The percentage of utilization in both the cases of machine and manpower were found to be less than 50. He concluded by proposing suggestions to achieve higher utilization that prior importance should be given to the overall management of the workers.

A consulting group[20] of Bangladesh Management Development Centre, Dhaka, has proposed a performance appraisal system for Bangladesh Jute Mills Corporation Workers. This was the part of "production incentive scheme" design. Factors affecting the performance of workers were selected through interview, group discussion and practical observation and finalized through a questionnaire survey. The survey was limited to managers and supervisory levels. On thebasis of in-depth analysis of the findings of the survey, performance appraisal scheme

were developed containing those factors affecting workers performance and their relative weightage reflected by the respondents. The factors selected were, job knowledge, sense of responsibility, accuracy, initiative, quality of work, speed of production, loyalty, co-operativeness with other worker, thoroughness and neatness, health, attendance, dependability, tardiness, adoptability and leadership. They have also developed three different performance appraisal forms for different catagories of workers. They have assigned different points(weightage) against each of the factors selected for particular types of form. But no mention was made on what basis the point-scheme was prepared. Another limitation of the study was the inherent difficulty on the part of a supervisor to assign a right figure(points) from amongst more than one alternatives. This assignment is necessary to give a score to a particular worker for finding out the performance index.

The above literature review would give a definite pointer that labour productivity or labour productivity index or labour performance Index(LPI) as termed are all synonymous. But certainly LPI differs significantly from overall labour productivity Index(OLPI). Though LPI plays the most important role towards productivity, yet it is not the only factor for measuring OLPI- there are also other technical factors which have direct bearing on OLPI. The explanations, conceptualiza-



tions and discussions of the various authors has finally led to a common point as to MAYO'S conclusion and wherefrom the science of human relation has evolved..Labour productivity is greatly influenced by the factors of human relations, the relation between the management and the workers, the informal social organization amongst the workers and its recognition by the management.

In quantitative assessment of qualitative attributes there exist various scaling procedures such as, Likert Scale, Gutman's Scale or a more generalise Flexible nine-point scaling method. Amongst these methods the Flexible nine-point scaling method has been improved by Islam[21]. This method is capable in giving a clearcut overall picture of qualitative attributes in quantifiable form. This scale is developed on the basis of different interval scales currently in practice. Measurement of a variable is done with a numerical scale ranging from 1 to 8 equal spaced.In the case of dichotomous questions, the value '8' was given for most suitable answer and value '1' was given for the least. This is depicted pictorially below.

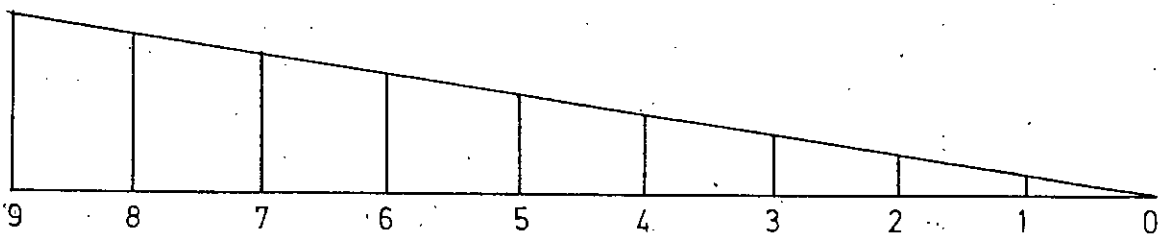


Fig. 2.1
Scale for Measuring the variables

The digits '0' and '9' were allotted to the "not responded" cases and "not applicable" cases for a particular question.

At the initial stage of the current work this method was thought to be most suited. But in later stage it was found that this method could not adopted in its own form. This is because of the variation of the intrinsic characteristics of the present research work. Thus necessary modifications were made according to the requirement of the present work. But the inherent logic of the method was carefully adopted and applied throughout the study.

But the major shortcoming of the above studies ends upto a point where such assessment of labour productivity Index and its evaluation quantitatively become a problem. The evaluator has to use his judgement which leads to subjectivity and then controversy. The present work is thus directed to propose a quantitative approach to use a simple linear equation to predict the productivity index. The explanation and development of proposed scaling method and of such a mathematical equation are detailed in Chapter 5 and 6.

CHAPTER - 3

METHODOLOGY AND DATA COLLECTION

The in-depth analysis of the literature survey in the preceeding chapter reveals that there exists a relationhsip between management of human relations and ultimate growth of a countrys' productivity and hence economic development. It is recognized that human resources are the major instruments of all development. A number of empirical studies have also proved that a country's economic progress has been due more to the knowledge and skill of the people than to the abundance of resources from nature. In view of the significant role of man as the most important agent of economic growth, a high priority has been given to the human resource development. With this view in perspective the current research work is directed towards relating human factors to the workers(human) productivity.

3.1 Methodology of the Study :

A multifactor analysis has been carried out concerning labour productivity, overall or total labour productivity and the factors affecting them. Any research in this field would require basic data which in most cases are generated. The present study is also no exception. However, a discussion on the data generation and collection procedure used in the present study is reserved at this point until article 3.3 of this chapter. Considering the time restriction of the present work

it is limited to only five industrial units. These are the Bangladesh Machine Tool Factory(BMTF), The Bangladesh Diesel Plant(BDP), The Telephone Shilpa Sangstha (TSS), The Metalex (Millat) Corporation and the Bangladesh Industrial Technical Assistance Centre (BITAC). The selection of these units was made on the basis of the similarity in their nature of production and willingness of the managements of these units to participate. It would be hypothesized that for similar production situation, with similar job structure and facilities, the productivity of the workers would be affected due to influence of factors similar in nature. Based on this hypothesis the field of investigation in the present context is limited to the shop-floor level workers who basically work on similar general purpose machine tools such as lathe machine, drilling machine, milling machine, grinding machine etc. such narrowing down of the work to a specific field had been made because of some inherent difficulties and unavailability of the secondary data(as mentioned in Art. 3.4).

From preliminary observations and few informal interviews with the Executives of the above units some principal factors and their related sub-factors had been selected for considerations. For quantification purpose and to find out their relative effectiveness two separate surveys were carried out with two separate questionnaires. The questionnaire(type I) was designed and a survey of this questionnaire had been carried out amongst

the top and mid-level management executives of those selected units. With a view to propose a quantitative technique for quantification of attributes for various factor a second questionnaire(Type II) had been designed and a survey of this questionnaire had been carried out among some selected floor-level workers(machine operators). This survey was carried out in only three units such as BDP, BMTF and TSS. From the preliminary and secondary data and by using some logical subjectivity, quantitative scales for different sub-factors had been proposed. An analysis of the questionnaires and with the help of the quantitative scales each of the selected workers were given scores out of total of 100 marks. Labour performance indices were calculated from the secondary data and collected data. A multiple regression analysis had been carried out to find a relationship between the workers job performance and the quantifiable explanatory principal factors.

Workers job performance and the overall labour productivity:- Formulation of a Model:

Preliminary observation and informal interviews revealed that there were many factors influencing the labour productivity. These are of two categories namely,(1) human related and (2) technical based. The human related factors are, basic education, experience, training, aptitude, accuracy, personality, wage-salary, incentive, leadership, performance rating, job satisfaction, general economic conditions, level of aspiration, on-job and off-job

activities,health, safety etc. There are few factors which concerns management such as organizational efficiency,organization structure, selection and placement, norms, lighting,temperature etc. may also affect productivity. The technical factors are technological development, raw materials, machines utilization, method and design, job layout, marketing, capital intensity etc. The labour productivity is mostly related with the first two categories of factors namely, human related and management related while all other factors including the technical factors would influence the overall labour productivity. These two terms of productivity can be defined as follows:

Labour productivity = function of purely human related factors and some factors related to management.

or, Labour productivity= f_1(ability, motivation)

Overall labour productivity= f_2(labour productivity, technological development, raw materials, m/c utilization, method and design, job layout, marketing, capital intensity etc.).

where, f_1, f_2 = linear functions of labour productivity and overall labour productivity.

The key-factors ability and motivation as given in function, f_1, are the two major factors influencing labour productivity.The possible attributory factors of the key-factors, ability, are "knowledge" and "skill" called the principal factors. Meaning

that ability is deemed to result from "knowledge" and "skill". The other key-factor "motivation" is considered to be constituted of principal factors such as "social conditions", individual needs" and "physical conditions of the job". So ability and motivation can be explained as follows:

$$\text{Ability} = f_3(\text{knowledge, skill})$$

$$\text{Motivation} = f_4(\text{social conditions, individual needs, physical conditions})$$

where, f_3, f_4 = linear functions.

In the present work, knowledge, skill, social conditions, individual needs and physical conditions are taken as five principal factors affecting labour productivity. Basic education, experience, training, interest-these four sub-factors are directly related to the principal factor "knowledge". "Skill" has sub-factors such as aptitude, personality and accuracy. "Social conditions" comprises of the sub-factors such as wage-salary level, incentives, organizational efficiency, organizational structure, selection and placement, leadership climate, job-content, job-evaluation, relationship with superior, communication, leadership, performance rating and norms. "Individual needs" is influenced by the sub-factors: job satisfaction, general economic condition, level of aspiration, perception of the situation and on-job and off-job activities. "Physical Condition" is the function of the following sub-factors:- lighting, temperature, ventilation, cleanliness, rest-period, safety and health. Factors related to management

gement are also considered here in the present study. Literature survey reveals that many behavioural scientists and management experts have often regarded labour productivity and labour performance as synonymous. In the present work the ratio of standard time(measured) for work done and actual time taken to do the work has been considered to be a measure of the labour performance index. More explicitly labour performance index is the ratio of actual quantity output to standard quantity output per-unit time. Thus, the labour performance index is given by:

$$LPI = \frac{Q_a}{Q_s}$$ where, Q_a = Output per hour (actual)

Q_s = Output per hour(Standard)

The above expression could be rewritten as:

$LPI = t_s/t_a$, where t_s= Standard time required to produce 1 unit

t_a= actual time required to produce 1 unit

From management(factors related to management) point of view labour productivity can be explained as follows:

Labour productivity $= f_5$(knowledge, skill, social conditions,individual needs,physical conditions, other related factors)

= Labour performance (LP)

= Labour performance Index(LPI)
(when considering the ratio of standard time versus actual time of operation).

The relationship between the overall labour productivity and the labour performance(workers' job performance) is given below:

$\therefore$ OLPI = f (LPI, TD, RM, MU, DM, JL, MR, CI)

where,
OLPI = Overall labour productivity index.
LPI = Labour performance index.
TD = Factor related to technological development
RM = Factor related to raw materials.
MU = Factor related to machine utilization.
DM = Factor related to design amd method.
JL = Job layout factor
MR = Marketing factor
CI = Capital intensity factor

Workers' performance and overall labour productivity model is shown diagrammatically in fig. 3.1. In the figure size of each segment does not reflect the relative importance of the effectiveness of the variables.

3.2 The use of Multiple Regression Analysis to Establish the Labour productivity Index Co-efficients:

It was hypothesised that labour performance Index(LPI) depends linearly on six principal factors. These principal

factors could be called the explanatory variables, x_i. Thus, the dependent variable LPI could be explained by x_i. Multiple regression analysis is a parametric method of estimation. Specially the object was to develop estimating equation by identifying the main explanatory variables, called regression and to relate these variables to a dependent variable, in order to produce the best estimation of the latter variable. Thus, the general form of the estimating equation is given:

$$Y = \beta_o + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6$$

where, Y = workers' job performance index, LPI.

X_1 = Knowledge of the worker

X_2 = Skill of the worker

X_3 = Social condition of the job

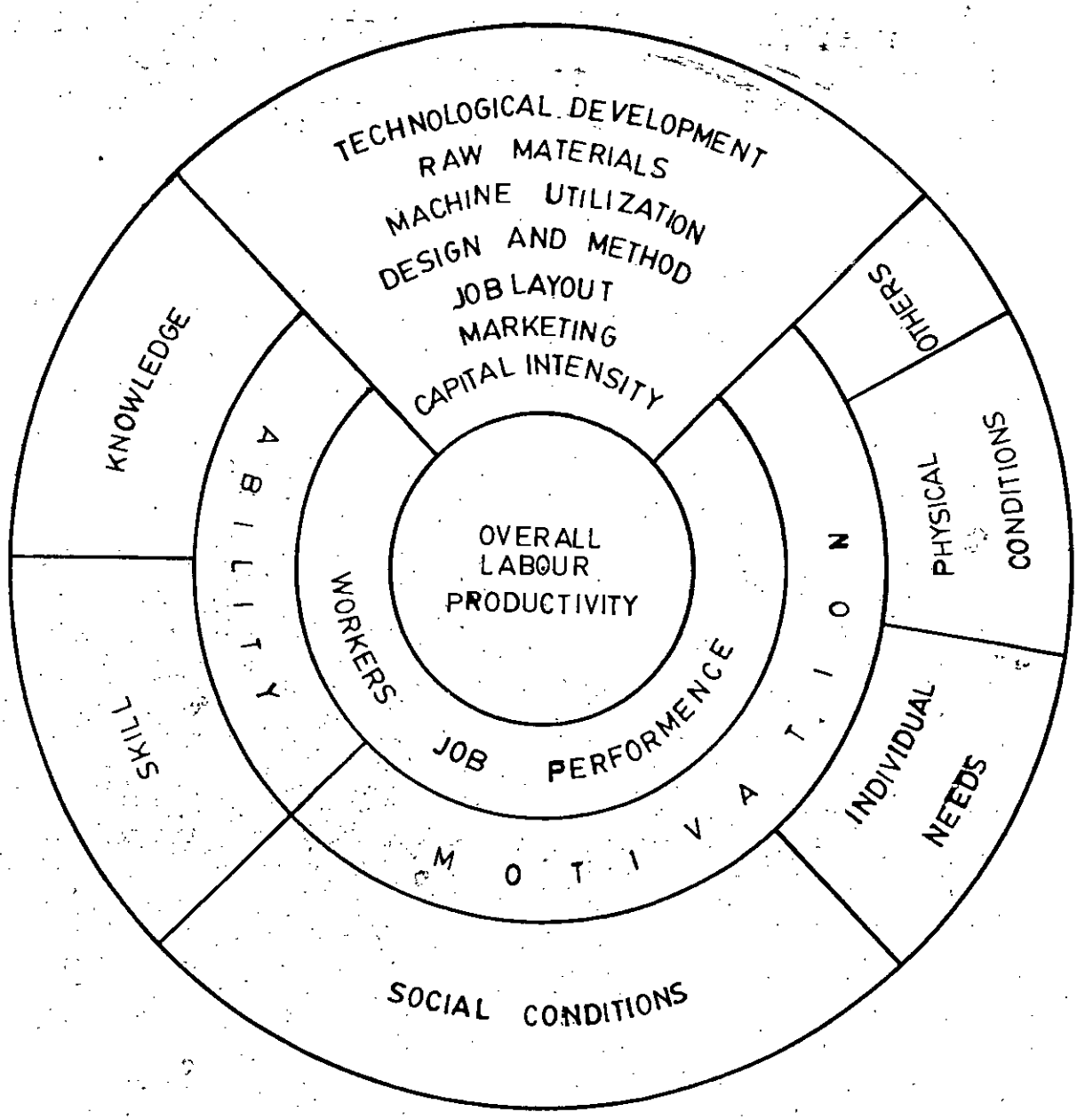
X_4 = Individual needs of the worker

X_5 = Physical condition of the job

X_6 = Other related factors.

β_o, β_1, β_2, β_3, β_4, β_5 and β_6 are the co-efficients of regression equation.

The values of the regression co-efficients were obtained by using the least sqares method. The method of multiple regression analysis is a powerful technique and is used in various fields of science and business.



Source:- Sutermeister's Productivity model 'People & Productivity' Mc Graw Hill, N. Y. 1963.

FIG. 3.1

OVERALL LABOUR PRODUCTIVITY MODEL

The 35 sets of data for the three units such as T.S.S. B.D.P. and B.M.T.F. in the present analysis were fed into a standard multiple regression program on the I.B.M. 370/115 Computer at Bangladesh University of Engineering and Technology, Dhaka. The data sets were prepared through questionnaire survey conducted in the present work. This section is devoted to collecting of data.

3.3 Data Collecting Method of the Study:

The data collection process of this study rather needs a special consideration. It is mainly because of the pioneering character of such a research work. In order to attain the desired objective, primary data was mostly used and there was a few secondary data.

In the collection of primary data the method could be phased in five stages, namely:

a) Phase - I : Interview sessions with management executives to identify the factors influencing labour productivity.

b) Phase -II : On the basis of outcome from Phase-I, design of a questionnaire (Type-I) and make a survey among the management executives.

c) Phase -III : Design of questionnaire(type-II) for the workers' and make a survey among the workers.

d) Phase - IV : Interview sessions with respondents and non-respondents of the questionnaires (Type- I & II) after the preliminary data compilation and analysis of the questionnaires.

e) Phase - V : Collection of secondary data based on work and time study for the standard times for various jobs as selected in the shop floors.

Phase - I Interview Sessions:

Informal interviews were conducted among top and mid-level management Executives of BMTF, BDP, TSS, BITAC and Metalex to identify and select the principal factors and their respective sub-factors which influence the workers' job performance. These were considered to be the basic tools in designing questionnaire (type-I) . The interviews taken were based on asking some general questions about workers performance, the overall labour productivity and the existing tools of management of the respective manufacturing units. Total number of persons interviewed were 20. Informal interview was also conducted among university teachers, behavioural scientists and management experts. Questionnaire for the 2nd phase may be considered mainly based on the result of the First Phase. The interview study has resulted in identifying the principal and

sub-factors of the performance model. In the next stage, a questionnaire was designed and tested in the study group of the management executives. Finally this was sent amongst the study group for actual filling up.

Phase - II : Survey of questionnaire (Type-I):

A questionnaire was designed for the top and mid-level management Executives including the engineers. This questionnaire Type-I in blank is shown in Appendix IV. These questionnaires were distributed amongst the 62 management Executives and supervisors of which 50 of them had responded. Out of 24 questionnaires sent, 18 had been returned by the BMTF respondents, the percentage of response being 75.00. The percentage of response in T.S.S., Metallex Corporation, B.M.T.F. and B.D.P. are 92.86, 85.71, 77.78 and 75.00 respectively as shown in Table 3.1.

TABLE - 3.1

PERCENTAGE RESPONSE OF QUESTIONNAIRE TYPE - I FOR THE VARIOUS UNITS

Name of the Organization	No. of questionnaire distributed	No. of respondents	% response questionnaire distributed	% from total respondents	comulative % response
BMTF	24	18	75.00	36	36
TSS	14	13	92.86	26	62
Metallex Industry	7	6	85.71	12	74
BITAC	9	7	77.78	14	88
BDP	8	6	75.00	12	100
Total :	62	50	80.65	100	100

The respondents while arranged positionwise(official designation) in their respective organizations the resulting distribution could be shown as in Table 3.2 below. Analysis of these 50 questionnaires returned by the study group was analysed in Chapter - 4.

TABLE - 3.2

PERCENTAGE RESPONSE OF QUESTIONNAIRE TYPE-I POSITIONWISE OF THE RESPONDENTS.

Designation	No. of Respondents	% from total Respondents	Cumulative
DGM/DPM and above	4	8.00	8.00
DCE	9	18.00	26.00
ME/Sr. Engr.	16	32.00	58.00
AME/AE/Jr.Engr.	19	38.00	96.00
Industrial psychologist	2	4.00	100.00
Total :	50	100.00	100.00

	Key	:	Position description
Where,	DGM	:	Deputy General Manager
	DPM	:	Deputy Production Manager
	DCE	:	Deputy Chief Engineer
	ME	:	Mechanical Engineer
	Sr.Engr	:	Senior Engineer
	AME	:	Asstt. Mechanical Engineer
	AE	:	Assistant Engineer
	Jr.Engr	:	Junior Engineer

Phase-III : Questionnaire(Type-II) survey amongst the workers:

The questionnaire(type-II) designed for the floor-level workers' is shown in Appendix-VI. These questionnaires were not directly sent to the workers', rather the author of this thesis filled by himself for the workers. Thus personal discussion sessions were held with each individual workers' surveyed at various times. The personal discussion sessions took the author one month in total. Although the interview of the 35 workers from the three different plants, namely,BDP, BMTF and TSS were surveyed thus as many questionnaires of type-II were filled in. The distribution of the participants plant-wise is shown in Table 3.3.

TABLE 3.3

DISTRIBUTIVE OF THE PARTICIPANTS OF QUESTIONNAIRE TYPE-II

Name of the Industry	No. of selected interviewee	% from total No. of selected interviewee	Cumulative
BDP	11	31.42	31.42
BMTF	12	34.29	65.71
TSS	12	34.29	100.00
Total :	35	100.00	100.00

Phase-IV : Informal Interviewes after questionnaire surveys:

The phase comprises of informal interview sessions with the respondents and non-respondents of management personnel group and also of the workers' after the preliminary compilations of questionnaire data. In the process of the compilation of the

primary data from the questionnaire returns, some critical and contradictive cases emerged. It was therefore felt necessary for further interview of the respondents. Thus few further interviews were arranged with those respondents whose returns deviated from the other normal returns. From the discussion this could explain the deviation, in some cases these were reduced.

Phase - V : Collection and generation of Secondary Data:

Secondary data of workers' job performance based on work and time study had been collected during this final phase. A detailed work and time study concerning standard time and actual time of operation had been carried out throughout a period of one month. The process of work measurement had been done for each of the individual 35 selected workers from the three plants.

3.4 Sampling Procedure of the Surveys:

During the opinion survey of questionnaire Type-I, the participants of the various organizations were found to be highly co-operative and had shown enthusiasm and encouragement of the research study. This indicates the high success rate of questionnaire(Type-I) returns of 80.65% out of 62 questionnaires, on the otherhand, more attention and effort had been given on the quality of the respondents rather than its size. The total number of workers selected for

interview of questionnaire Type -II, was 35 which is rather small but this size would well represent the population from statistical point of view. Thus analyses using these samples for each of the questionnaires were able to explain certain important characteristics. These are as follows:

a. For Questionnaire Type - I Survey (considering proportion of respondents to the total number of management personnels of each industrial organization). The sample sizes of the respondents from the various organisations represented in terms of percentage of the total population in the plant are given below in Table 3.4.

TABLE 3.4

SAMPLE REPRESENTATION OF THE TOTAL POPULATION

Name of the Organization	No. of respondents	Percentage of Total population
BMTF	18	60
TSS	13	75
METALEX	6	80
BITAC	7	70
BDP	6	60
Total:	50	

b. For Questionnaire type-II survey(considering proportions of selected interviewee to the total no. of floor-level workers of each industrial organizations).

: Sample taken for B.D.P. represents 40% of the total population.

: Sample of BMTF represents 20% of the total population.

: TSS sample represents 40% of the total population.

Thus it may be stated that the sample sizes are quite representative from the statistical point of view.

3.5 Limitation of the Study:

This present research work has been made with an archiserious conceptual constraints-subjective in nature, scarcity of dependable data and empirical investigations into the field of observations. Efforts had been given to achieve best possible results despite the author could not overcome few limitations, mainly for two reasons:

a. A few limitations which were beyond the scope of the present study.

b. Nature and volume of the work.

The serious limitations encountered in the present study were given below:

1) The time limitation of the study period had restricted to end up with any 35 workers at the floor level. This is because the time required for each interview was very lengthy.

2. Considering the general level of inteligence of the workers and the spontaneousness in willing to participate, it has forced the author to restrict in taking interviews of only the skilled and semi-skilled workers.

3. Labour performance Index(the value of Y in the regression model) was calculated taking specific production operations of few specific type of machines into consideration irrespective of their type, dimension and exact sequence of operation.

4. In BITAC relevant data were not available to find out performance index (LPI) in terms of standard man hour and the actual man hour of each of the workers due to some technical difficulties. So survey of questionnaire of type-II was not carried out in BITAC and Metalex Corporation.

5. All the five selected manufacturing organization were not exactly similar from manufacturing point of view (as output was different for different plants) although there existed identical machinery facilities in the workshop levels.

6. Among the respondents of the questionnaire(Type -I), none-from the highest level of the organizational hierarchy such as the general Manager, the Chief Engineers and others could be available in the study.

7. The value of LPI for most of the workers of TSS is more than 1 (i.e. more than 100% efficient), theoritically which is not always possible, even though they are much more efficient than the workers of other two plant.

The causes of the above limitations could be explained as follows:

i. The relevant managements of the study plants would not allow the writer to take interviews of sufficient number of workers. This is because that this would hamper the sequence of operation and thus would disrupt the flow of production. Besides the writer had to face some inherent problems in conducting interviews with questionnaire type -II with the workers. To overcome this latter problem the writer had to select skilled and semi-skilled workers.

ii. Non-availability of accurate secondary data of the values of LPI(Y) from "live files" of the relevant plants. These values should usually be obtainable from work measurement studies of the plant itself. Thus in the present study the writer had to generate sometimes these secondary data by taking actual readings during the study period.

iii. Variation in production technology and production/output had been observed amongst the plant. This resulted in that the workers' degree of involvement in production unit,

varied plant to plant. BITAC is an example, as its major objectives are to offer technical assistance to provide advisory services to industrial organization in serving individual in plant problems including installation techniques production planning etc. to develop skills of industrial personnels through practical oriented advance technical training and also by dissemination of technical know-how among industrial persons. Thus, BITAC could not forecast and plan its future activities in terms of production and manufacturing activities which result in that the workers are not properly and fully engaged in production.

iv. In Metalex Corporation it was found that only a few workers are involved in the machine tools operation. But their involvements were not as relevant as required by the present research scope. Thus this manufacturing unit was excluded for the questionnaire survey type -II.

v. The top level management Executives could not, in some cases, give required time as the time of the study coincided with the closing time of the financial year. In some cases the author could not convince the respondents of the inner significance and meaning of the current research work and the implications of its findings. They feared that the findings of the work would implicate

interms of affecting their respective industrial status. Thus few of them refused to fill in the questionnaires.

vi. The labour productivity index of the TSS workers had been measured on the basis of a rating which the responding Executives indicated to be imperfect. This is because the standard time as prepared and latter accepted by the trade union of the organization was fixed at higher values; so that, the workers' could achieve the target and get incentive bonuses at normal situation.

Incentive bonuses are awarded to those workers who exceed the rating of 100.

CHAPTER - 4

PERFORMANCE MODEL AND THE MAJOR FACTORS INFLUENCING WORKERS' JOB PERFORMANCE

Analysis of the attributes, variables or factors which are related to the basic phenomena of behavioural sciences and the human relations is a difficult task. The problem becomes more complex when analytical approaches are necessary. The social scientists, the management scientists, the economist and many others have given considerable efforts to overcome this problem of quantification of such factors, variable etc. which are of qualitative in nature. An example may be given when defining the attributes of a factor such as "individual need of a person". The scale for such attribution may be—

Low ⟶ Average ⟶ High ⟶ Very High

The above scaling may not be of any usefulness to a researcher unless he can put some numerical values for these attributes of low, average, high, very high. This quantification approach has predominantly taken its place when computer application has become a pre-requisite. In the present work also quantification of attributes of factors which are otherwise qualitative, becomes necessary. Thus the present chapter is devoted to establish such quantification scales.

4.1 Identification of the Principal Factors Affecting Labour Productivity and their Relative Weightages:

In the preceding chapter the data collection methodology and a sampling procedure has been described in details. The scheme of the questionnaire survey and data collection has given the basic foundation in the development of the proposed scale. Opinion survey based on questionnaire(Type-I) revealed that most of the supervisors and top-level management Executives (including the engineers who are directly related to production) had placed the attributes of the factor" ability" over those of the factor "motivation" in influencing productivity. Ability may be considered to be a function of two basic factors such as "knowledge" and "Skill". It has been observed that more than 50% of the workers' performance depended on these two factors. The actual figure which has been obtained throughout the opinion survey has indicated that knowledge and skill have 55.5% in direct bearing on the performance and that of motivation of 42.5% and others 2%. Motivation is composed of three basic factors such as 'social condition', 'individual needs', and 'physical conditions' and 'others'. The actual strengths (measured in terms of percentage) of these identifiable variables are shown in Table 4.1 below. Relevant primary data obtained from the opinion of the management Executives is given in Table A.5.1 in Appendix -V.

TABLE 4.1

RELATIVE WEIGHTAGE OF THE KEY AND PRINCIPAL FACTORS AFFECTING LABOUR PERFORMANCE

Key Factors	Factors	Range		Average	Total
		Lowest	Highest		
Ability	Knowledge	12	47	28.5	55.5
	Skill	10	40	27.0	
Motivation	Social conditions	05	40	17.0	44.5
	Individual needs	08	25	12.5	
	Physical conditions	08	21	13.0	
	Others	07	26	2.0	
Total :					100.00

In Table 4.1 the ranges of each factors are shown. These extreme values(the lowest and the highest) are given by the Management Executives through the opinion Survey. The relative weightages(Average values) of each factors have been obtained by adding all the values as given by the respondents then dividing this aggregate by the total no. of respondents. These average values could be used as expected values and as the "best" estimators by the population. A sample of the respondents was prepared who represented the total community of such

management Executives working in the manufacturing industries of similar nature having similar working facilities.They showed willingness to participate in the survey. The total number of the respondents was 50.

Other factors affecting the performance are discipline and working environment. These factors are only mentioned by a few of the respondents, their relative strength (qualitative value of 2.0) affecting workers performance is not of any significance. These social factors can be included in the motivating factors. Sound and effective working environment depends on organizational policy. The workers will maintain discipline if the management takes possible measures to satisfy their social needs and pays proper attention towards their welfare.The relative weightage of 44.5 , could be assigned to the motivating factors; this meaning that 44.5% has direct bearing on performance. The total scores allocated for quantification of the six factors was 100. According to relative weightage these factors could be ranked in a hierarchy as knowledge 28.5%,Skill 27%, social conditions 17%, individual needs 12.5%, Physical conditions 13% and other relevant factors 2% respectively.So far five principal factors and one minor principal factor have been established and these are ranked according to their relative merit and importance. It now becomes necessary to establish relevant sub-factors for each of the principal factors which are composed of these sub-factors.

4.2 Establishment of sub-factors for the 'knowledge' factor:

It has been observed from the questionnaire survey with the management Executives that most significant sub-factors which constitute the factor "Knowledge" are the 'basic education' of the workers, 'training', 'experience' and 'interest in job' etc. The qualitative values in terms of the relative weightages of the sub-factors are shown in Table 4.2. These relative weightages are derived by using similar approach as used in the previous section for the principal factors.

TABLE 4.2

RELATIVE WEIGHTAGES OF SUB-FACTORS UNDER THE PRINCIPAL FACTOR "KNOWLEDGE"

Sub-Factors	Range		Average weightage	Total
	Lowest	Highest		
Basic education	2.5	17.0	9.0	28.5
Experience	1.5	12.0	6.5	
Training	2.0	17.0	7.0	
Interest	2.4	11.5	6.0	

Significance-distribution of different sub-factors under the principal factors "knowledge" is shown in table A.5.2 in Appendix V. It should be mentioned here that some of the respondents had pointed out that a few other sub-factors such as I.Q., continued self education, drive etc. might be influential. But because of very low response and importance as shown by the

respondents, these are not included in the analysis and also in Table 4.2.

4.3 Establishment of Sub-Factors for Principal Factor"Skill":

The quantitative relative weightages of the sub-factors which constitute the principal factor "Skill" are shown in Table 4.3 below. These values are derived from the result of the questionnaire survey.

TABLE 4.3

RELATIVE WEIGHTAGE OF SUBFACTORS UNDER THE PRINCIPAL FACTOR "SKILL"

Sub-factors	Range		Average weightage	Total
	Lowest	Highest		
Aptitude	5	18	11.5	
Personality	2	12	6.5	27.0
Accuracy	3	18	9.0	

Significance-distribution of different sub-factors influencing labour performance under the principal factor"skill" is shown in Table A.5.3 in Addepdix V. A few respondents mentioned that penetration, capability,initiativeness, hard working etc. might be included along with the sub-factors as indicated in Table 4.3. But the relative importance given, for these sub-factors, by the respondents were too low; thus these were not included in the final consideration. Table 4.3 shows

that aptitude has relative weightage of 11.5% of the total performance whereas personality affects 6.5% and accuracy of 9% .

4.4 Establishment of sub-factors for the Principal Factor "Social Conditions" :

The relative strength of the constituent sub-factors which constitute the Principal factor" social conditions" is shown in Table 4.4. Relevant primary data obtained from opinion survey of the management Executives is given in Table A.5.4 in Addpendix V.

TABLE 4.4

RELATIVE WEIGHTAGE OF SUB FACTORS UNDER THE PRINCIPAL FACTOR "SOCIAL CONDITIONS"

Sub Factors	Range		Average Weightage	Total
	Lowest	Highest		
Organization structure	0.25	4.8	1.40	
Organization efficiency	0.20	6.5	1.70	
Leadership Climate	0.2	5.0	1.20	
Job Content	0.2	3.4	1.15	
Selection & placement	0.2	4.0	1.35	
Norms	0.3	3.0	0.80	17.00
Wage-salary level	0.4	6.0	2.30	
Incentives	0.3	8.0	2.20	
Job evaluation	0.2	3.25	1.12	
Communication	0.4	5.0	1.00	
Relationship with Superior	0.2	3.2	1.10	
Leadership	0.2	5.5	0.90	
Performance Rating	0.3	3.8	0.80	

The relative importance of each of the sub-factors along with their weightages as given by the respondents is shown in the above table. It can be observed that wage-salary level with 2.3% and incentive payment with 2.2% are the two important sub-factors.

4.5 Establishment of sub-factors for the Principal Factor "Individual Needs" :

It has been observed that the most significant sub-factor under the principal factor "individual needs" is the job satisfaction. The hierarchical importance of the other sub-factors are, general economic conditions(2.75%) , level of aspiration(2.35%), perception of the situation(2.3%) and on job and off-job activities (1.7%). Table 4.5 shows the relative weightages of the above mentioned sub-factors along with their lowest and highest values indicating their ranges. It may be mentioned that sum of the scores of the sub-factors equals to the score of 12.5% for the principal factor. Significance-distribution of different sub-factors under the principal factor "Individual Needs" is shown in Table A.5.5 in Appendix V.

It should be mentioned here that a few sub-factors viz, recognition, promotion, working tool/machine condition etc. were pointed out by some of the respondents as other influential sub-factors. They had also assigned points against these sub-factors. But due to very low responses and

importances given these were omitted from the study.

TABLE 4.5

RELATIVE WEIGHTAGE OF THE SUB-FACTORS UNDER THE PRINCIPAL FACTOR " INDIVIDUAL NEEDS"

Sub-Factor	Range		Average weightage	Total
	Lowest	Highest		
Level of aspiration	1.0	4.0	2.35	
Job satisfaction	1.6	7.0	3.40	
Perception of situation	0.8	4.8	2.30	12.50
On job & off-job activities	0.4	3.8	1.70	
General economic condition	1.0	6.50	2.75	

4.6 Establishment of Sub-factors for the Principal Factor "Physical Conditions":

Table 4.6 below shows the relative importance of each of the sub-factors which constitute the principal factor "Physical Conditions", on the basis of the assigned points as given by the respondents. Relevant primary data regarding significance-distribution of the different sub-factors under the principal factor"Physical Conditions" is shown in Table A.5.6. in Appendix - V.

TABLE 4.6

RELATIVE WEIGHTAGE OF SUB-FACTORS UNDER THE PRINCIPAL FACTOR "PHYSICAL CONDITIONS"

Sub-Factor	Range		Average weightage	Total
	Lowest	Highest		
Lighting	0.8	4.4	1.82	
Temperature	0.5	4.2	1.80	
Ventilation	0.6	3.6	1.85	13.00
Cleanliness	0.5	4.5	1.58	
Rest period	0.5	3.2	1.50	
Safety	0.5	5.0	2.20	
Health	0.8	5.0	2.25	

A few respondents mentioned that sanitation facility, alertness and fatigue, devices such as jigs and fixtures, subsidised food etc. might be taken as other sub-factors affecting physical conditions. But the frequency of the response was so low that these were dropped.

4.7 General Discussion :

It has been observed that the relative weightages of the principal and sub-factors affecting labour performance are widely ranged interms of the lowest and highest values. The possible explanations for such wide variability in the responses were as given in the next page.

(a) The mid and top-level management Executives are not

much aware of the human aspects, behaviour and human relations.

b) Speciality of supervision were different for the respondents and also different plant wise.

c) The type of product and output, technology of production were different plantwise.

d) Complexity of the job-content of workers under the respective Executives' supervision were different.

e) Existing facilities were different for different plants.

The present work would provide a basis for evaluation of workers' job performance on the basis of their individual contribution towards performance. The principal and the sub-factors identified in the previous sections and their relative weightages given could be used to measure the work productivity index quantitatively. Based on the relative weightages a performance model is developed as shown diagramatically in Fig. 4.1. The model has some special characteristics such as (i) size of each segment reflects its relative importance(ii) the factors in each segment of each circle are deemed to effect and help determination of the factors in the corresponding segment of the next smaller circle (iii) the factors in each segment of each circle may frequently affect other segments in the same circle and consequently they are affected by the factors in some of the other segment in that circle and (iv) the factors in each segment in each circle

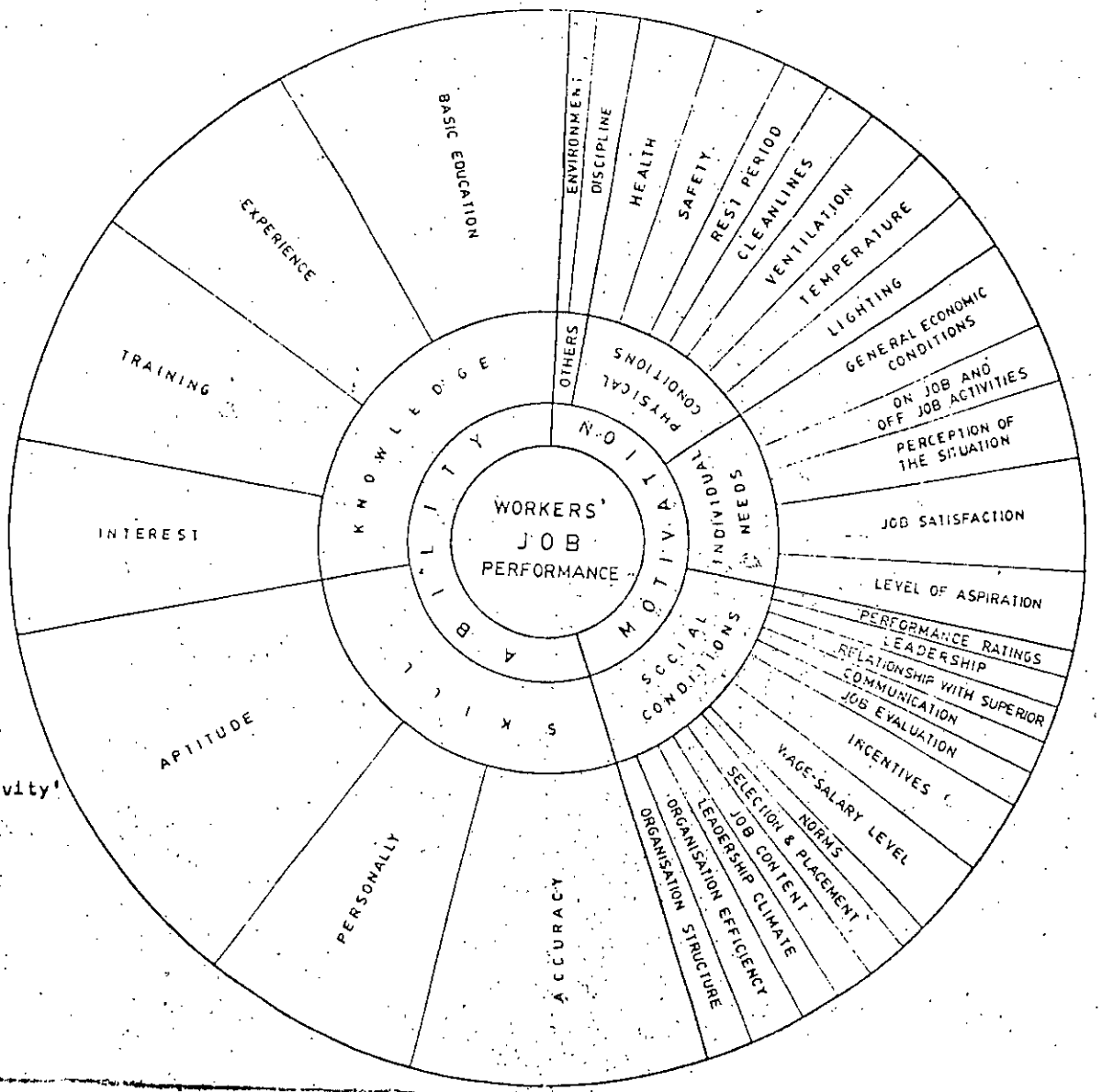


Fig. 4.1
PERFORMANCE MODEL FOR EVALUATION OF WORKERS' PRODUCTIVITY.

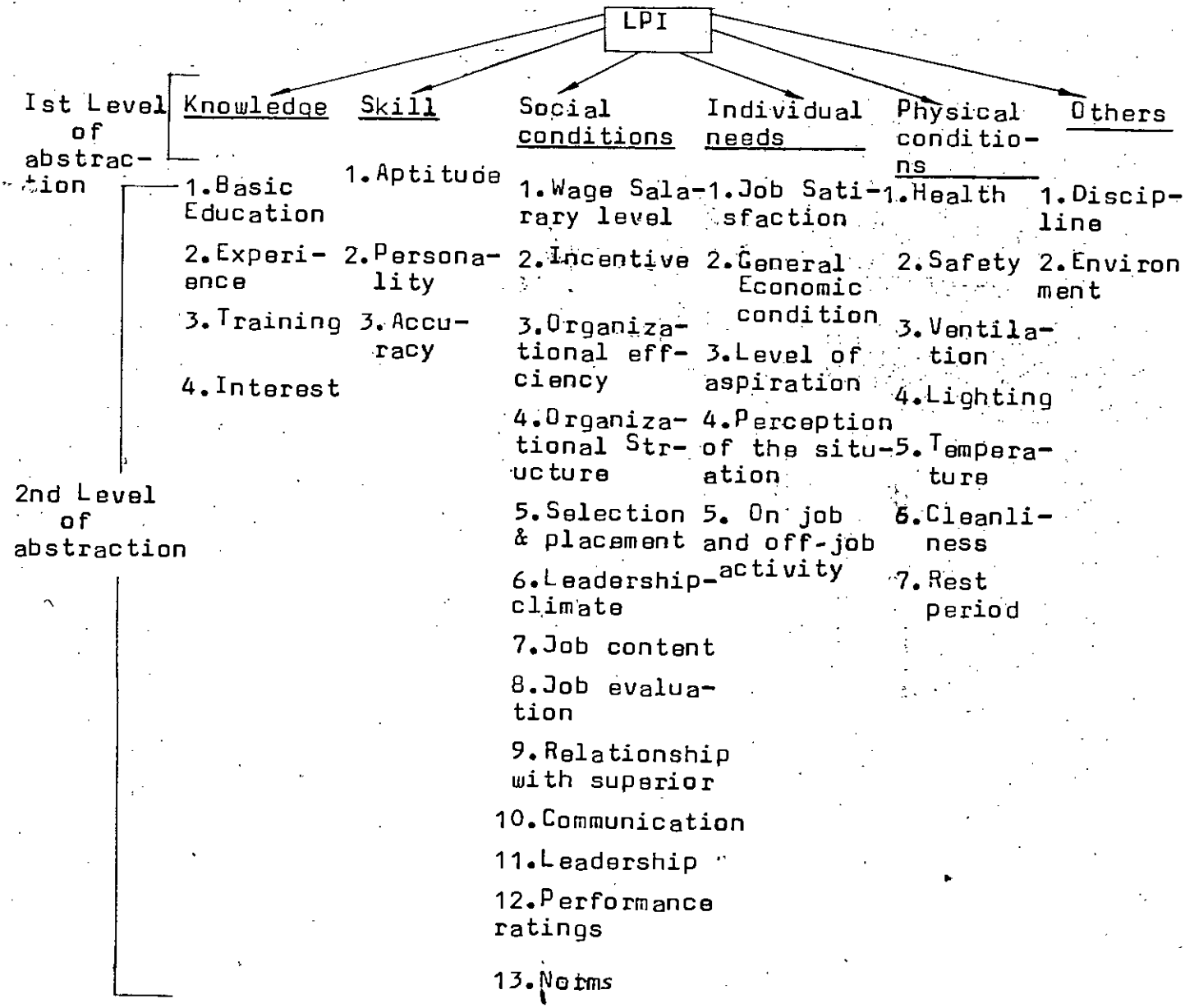
Source:
Outermeister's Productivity model 'People & Productivity' Mc Graw Hill, N.Y. 1963.

significantly affect the smallest circle(indicated by workers' job performance - L_p) . The utilitiy of this model is multi-dimensional, specially for evaluation of the overall labour productivity index (OLPI) as there exists a high correlation between the labour productivity index and the overall labour productivity Index.

CHAPTER - 5

AN ANALYTICAL METHOD TO QUANTIFY THE PRINCIPAL FACTORS WHICH INFLUENCE LABOUR PRODUCTIVITY

The proposed quantification approach for the measurement of the principal factors influencing labour productivity is developed on logical and subjective basis. The labour productivity Index model is depicted in Fig. 4.1 in Chapter 4. In the figure the principal and sub-factors influencing LPI are shown. The circular diagram in Fig.4.1 is now transformed into linear form below:



It is evident from the above system that six principal factors have been included in the first level of abstraction and 34 sub-factors in the second level of abstraction. A few other factors which because of their insignificant role in affecting labour performance are not included in the analysis.

The basis of the proposed quantification procedure is collection of values of the sub-factors in hierarchy. The hierarchies are as follows:

i. The values of the principal factors and are placed at the top of the hierarchy.

ii. The values of the sub-factors are placed next.

iii. Range of values of the sub-factors(based on writers' opinion which again based on logic of the economic and managerial sciences).

It has been discussed that on the basis of the questionnaire survey numerical values for the first level and second level attributes are assigned. The minimum assignable values for the factors such as knowledge, skill, social conditions, individual needs, physical conditions and other factors influencing labour performance are 28.5, 27, 17, 12.5, 13 and 2 units(out of 100) respectively.

The central theme of this section is to develop a procedure for the determination of a range of values/weightages of the sub-factors which is rather a complex task. In this study

the problem has been resolved with the help of logic and statistics. Some relevant information regarding the proposition of quantitative scales of different sub-factors as obtained from questionnaire (Type-II) survey have been shown in Appendix -IV.

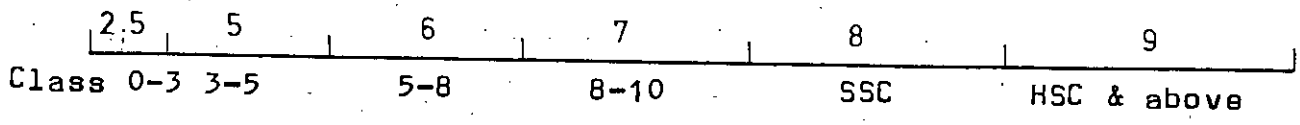
5.1 Establishment of quantification scales for the factor 'knowledge' :

The range of values (i.e. relative weightages) for different states of sub-factors of the principal factor"knowledge" have been shown in Fig. 5.1. The proposed scale is based on the following points:

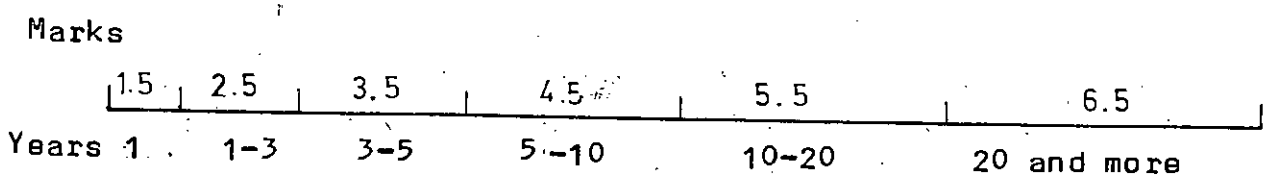
i. The highest marks of 9 points has been awarded to those workers whose level of education is higher secondary and above and the lowest of 2.5 for level of education of 0-3 classes as basic education(Schooling). The remaining scale of points of 5, 6, 7 and 8 is considered for levels of education as basic education upto 3-5 classes, 5-8 classes, 8-10 classes and secondary school level(S.S.C.) respectively.

ii. The highest mark of 6.5 has been awarded to those having 20 years or more of experience and the lowest of 1.5 marks upto 1 year of experience in the respective field. The intermediate scale of points for 1-3 years, 3-5 years, 5-10 years, 10-20 years of experience are 2.5, 3.5, 4.5 & 5.5 respectively.

Basic education

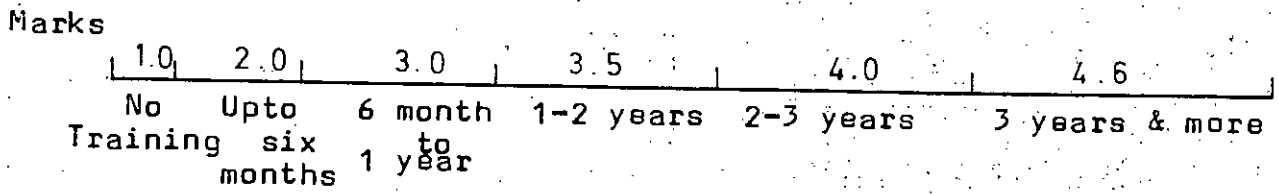


Experience

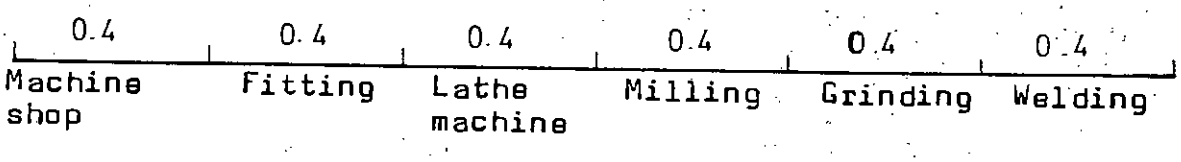


Training

Total longitude



Total area of training (subject matter)



Interest

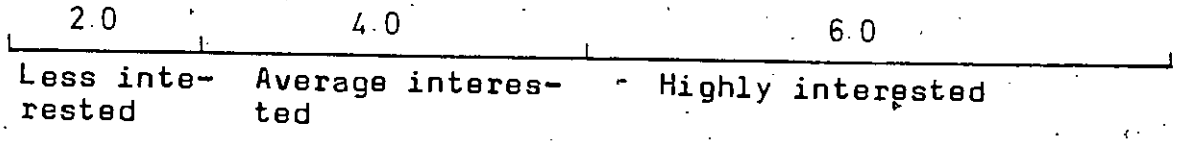


Fig. 5.1

Weightages and their distribution for different states of the sub-factors of 'knowledge'(principal factor).

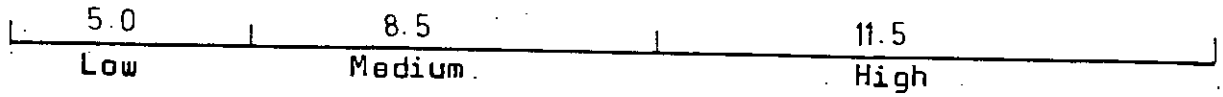
iii. Two separate scales for points-score for training has been prepared. One linear scale is used for the total longitude of training and other for subject matter of training. The highest points for those two categories are 4.6 and 2.4 respectively. Usually the length of training is more important than the subject matter of training. For a worker having no training but a process of continued self education through working experience exist he will be graded with 1 mark, for upto 6 months it is 2 marks, for 6 to 12 months it is 3 marks, for 1 to 2 years it is 3.5 marks, for 2 to 3 years it is 4 marks and for 3 years and more it is 4.6 marks. Marks for the subject matter of training has been distributed equally among the principal areas of training such as machine shop, fitting, Lathe machine practice, milling machine practive, grinding machine practice and welding practice, and in every case the mark is 0.4.

iv. The degree of interest in a specific job can only be measured through a simplified classification scale such as low average and high. Thus the marks have been allocated for such a scale of low to high as 3.4 and 6.

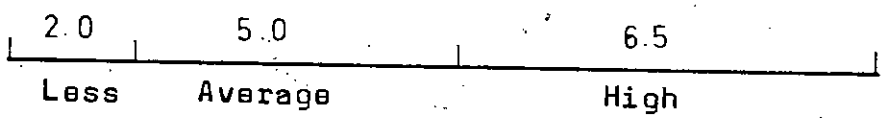
5.2 Establishment of quantification scales for the factors, "Skill" and "Social Conditions" :

The scale values of the relative weightage for the different states of the sub-factors of"Skill" has been shown in Fig.5.2 The distribution of weightages for the different states for the sub-factors of"social conditions"is rather complicated.The factor is composed of several sub-factors which are themselves multi-

Aptitude



Personality



Accuracy

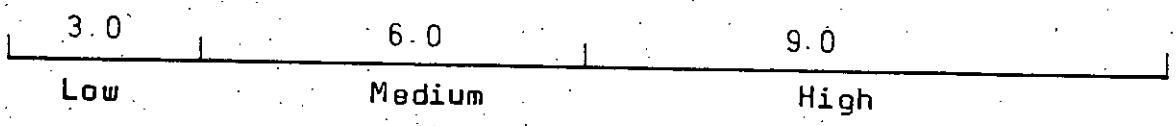


Fig. 5.2

Weightages and their distribution for different states of the sub-factors of "Skill" (principal factor).

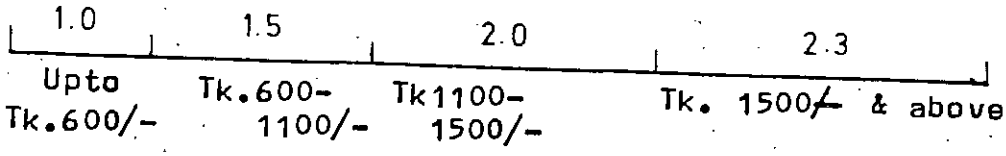
dimensional. The various scales are given in Fig. 5.3. The following points may be observed from the various scales of Fig. 5.3.

i. The highest and the lowest marks of 2.3 and 1.0 respectively have been allocated to workers having wage equivalent to Tk. 1500/- or more and upto 600/- per month respectively. In between these two extreme values two more intermediate attributes have been installed. These are given as a class of Tk. 600-1100 and Tk. 1100-1500. The points allocated of 1.0, 1.5, 2.0 and 2.3 are given for the four attributes. Similar procedure has been followed for the sub-factor "incentive" as shown in Fig. 5.3.

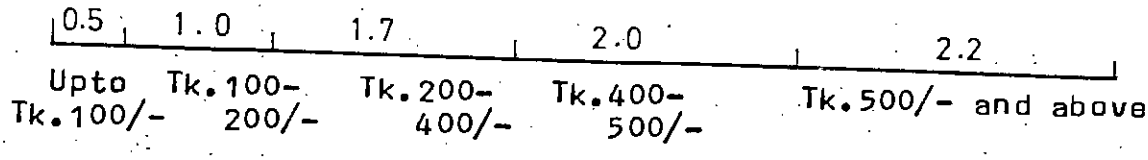
ii. Organizational efficiency has been divided into three rating levels such as less, average and highly efficient and knowing the highest and lowest values for high and low the average has been taken as the mid-point of the two extreme values. Similar is the weightage distribution method for the sub-factors-job content and job-evaluation.

iii. The distribution of weightages for sub-factors such as organizational structure, selection and placement, leadership climate, relationship with superior and communication are made using similar procedure. Each sub-factor has three attributes which are graded accordingly. The allocation of scores for each of these attributes are such that less than proportionate values are assigned for the highest rating levels of each sub-factors.

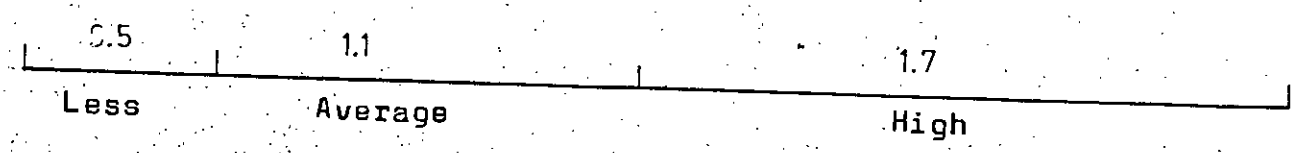
Wage/Salary



Incentive



Organization efficiency



Organization structure

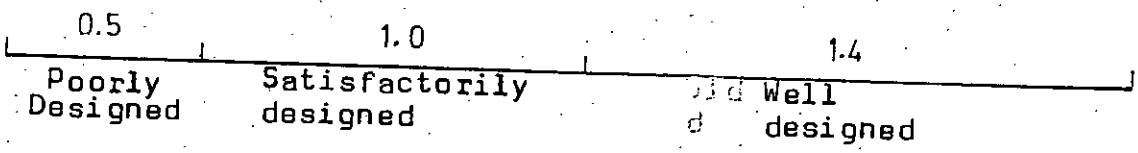
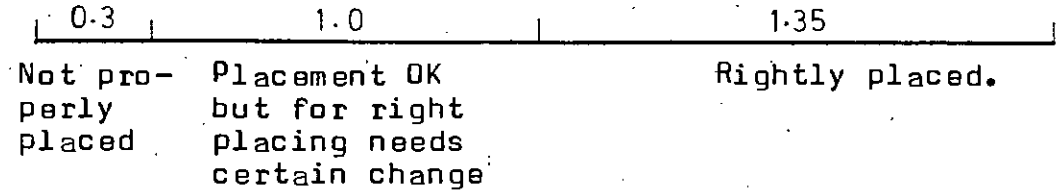


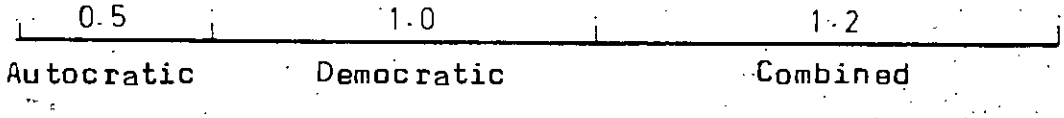
Fig. 5.3

Weightages and their distribution for different states of the sub-factors of 'social conditions'(principal factor).

Selection and Placement



Leadership Climate



Job content

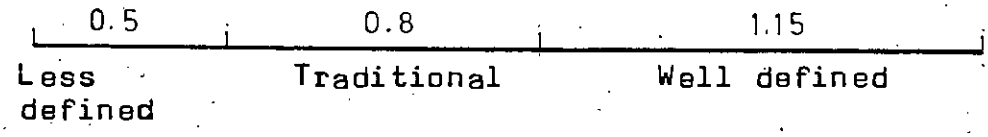
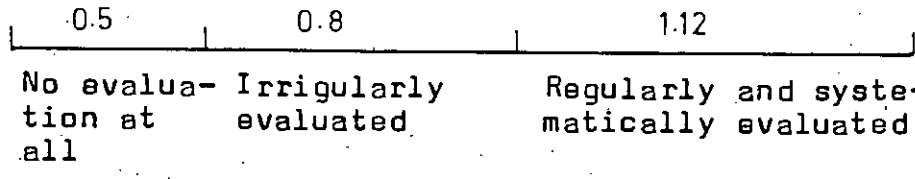
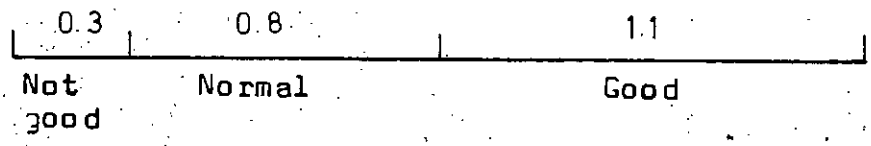


Fig. 5.3 (continued)

Job Evaluation



Relationship with superior



Communication

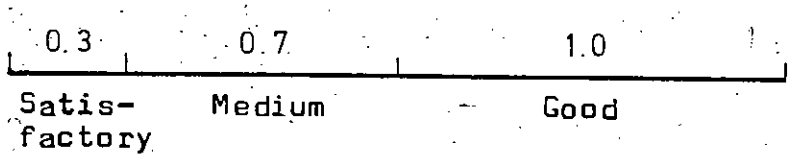
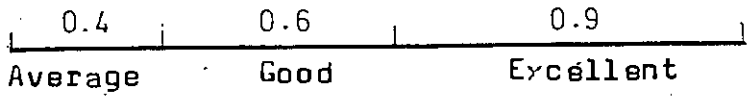
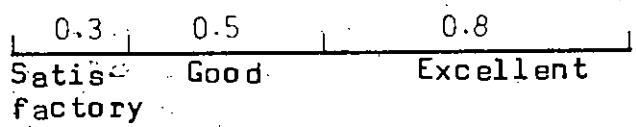


Fig. 5.3 (continued)

Leadership



Performance Rating



Norms

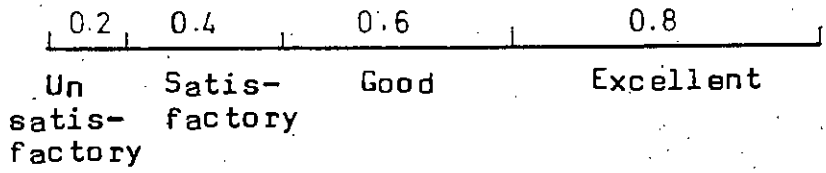


Fig. 5.3(continued)

iv. Leadership has been divided into three rating levels such as average, good and excellent. Performance rating has also been divided into three rating levels such as satisfactory, good and excellent. In both such cases the allocation of scores were made in more than proportionate basis. This is because the respondents emphasised strongly that attainment of the highest ratings for such sub-factors require special effort, sufficiently long experience, willingness for self-development etc. on the part of the workers.

5.3 Establishment of quantification scales for the factor " Individual Needs" :

The range of numerical values for the different states of sub-factors under "Individual Needs" have been shown in Fig.5.4. The distribution of weightages for the different states of sub-factors have been done considering the following points:

i. Average job satisfaction has greater effects in productivity than low satisfaction whereas high job satisfaction has less than proportionate effects on productivity. Accordingly rating factors have been assigned with scores.

ii. General economic condition of a worker could be measured interms of incomes other than salary income. There are four grades such as income (a) upto Tk.300/-(b) Tk.300-600/-(c) Tk.600-1000/- and(d) Tk.1000/- and more per month. Ratings for these four levels were given on the basis of a non-linearly increasing pattern.

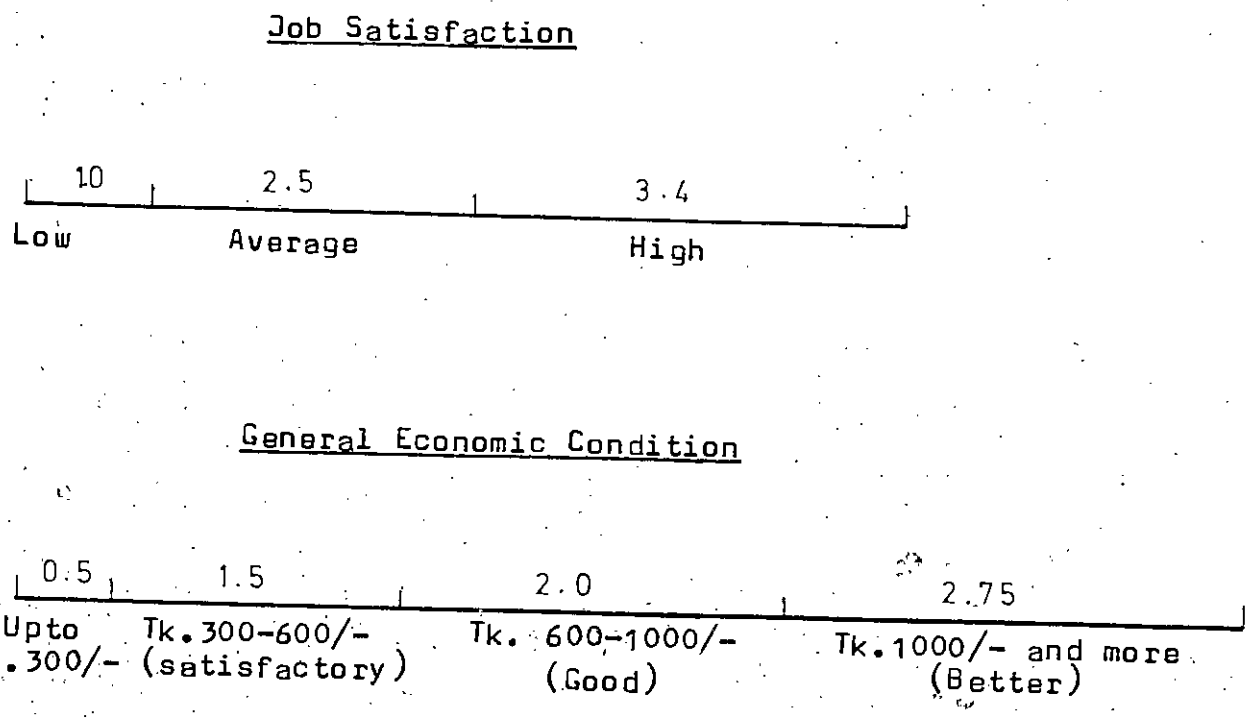
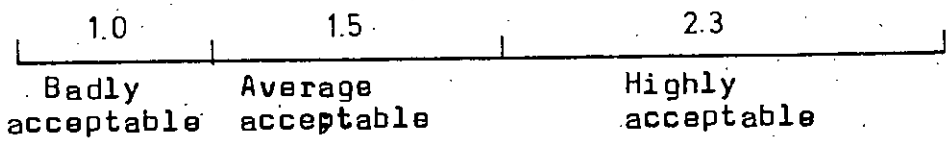


Fig. 5.4

Weightages and their distribution for different states of the sub-factors of "individual needs"(principal factor).

Perception of situation



On-job and off-job activities

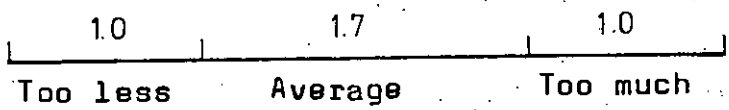


Fig. 5.4 (continued)

iii. Level of aspiration is the gap between 'desired' and actual salary of the worker. There are three groups of rating levels such as high, low and average. When the above gap is more than Tk.600/ month the workers aspiration is high, when the gap is upto Tk.300/ month it is low, for Tk. 300/- to Tk.600/ month it is average. The weightage would increase as follows, high-low -average. The rating is given strictly proportionately as 1.3, 1.8 and 2.35 for high, low and average respectively.

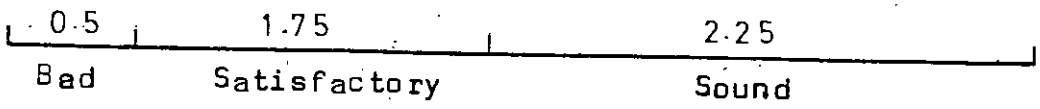
iv. Perception of the situation has been divided in three-rating levels such as badly acceptable, average acceptability, highly acceptable. The rating levels were given score on more than proportionate basis.

v. On-job and off-job activities has been divided into three rating groups such as too less(low) average and too-much(high) but the relative weightage for low and high are same. The argument is that too-less and too-much of such activities have equally negatively influences the level of productivity. In such a case the average value should have the best effect on productivity. For average of the attribute 1.7 points was allocated and 1.0 point each for the other two categories(too less and too much).

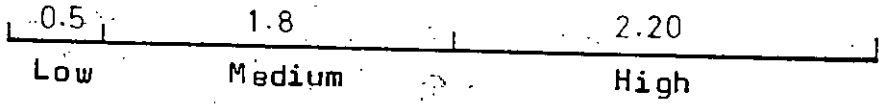
5.4 Establishment of quantification scales for the Factor "Physical Conditions" :

The weightage distribution for the different states of sub-factors under "physical condition" have been shown in Fig.5.5. All the sub-factors under physical condition have been divided

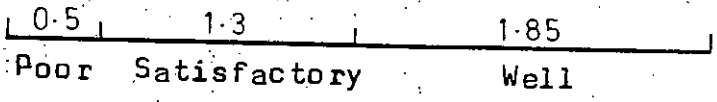
Health



Safety



Ventilation



Lighting

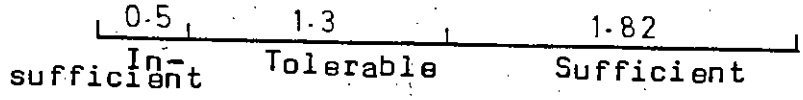
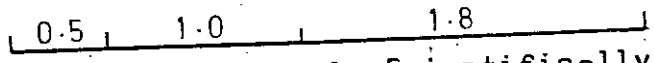


Fig. 5.5

Weightages and their distribution for different states of the sub-factors of "physical conditions" (principal factor).

Temperature

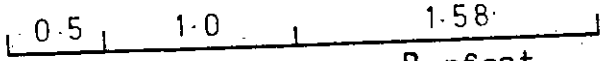


Badly adjusted too high or too low

Traditional more or less satisfactory

Scientifically adjusted.

Cleanliness

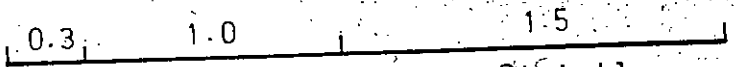


Imperfect

Satisfac-tory

Perfect

Rest Period



Not properly followed

More or less followed

Strictly followed

Fig. 5.5(Continued)

into three rating levels. The groupings for the various sub-factors are given as follows:

i. Health — bad → satisfactory → sound.

ii. Safety — low → medium → high

iii. Ventilation — poor → satisfactory → well

iv. Lighting — Insufficient → tolerable → sufficient.

v. Temperature — badly adjusted →satisfactory→Scientifically adjusted.

vi. Cleanliness— imperfect →satisfactory→perfect.

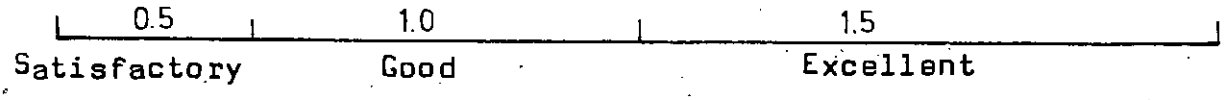
vii. Rest period — Not properly followed → more or less followed→ strictly followed.

The allocation of points for the above rating levels of each of the sub-factor was made in such a way that the numerical values increase more than proportionately. The sub-factor's temperature' and 'cleanliness are the exceptions because of their relative significance(Table A 5.5 in Appendix V) in affecting the labour performance. For the other sub-factors the ratings of their attributes were made in such a way that their values increase less than proportionately.

5.5 Establishment of quantification scales for the factor, 'others':

It may be mentioned that 32 sub-factors variables have so far been identified and hence quantified by appropriate rating scales. There are other important sub-factors such as discipline and environment not considered yet. These sub-factors have been

Discipline



Environment

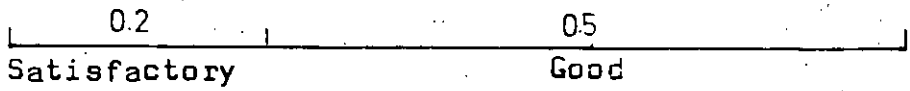


Fig. 5.6

Weightages and their distribution for different states of the sub-factors of "others" (Principal factor).

placed in a separate category of principal factor called "others" which has an influence of 2% on the productivity as revealed from the questionnaire survey type - I . The sub-factor discipline is being divided into three rating levels(attributes) such as satisfactory, good and excellent and their relationship with productivity is directly proportional. Thus their rating values were given strictly proportionately as shown in Fig. 5.6. The sub-factor environment has two attributes, such as satisfactory and good ; the marks allocated are 0.2 and 0.5 respectively.

The quantification of all the factors and the sub-factors is complete. The application and adoption of the quantification procedure would require the user(s) some mental training. Since some degree of subjectivity is inherent in such type of procedure there is scope of some degree of variability in assessment. This variability on the part of the assessor couldbe reduced if following measures are taken:

i. The assessor may develop a little awareness of the subjectivity nature of the proposed scaling system.

ii. A detailed study of the management system of the concerning authority.

iii. The assessor would be 'honest' and accurate in assigning scores to the attributes of the factors and sub-factors so that the any degree of biasness could be avoided.

iv. The target workers may also have mental preparedness of the quantification procedure so that any degree of biasness in their performance assessment could be kept at a low level.

CHAPTER - 6

ESTABLISHMENT OF THE PERFORMANCE MODELS

The possible scope and application of Multiple Regression analysis technique has been proposed in Chapter-3. Mention has been made that three manufacturing units(engineering)namely (i) Bangladesh Diesel Plant (BDP), (ii) Bangladesh Machine Tools Factory(BMTF) and (iii) Telephone Shilpa Shangstha (TSS) were considered in the present work. The present chapter is devoted to make a complete analysis of the data collected from the above three units. A multiple Regression Computer Package in the SPSS library has been used. This method is an extremely powerful tool for the present type of analysis. The IBM 370/115 computer in the BUET Centre has been used. The results and performance equations from the regression analysis are presented in the Chapter. Moreover, discussions on the results have also been given.

6.1 Development of Performance Equation Using Multiple Regression Analysis:

In the regression equation the left hand side variable is the workers' job performance index(Y). Values of this variable were calculated for each of the selected workers. The Y-values were calculated by using a simple ratio of standard(measured) time for work done and the actual time taken to do the work. This has already been discussed in Art. 3.3 of Chapter-3. An example of calculating the Y-values of a particular worker has been given in Table A.7.1 of Appendix VII. The right hand side variables of

the regression equation i.e. the explanatory variables X_1, X_2, X_3, X_4, X_5 and X_6 were calculated by using the quantification scale developed in Chapter-5. The scheme for calculation of the values of the explanatory variables has been given in details in that Chapter. It could be recalled that values of X'S are ascertained by adding the values of all their sub-factors. For variable X_1, (knowledge) for example, four quantifiable sub-factors, such as basic education, experience, training and interest in job are to be considered. These sub-factors are quantified with the help of the proposed quantification scale. The calculated values of the Y and corresponding explanatory variables for a total of 35 cases from three separate plants were tabulated as shown in Table A 7.2 in Appendix- VII.

6.1.1 Use of Multiple Regression Analysis:

The numerical values of each co-efficients, along with various diagnostic statistics were obtained separately for the three plants. Finally a combined regression equation was established when the 35 cases were considered together. Analysis of variances has been made for all the regressions. By analysing variances, the hypothesis that no relationship exists between the dependent and independent variables may be tested, this is performed by computing the statistics, F— value* and comparing

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*F - value is defined as the ratio of variances between two populations.

it with critical values at various levels of confidence limits. Durbin-Watson test of residual differences shows whether the predicted values of the dependent variable 'KP' (performance) deviate significantly from those of observed or not.

Regression Equation for the Dieseal Plant:

For the Diesel plant questionnaire survey was limited to a total of eleven workers'. The highest value of the performance index obtained from the sample was 84.6 percent(LPI= 0.8460) and the lowest value was 67.9 percent(LPI=0.6790).

The regression equation obtained is given below:

$$Y = 0.241 + 0.00182X_1 + 0.01620X_2 + 0.00891X_3 - 0.00443X_4 + 0.0097X_5 - 0.02154X_6 \qquad (6.1)$$

A stepwise regression had been made in the analysis. Table 6.1 presents the mean, standard deviation of the variables and in Table 6.2 a matrix of rank correlation co-efficients(pearson co-efficients) is presented. Numerical values of each regression co-efficients, the various statistics such as F-values, multiple regression co-efficients, R^2 and analysis of variances are shown in Table 6.3. In Table 6.4 the residual differences between the observed and predicted values of KP are shown.

Regression Equation for Bangladesh Machine Tools Factory:

Questionnaire type- II had been distributed among twelve selected workers of BMTF. Thus the regression analysis had been carried out on these twelve cases. The highest performance level found was 80.15 percent(i.e. LPI=0.8015) and the lowest of 50.60 percent (LPI= 0.5060).

The multiple regression equation is given by:

$$Y = -0.133+0.0079X_1 + 0.01093X_2+0.01116X_3+0.00368X_4 +0.03026X_5 + 0.01903X_6 \quad (6.2)$$

From the regression analysis as is done for the Diesel Plant the corresponding Tables are given in Table 6.5, Table 6.6, Table 6.7 and Table 6.8.

Regression Equation for the Telephone Shilpa Sangstha :

A total of twelve workers' of the Telephone Shilpa Sangstha(TSS) had been selected for the questionnaire Survey. The regression analysis was thus carried out on these twelve cases. The highest performance level obtained from this sample was 115.2 percent(i.e. LPI = 1.152) and the lowest of 99 per cent (LPI = 0.99). The multiple linear regression equation is given as follows:

$$Y = -0.933+ 0.00475X_1+0.00658X_2+0.03846X_3 -0.00151X_4 + 0.07917X_5+ 0.0888X_6 \quad (6.3)$$

The various statistics, pearson co-relation metrix, values of the regression co-efficients with the analysis of variance and the residual differences are given in Table 6.9, 6.10,6.11 and 6.12.

The Regression Equation for the three plants Combined:

A multiple regression analysis had been carried out with the combined 35 cases from Diesel plant, BMTF and TSS together. The idea behind this pooling effort is that the three plants are similar in nature(Machine facilities) so that they would behave identical in terms of workers' performance. In this context the highest value of the performance level obtained was 115.2 percent and the lowest of 50.60 percent.

Thus the generalized performance model applicable to all the workers working in a manufacturing unit and performing similar jobs(mechining operation) using similar technique on the same technology, the regression equation is given by,

$$Y = -0.159 + 0.00212X_1 + 0.00884X_2 + 0.03456X_3 - 0.01366X_4 + 0.03698X_5 + 0.0548X_6 \qquad (6.4)$$

The various statistics, the pearson correlation matrix, values of the regressors' coefficients with the analysis of variance and the residuals are given in Table 6.13,6.14, 6.15 and 6.16. Numerical values of the regressor coefficients with the constant terms for three regression equations for the three plants(Diesel plant, TSS ,BMTF) are consolidated in Table 6.17

6.2 Results and Discussion :

A stepwise regression analysis has been made in the present work. The symbols used to represent the dependent and independent variables are as follows:

Y = KP = Performance(workers job performance index)

X_1 = KN = Knowledge

X_2 = KS = Skill

X_3 = NS = Social Conditions

X_4 = IN = Individual needs

X_5 = NP = Physical conditions

X_6 = NC = Others(other explanatory factors)

From Table 6.1, 6.5, 6.9 it has been observed that average performance levels for BDP workers' is 76.1 percent for BMTF and TSS workers', the values are 67.87 and 108.9 percent respectively. Table 6.13 indicates that average performance level is 84.55 percent considering 35 cases of the three plants combined. This performance level is high enough because questionnaire survey was limited to selected skilled and semi-skilled workers. From Table 6.2 it could be observed that workers performance, KP is positively correlated with all the six explanatory variables. High correlations exists between KP and KN(knowledge), KS(Skill) NS (Social conditions), IN(individual needs) and NC(Others). A low value of correlation coefficient between KP and NP(physical condition) suggests that the influence of this particular variable

is very low. The possible explanation is that physical condition for all the workers' interviewed were almost similar. Thus the workers' of good performance level and those of the average had been graded equally.

Table 6.3 shows that the regression co-efficients are significant below 1% level of significance. Observed F-value of 92.43 is much higher than F =15.2 and the multiple correlation coefficient, R^2, was 0.993. The regression equation 6.1 shows that the variables such as knowledge, skill, social conditions and physical conditions have positive co-efficients meaning that any increase in their values would increase the performance level, but variables NC and IN are negatively signed. It is interesting to note that simple correlation of KP with NC and IN are high and positively signed yet they fail to show up with positive sign in the regression equation. This might be due to the intercorrelation between the independent variables. Durbin Watson test value of 1.568 of the residual differences shows that the predicted values of the dependent variable deviate insignificantly from that of the observed values.

In Table 6.6, it is observed that BMTF workers' performance is positively correlated with all the explanatory variables. The highest correlation exists between performance and skill. The correlation between the performance and sosial conditions, knowledge, others, individual needs and physical conditions are also highly significant. The correlation matrix shows that the partial correlation co-efficients are all positively signed. Table 6.7 shows

that all the regression co-efficients are significant below 1% ($F_{0.01}$; 6,5) level of significance. The observed F-value of 457.23 is much higher than 10.7 and the multiple correlation co-efficient R^2, is found 0.998. The Regression equation 6.2 shows that all the six explanatory variables are positively signed. It indicates that increase of any one of the variables will give rise to increased value of performance index. Again Durbin-Watson Test Statistics of 1.70 shows that the residual differences between the observed and predicted deviate insignificantly.

Table 6.10 indicates that in TSS the workers' performance variable is positively correlated with knowledge, skill, social conditions, individual needs and others while negatively correlated with physical conditions.

During the survey it was found that those workers' selected for interview had been working throughout the same working conditions including ventilation, lighting, temperature, cleanliness etc. Thus identical marks had been allocated to most of the workers considering those physical conditions which are similar in nature. Naturally marks allocated were alsmost same irrespective of the performance level. Thus, the negative sign appears to be appropriate. It means that an increased value of NP does not necessarily imply on increased value of KP and vise-versa. Table 6.11 shows that all the regression co-efficient are significant below 1% level of significance. The observed high F-value of 44.6 is higher than that $F_{0.01}$ of 10.7; the multiple correlation

co-efficient, R^2, is 0.982. Regression equation 6.3 shows that out of six explanatory variables, five variables such as KN, KS, NS, NP and NC are positively signed. The only variable, IN, is negatively signed. A possible explanation is that marks allocated to the variables KN, KS, NS, NP and NC are such that increase in their values will result in increase in value of KP but this does not apply with the variable IN increase in value of which results in decrease in KP. Workers' having more experience, training, aptitude, accuracy, pay scale, incentives etc. had been graded with more marks, whereas the workers whose individual needs are high to satisfy their physiological and egoistic expectations and level of aspiration had been allocated low scores. Thus the correlation between performance and individual needs is negative and this is rather artificially schemed by the writer. Moreover, it is interesting to note that although the simple correlation between KP and NP (negatively correlated) was of much low value, the co-efficient of the regressor NP, is positively signed in the regression equation. This is no way indicates that NP has significant contribution towards the prediction. Durbin-Watson Test of 1.97 of the residual differences shows that the regression values are negatively auto-correlated. The high value of Durbin-Watson statistics of around 2.0 signifies that the values are highly correlated.

Table 6.14 shows that performance , KP is positively correlated with all the six explanatory variables, while considering 35 cases of all the three points combined. For each

combination the highest correlation exists between performance and social conditions. The significant correlations of KP with other variables are given in order as physical conditions, others, skill, individual needs. This correlation could be explained by Tables 6.1, 6.5 and 6.9 where the mean values of these variables NS, NP, and NC substantially differ plant-wise. In contrast variable KN does not differ much plant to plant. This is evident as most of the subject workers' were skilled and semi-skilled in nature as stated earlier. Most of them had identical basic education, experience, training and interest. The mean values of the variable NS are found to be 11.42 for BDP, 9.99 for BMTF and 15.68 for TSS respectively. It signifies that TSS workers are getting more social benefits than the workers of the other two plants. The social benefits given to the workers of the BMTF are not much. Thus the workers' average job performance is high in TSS and relatively low in BMTF. From this finding it is becoming evident that the social condition is the most significant factor for incresing performance. Equation 6.4 shows that the explanatory variables KN, KS, NS, NP and NC are highly influential all having positive coefficients. The only variable IN has the negative co-efficient. Table 6.15 indicates that association of the independent variables with the dependent variable is highly significant below 1% level of significance. The observed F-value of 507.49 is much higher than $F_{0.01}$ of 3.56. The multiple correlation co-efficients, R^2, was found to be 0.99. Durbin-Watson Test of 1.57 of the residual

difference shows that the values are almost negatively auto-correlated and the predicted value of dependent variable is most likely equal to that of observed one. Hence for high value of F and R^2 the equation 6.4 can be taken as the generalized regression equation for measuring the labour performance Index of workers' from similar plants such as these considered in the study.

REGRESSION ANALYSIS FOR WORKERS JOB PERFORMANCE

FILE NONAME (CREATION DATE = 16/11/83)

16/11/83

VARIABLE	MEAN	STANDARD DEV.	CASES
KP	0.7610	0.0634	11
KN	20.3182	3.1125	11
KS	22.3536	3.7623	11
NS	11.4162	0.9722	11
IN	9.7909	1.0637	11
NP	9.6591	0.2023	11
NC	1.4273	0.5438	11

TABLE 6.1

STATISTICS OF VARIABLES IN DIESEL PLANT.

REGRESSION ANALYSIS FOR WORKERS JOB PERFORMANCE

FILE NONAME (CREATION DATE = 16/11/83)

16/11/83

CORRELATION COEFFICIENTS

A VALUE OF 99.00000 IS PRINTED
IF A COEFFICIENT CANNOT BE COMPUTED.

	KP	KN	KS	NS	IN	NP	NC
KP	1.00000	0.73295	0.97524	0.90188	0.65653	0.26295	0.79251
KN	0.73295	1.00000	0.84968	0.66860	0.26631	-0.01330	0.44435
KS	0.97524	0.84968	1.00000	0.82096	0.76019	0.17920	0.89618
NS	0.90188	0.66860	0.82096	1.00000	0.48442	0.39067	0.51002
IN	0.65653	0.26631	0.76019	0.48442	1.00000	-0.05071	0.81296
NP	0.26295	-0.01330	0.17920	0.39067	-0.05071	1.00000	-0.03269
NC	0.79251	0.44435	0.89618	0.51002	0.81296	-0.03269	1.00000

TABLE 6.2

PEARSON CORRELATION CO-EFFICIENT MATRIX FOR BDP MODEL.

REGRESSION ANALYSIS FOR WORKERS JOB PERFORMANCE 16/11/83

FILE NONAME (CREATION DATE = 16/11/83)

* MULTIPLE REGRESSION * * * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. KP PERFORMANCE

VARIABLE(S) ENTERED ON STEP NUMBER 1.. NC OTHERS
KN KNOWLEDGE
KS SKILL
NS SOCIAL CONDITION
IN INDIVIDUAL NEEDS
NP PHYSICAL CONDITION

		ANALYSIS OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	F
MULTIPLE R	0.99641	REGRESSION	6.	0.03994	0.00666	92.43235
R SQUARE	0.99284	RESIDUAL	4.	0.00029	0.00007	
ADJUSTED R SQUARE	0.98213					
STANDARD ERROR	0.00849					

VARIABLES IN THE EQUATION

VARIABLE	B	BETA	STD ERROR B	F
NC	-0.21535320-01	-0.11673	0.04234	0.259
KN	0.18182570-02	0.03823	0.00156	1.355
KS	0.16203500-01	0.96118	0.00604	7.194
NS	-0.85091630-02	-0.13656	0.01075	3.677
IN	-0.44327690-02	-0.07434	0.00498	3.793
NP	0.96933620-02	0.33093	0.01771	0.300
(CONSTANT)	0.24135930			

VARIABLES NOT IN THE EQUATION

VARIABLE	BETA IN	PARTIAL	TOLERANCE	F

ALL VARIABLES ARE IN THE EQUATION

STATISTICS WHICH CANNOT BE COMPUTED ARE PRINTED AS ALL NINES.

TABLE 6.3

R, R^2, F-VALUES AND REGRESSION CO-EFFICIENTS FOR BOP MODEL

REGRESSION ANALYSIS FOR WORKERS JOB PERFORMANCE 16/11/83

FILE NONAME (CREATION DATE = 16/11/83)

* MULTIPLE REGRESSION *

DEPENDENT VARIABLE KP FROM VARIABLE LIST 1
REGRESSION LIST 1

SEQNUM	OBSERVED KP	PREDICTED KP	RESIDUAL	PLOT OF STANDARDIZED RESIDUAL -2.0 -1.0 0.0 1.0 2.0
1	0.8460000	0.8505393	-0.4539397E-02	
2	0.8400000	0.8435711	-0.3571233E-02	
3	0.8450000	0.8417798	0.3220036E-02	
4	0.8180999	0.8115891	0.7410858E-02	
5	0.7399999	0.7352142	0.4785692E-02	
6	0.7395000	0.7454458	-0.5945699E-02	
7	0.7145000	0.7192856	-0.4785693E-02	
8	0.7320000	0.7242843	0.7715e636E-02	
9	0.7126000	0.7126296	0.1170301E-02	
10	0.6790000	0.6776899	0.1310077E-02	
11	0.7020000	0.7087204	-0.6720427E-02	

DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1, REGRESSION LIST 1. DURBIN-WATSON TEST 1.56836

TABLE 6.4
OBSERVED AND PREDICTED VALUES OF PERFORMANCE AND THEIR RESIDUAL DIFFERENCES FOR BOP MODEL.

REGRESSION ANALYSIS FOR WORKERS JOB PERFORMANCE

FILE NONAME (CREATION DATE = 16/11/83)

16/11/83

VARIABLE	MEAN	STANDARD DEV.	CASES
KP	0.6787	0.1071	12
KN	22.1167	3.3796	12
KS	22.3750	4.2859	12
NS	9.5875	1.2851	12
IN	7.8625	1.2072	12
NP	7.5083	0.7154	12
NC	1.2333	0.4174	12

TABLE 6.5
STATISTICS OF VARIABLES IN BMTF.

REGRESSION ANALYSIS FOR WORKERS JOB PERFORMANCE

FILE NONAME (CREATION DATE = 16/11/83)

16/11/83

CORRELATION COEFFICIENTS

A VALUE OF 99.00000 IS PRINTED
IF A COEFFICIENT CANNOT BE COMPUTED.

	KP	KN	KS	NS	IN	NP	NC
KP	1.00000	0.93542	0.96778	0.94271	0.79749	0.55770	0.94429
KN	0.93542	1.00000	0.89703	0.90726	0.69695	0.36506	0.94300
KS	0.96778	0.89703	1.00000	0.91699	0.83317	0.39843	0.93271
NS	0.94271	0.90726	0.91699	1.00000	0.74140	0.40038	0.94693
IN	0.79749	0.69695	0.83317	0.74140	1.00000	0.29594	0.79604
NP	0.55770	0.36506	0.39843	0.40038	0.29594	1.00000	0.33235
NC	0.94429	0.94300	0.93271	0.94693	0.79604	0.33235	1.00000

TABLE 6.6

PEARSON CORRELATION CO-EFFICIENTS MATRIX FOR BMTF MODEL.

REGRESSION ANALYSIS FOR WORKERS JOB PERFORMANCE 16/11/83

FILE NONAME (CREATION DATE = 16/11/83)

* MULTIPLE REGRESSION * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. KP PERFORMANCE

VARIABLE(S) ENTERED ON STEP NUMBER 1.. NC OTHERS
KN KNOWLEDGE
KS SKILL
NS SOCIAL CONDITION
IN INDIVIDUAL NEEDS
NP PHYSICAL CONDITION

		ANALYSIS OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	F
MULTIPLE R	0.99903	REGRESSION	6.	0.12006	0.02101	457.23037
R SQUARE	0.99818	RESIDUAL	5.	0.00023	0.00005	
ADJUSTED R SQUARE	0.99600					
STANDARD ERROR	0.00678					

VARIABLES IN THE EQUATION

VARIABLE	B	BETA	STD ERROR B	F
NC	0.19032650-01	0.07414	0.02219	0.674
KN	0.75016810-02	0.24923	0.00198	15.905
KS	0.10930410-01	0.43722	0.00163	44.856
NS	0.11157360-01	0.13382	0.00541	4.256
IN	0.36826710-02	0.04149	0.00336	1.205
NP	0.30257590-01	0.23201	0.00324	87.027
(CONSTANT)	-0.1326454			

VARIABLES NOT IN THE EQUATION

VARIABLE	BETA IN	PARTIAL	TOLERANCE	F

ALL VARIABLES ARE IN THE EQUATION

STATISTICS WHICH CANNOT BE COMPUTED ARE PRINTED AS ALL NINES.

TABLE 6.7

R, R^2, F-VALUES AND REGRESSION CO-EFFICIENTS FOR BMTF MODEL.

REGRESSION ANALYSIS FOR WORKERS JOB PERFORMANCE 16/11/83

FILE NONAME (CREATION DATE = 16/11/83)

* MULTIPLE REGRESSION *

DEPENDENT VARIABLE KP FROM VARIABLE LIST 1
REGRESSION LIST 1

SEQNUM	OBSERVED KP	PREDICTED KP	RESIDUAL	PLOT OF STANDARDIZED RESIDUAL -2.0 -1.0 0.0 1.0 2.0
1	0.8015000	0.8078896	-0.6389692E-02	* I
2	0.7900000	0.7903811	-0.3811654E-03	* I
3	0.8010000	0.8002408	0.7591497E-03	I*
4	0.7959999	0.7948550	0.1144873E-02	I *
5	0.7385000	0.7385165	-0.1654954E-04	*
6	0.6916000	0.6895890	0.2010952E-02	I *
7	0.5860000	0.5866966	-0.6966455E-03	* I
8	0.6750000	0.6635722	0.1142771E-01	I *
9	0.6125000	0.6121439	0.3559715E-03	I*
10	0.5484999	0.5542437	-0.5743712E-02	* I
11	0.5975000	0.6015278	-0.4027670E-02	* I
12	0.5060000	0.5044430	0.1556977E-02	I *

DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1, REGRESSION LIST 1. DURBIN-WATSON TEST 1.70333

TABLE 6.8

OBSERVED AND PREDICTED VALUES OF PERFORMANCE AND THEIR RESIDUAL DIFFERENCES FOR BMTF MODEL.

REGRESSION ANALYSIS FOR WORKERS JOB PERFORMANCE

FILE NONAME (CREATION DATE = 15/11/83)

15/11/83

TABLE 6.9

STATISTICS OF VARIABLES IN TSS

VARIABLE	MEAN	STANDARD DEV	CASES
KP	1.0898	0.0456	12
KN	20.0750	1.9349	12
KS	24.3750	3.0085	12
NS	15.6783	0.0156	12
IN	9.6167	0.9186	12
NP	12.8750	0.2261	12
NC	1.7917	0.2575	12

REGRESSION ANALYSIS FOR WORKERS JOB PERFORMANCE

FILE NONAME (CREATION DATE = 15/11/83)

15/11/83

CORRELATION COEFFICIENTS

A VALUE OF 99.00000 IS PRINTED
IF A COEFFICIENT CANNOT BE COMPUTED.

TABLE 6.10

PEARSON CORRELATION CO-EFFICIENTS METRIX FOR TSS MODEL

	KP	KN	KS	NS	IN	NP	NC
KP	1.00000	0.53299	0.81229	0.48718	0.59830	-0.10809	0.65552
KN	0.53299	1.00000	0.28520	0.40123	0.33489	-0.22595	0.19545
KS	0.81229	0.28520	1.00000	0.05656	0.64393	-0.22549	0.81422
NS	0.48718	0.40123	0.03866	1.00000	0.23144	-0.23671	-0.05974
IN	0.59830	0.33489	0.64393	0.23144	1.00000	-0.33918	0.56377
NP	-0.10809	-0.22595	-0.22549	-0.23671	-0.33918	1.00000	-0.49795
NC	0.65552	0.19545	0.81422	-0.05974	0.56377	-0.49795	1.00000

REGRESSION ANALYSIS FOR WORKERS JOB PERFORMANCE 15/11/83

FILE NONAME (CREATION DATE = 15/11/83)

* MULTIPLE REGRESSION * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. KP PERFORMANCE

VARIABLE(S) ENTERED ON STEP NUMBER 1.. NC OTHERS
KN KNOWLEDGE
KS SKILL
NS SOCIAL CONDITION
IN INDIVIDUAL NEEDS
NP PHYSICAL CONDITION

		ANALYSIS OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	F
MULTIPLE R	0.99079					
R SQUARE	0.98166	REGRESSION	6.	0.02241	0.00374	44.60547
ADJUSTED R SQUARE	0.95965	RESIDUAL	5.	0.00042	0.00008	
STANDARD ERROR	0.00915					

VARIABLES IN THE EQUATION

VARIABLE	B	BETA	STD ERROR B	F
NC	0.88796360-01	0.60179	0.02239	14.409
KN	0.47449030-02	0.20151	0.00166	8.135
KS	0.65777390-02	0.43435	0.00192	11.794
NS	0.38457770-01	0.51966	0.00530	52.615
IN	-0.15079800-02	-0.03340	0.00424	0.127
NP	0.79167210-01	0.39293	0.01635	23.458
(CONSTANT)	-0.93287 66			

VARIABLES NOT IN THE EQUATION

VARIABLE	BETA IN	PARTIAL	TOLERANCE	F

ALL VARIABLES ARE IN THE EQUATION

STATISTICS WHICH CANNOT BE COMPUTED ARE PRINTED AS ALL NINES.

TABLE 6.11

R, R^2, F-VALUES AND REGRESSION CO-EFFICIENTS FOR TSS MODEL

REGRESSION ANALYSIS FOR WORKERS JOB PERFORMANCE 15/11/83

FILE NONAME (CREATION DATE = 15/11/83)

* MULTIPLE REGRESSION *

DEPENDENT VARIABLE KP FROM VARIABLE LIST 1
REGRESSION LIST 1

SEQNUM	OBSERVED KP	PREDICTED KP	RESIDUAL	PLOT OF STANDARDIZED RESIDUAL (-2.0 -1.0 0.0 1.0 2.0)
1	1.151999	1.152663	-0.66354233E-03	
2	1.143699	1.136540	0.74584719E-02	
3	1.120100	1.114916	0.55831453E-02	
4	1.110000	1.104497	0.55017833E-02	
5	1.122000	1.132220	-0.10221392E-01	
6	1.089999	1.093667	-0.66686953E-02	
7	1.059999	1.058738	0.12610225E-02	
8	1.105000	1.099342	0.51574073E-02	
9	1.065100	1.070215	-0.52163713E-02	
10	1.070000	1.065697	0.43024233E-02	
11	1.049999	1.056310	-0.65111183E-02	
12	0.9999999	0.9877320	0.22576635E-02	

DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1, REGRESSION LIST 1. DURBIN-WATSON TEST 1.97600

TABLE 6.12

OBSERVED AND PREDICTED VALUES OF PERFORMANCE AND THEIR RESIDUAL DIFFERENCES FOR TSS MODEL.

REGRESSION ANALYSIS FOR WORKERS JOB PERFORMANCE 15/11/83

FILE NONAME (CREATION DATE = 15/11/83)

VARIABLE	MEAN	STANDARD DEV	CASES
KP	0.8455	0.1969	38
KN	20.8514	2.9369	38
KS	23.0571	3.7373	38
NS	12.3383	2.6035	38
IN	9.0700	1.3058	38
NP	5.5929	2.3163	38
NC	1.5029	0.4011	38

TABLE 6.13

STATISTICS OF VARIABLES FOR THE COMBINED MODEL.

REGRESSION ANALYSIS FOR WORKERS JOB PERFORMANCE 15/11/83

FILE NONAME (CREATION DATE = 15/11/83)

CORRELATION COEFFICIENTS

A VALUE OF 99.000000 IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

	KP	KN	KS	NS	IN	NP	NC
KP	1.00000	0.06999	0.57212	0.96077	0.56892	0.92336	0.77403
KN	0.06999	1.00000	0.58603	0.02789	0.14831	-0.23127	0.37190
KS	0.57212	0.58603	1.00000	0.46887	0.63776	0.27975	0.86027
NS	0.96077	0.02789	0.46887	1.00000	0.54814	0.92700	0.70615
IN	0.56892	0.14831	0.63776	0.54814	1.00000	0.49639	0.71556
NP	0.92336	-0.23127	0.27975	0.92700	0.49639	1.00000	0.55878
NC	0.77403	0.37190	0.86027	0.70615	0.71556	0.55878	1.00000

TABLE 6.14

PEARSON CORRELATION CO-EFFICIENTS MATRIX FOR THE COMBINED MODEL

REGRESSION ANALYSIS FOR [illegible] JOB PERFORMANCE 15/11/83

FILE NONAME (CREATION DATE = 15/11/83)

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * *

VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. NP PERFORMANCE

VARIABLE(S) ENTERED ON STEP NUMBER 1.. NC OTHERS
KN KNOWLEDGE
KS SKILL
NS SOCIAL CONDITION
IN INDIVIDUAL NEEDS
NP PHYSICAL CONDITION

		ANALYSIS OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	F
MULTIPLE R	0.99543	REGRESSION	6.	1.30620	0.21771	507.48515
R SQUARE	0.99089	RESIDUAL	28.	0.01201	0.00043	
ADJUSTED R SQUARE	0.98894					
STANDARD ERROR	0.02071					

VARIABLES IN THE EQUATION

VARIABLE	B	BETA	STD ERROR B	F
NC	0.54798750D-01	0.11162	0.02377	5.316
KN	0.21179960D-02	0.03159	0.00190	1.237
KS	0.88403190D-02	0.16775	0.00240	13.593
NS	0.34560540D-01	0.46749	0.00514	45.233
IN	-0.13664240D-01	-0.09478	0.00395	11.575
NP	0.36982550D-01	0.43505	0.00582	40.353
(CONSTANT)	-0.1586166			

VARIABLES NOT IN THE EQUATION

VARIABLE	BETA IN	PARTIAL	TOLERANCE	F

ALL VARIABLES ARE IN THE EQUATION

STATISTICS WHICH CANNOT BE COMPUTED ARE PRINTED AS ALL NINES.

TABLE 6.15

R, R^2, F-VALUES AND REGRESSION CO-EFFICIENTS FOR THE COMBINED MODEL.

REGRESSION ANALYSIS FOR WORKERS JOB PERFORMANCE 15/11/83

FILE NONAME (CREATION DATE = 15/11/83)

* MULTIPLE REGRESSION *

DEPENDENT VARIABLE KP FROM VARIABLE LIST 1
REGRESSION LIST 1

SEQNUM	OBSERVED KP	PREDICTED KP	RESIDUAL	PLOT OF STANDARDIZED RESIDUAL (-2.0 -1.0 0.0 1.0 2.0)
1	0.8460000	0.8853971	-0.3539717E-01	
2	0.8400000	0.8682963	-0.2829630E-01	
3	0.8450000	0.8739262	-0.2892631E-01	
4	0.8189995	0.8354747	-0.1647478E-01	
5	0.7399995	0.7199771	0.2002287E-01	
6	0.7395000	0.7536629	-0.1416300E-01	
7	0.7145000	0.7217904	-0.7290475E-02	
8	0.7320000	0.7505533	-0.1855331E-01	
9	0.7138000	0.7152124	-0.1412499E-02	
10	0.6790000	0.6737901	0.5209837E-02	
11	0.7020000	0.7234979	-0.2149794E-01	
12	0.6815000	0.7908421	-0.1093421E-01	
13	0.7900000	0.7755659	0.1443399E-01	
14	0.8010000	0.8269464	-0.2594643E-01	
15	0.7959995	0.8037410	-0.7741086E-02	
16	0.7385000	0.7253397	0.1260028E-01	
17	0.6916000	0.6553809	0.3651903E-01	
18	0.5360000	0.5997916	-0.1370167E-01	
19	0.6750000	0.6421961	0.3280394E-01	
20	0.6125000	0.6115888	0.9111208E-03	
21	0.5484995	0.5297117	0.1878827E-01	
22	0.5975000	0.5932758	0.4224334E-02	
23	0.5060000	0.5067286	-0.7284982E-03	
24	1.1519995	1.1247726	0.2722307E-01	
25	1.1439995	1.1357736	0.8262631E-02	
26	1.1200000	1.1092566	0.1071093E-01	
27	1.1100000	1.0931477	0.1685215E-01	
28	1.1220000	1.1152877	0.6712109E-02	
29	1.0899995	1.0905906	-0.5074560E-03	
30	1.0599995	1.0555829	0.3169762E-02	
31	1.1050000	1.0704437	0.3456150E-01	
32	1.0650000	1.0766000	-0.1160064E-01	
33	1.0700000	1.0742770	-0.4277623E-02	
34	1.0499995	1.0632740	-0.1324171E-01	
35	0.9859995	0.9995129	-0.9512983E-02	

DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).

VARIABLE LIST 1, REGRESSION LIST 1. DURBIN-WATSON TEST 1.57223

TABLE 6.16
OBSERVED AND PREDICTED VALUES OF PERFORMANCE AND THEIR RESIDUAL DIFFERENCES FOR THE COMBINED MODEL.

TABLE 6.17

RESULTS OF REGRESSION ANALYSIS

(Numerical Values of Regression Coefficients with the constant terms)

Regression No	Constant	KN	KS	NS	IN	NP	NC
6.1 (For BDP)	0.241	0.00182	0.0162	0.00891	-0.0043	0.0097	-0.02154
6.2 (For BMTF)	-0.133	0.00790	0.01093	0.01116	0.00368	0.03026	0.01903
6.3 (For TSS)	-0.933	0.00475	0.00658	0.03846	-0.00151	0.07917	0.08880

CHAPTER - 7

CONCLUSION, RECOMMENDATION AND SCOPE OF FUTURE WORK

The objective of the present work was firstly to identify the factors which influence the labour performance in selected manufacturing(engineering) units. In this respect six principal factors such as 'knowledge', 'Skill', 'Physical Conditions',Individual needs",'Social Conditions' and 'others' have been identified through two questionnaire surveys. The first survey was conducted with questionnaire type-I amongst the top and mid-level Executives in five engineering plants such as Bangladesh diesel Plant, Bangladesh Industrial Technical Assistance Centre, Bangladesh Machine Tools Factory, Telephone Shilpa Sangshtha and Metalex Industry. The outcome of this survey is detailed in Chapter- 3.

Secondly an effort was given to quantify the factors with numerical values. The quantification was made through a second questionnaire survey of type-II. This survey was carried amonst the floor-level workers of three units such as BDP, BMTF and TSS. In this survey 34 sub-factors were considered which build up the six principal factors mentioned above. The methodology of the above quantification and establishment of the various scales are described in Chapter-5.

Thirdly, a multiple regression analysis was used to develop regression equations for estimating the workers'performance

with 35 data points from 35 workers' in three manufacturing units. The results along with discussion in detaile are given in Chapter-6.

7.1 Conclusions and Recommendations:

The Multiple Regression Analysis explained in inter-industry differences in productivity based on some common variables. The results of the analysis suggest that the value of the multiple correlation co-efficient, R^2, of 0.98 is sufficiently good in explaining the variance in productivity. Similar findings were obtained when regression analysis were made for the three units separately. Fig. 7.1, 7.2 and 7.3 in bar-charts indicate the comparative performances of the workers' having the highest and lowest performance levels for the three plants under consideration. Fig. 7.4 shows the highest scaling and lowest scaling for the combined sample of 35 workers' of the three plants.

From a comparative analysis of these bar-charts one would find the real differences of the explanatory variables of the labour performance. From these figures it would be evident that the average performance level of the TSS workers' is the highest. It has been observed that inter-industry performance differentials as reflected by the bar-charts is mainly due to the variables"Social Conditions" and "Physical Conditions". Social conditions in TSS plant are clearly defined and the management is quite aware of the human as well as the technical problems encountered by the workers. The factors of the physical conditions

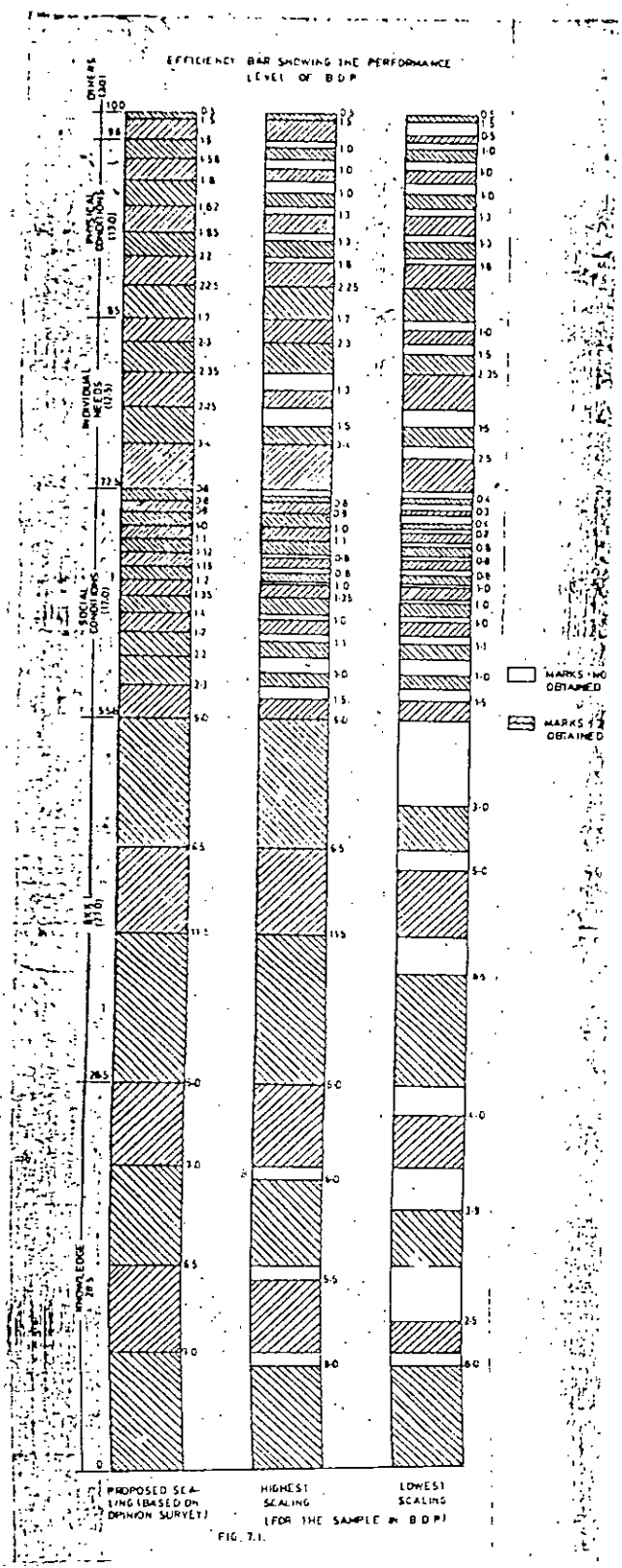

EFFICIENCY BAR SHOWING THE PERFORMANCE LEVEL OF BDP
OTHERS (20)
PHYSICAL CONDITIONS (13.0)
INDIVIDUAL NEEDS (10.5)
SOCIAL CONDITIONS (11.0)
KNOWLEDGE (28.5)
MARKS NOT OBTAINED
MARKS OBTAINED
PROPOSED SCALING (BASED ON OPINION SURVEY)
HIGHEST SCALING
LOWEST SCALING
(FOR THE SAMPLE IN BDP)

FIG. 7.1.

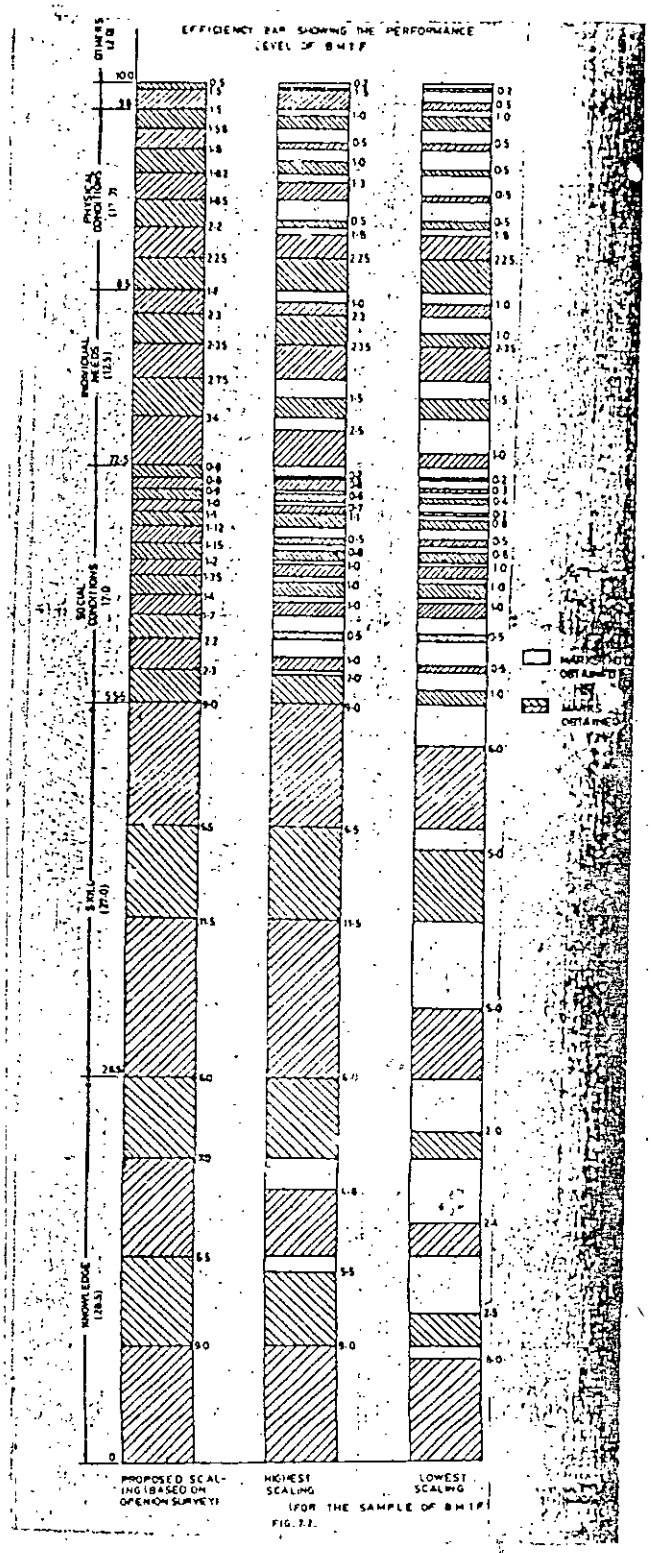

EFFICIENCY BAR SHOWING THE PERFORMANCE LEVEL OF BMIP
OTHERS (2.0)
PHYSICAL CONDITION (11.75)
INDIVIDUAL NEEDS (12.5)
SOCIAL CONDITIONS (17.0)
SKILL (27.0)
KNOWLEDGE (28.5)
PROPOSED SCALING (BASED ON OPINION SURVEY)
HIGHEST SCALING
LOWEST SCALING
(FOR THE SAMPLE OF BMIP)

FIG. 7.2.

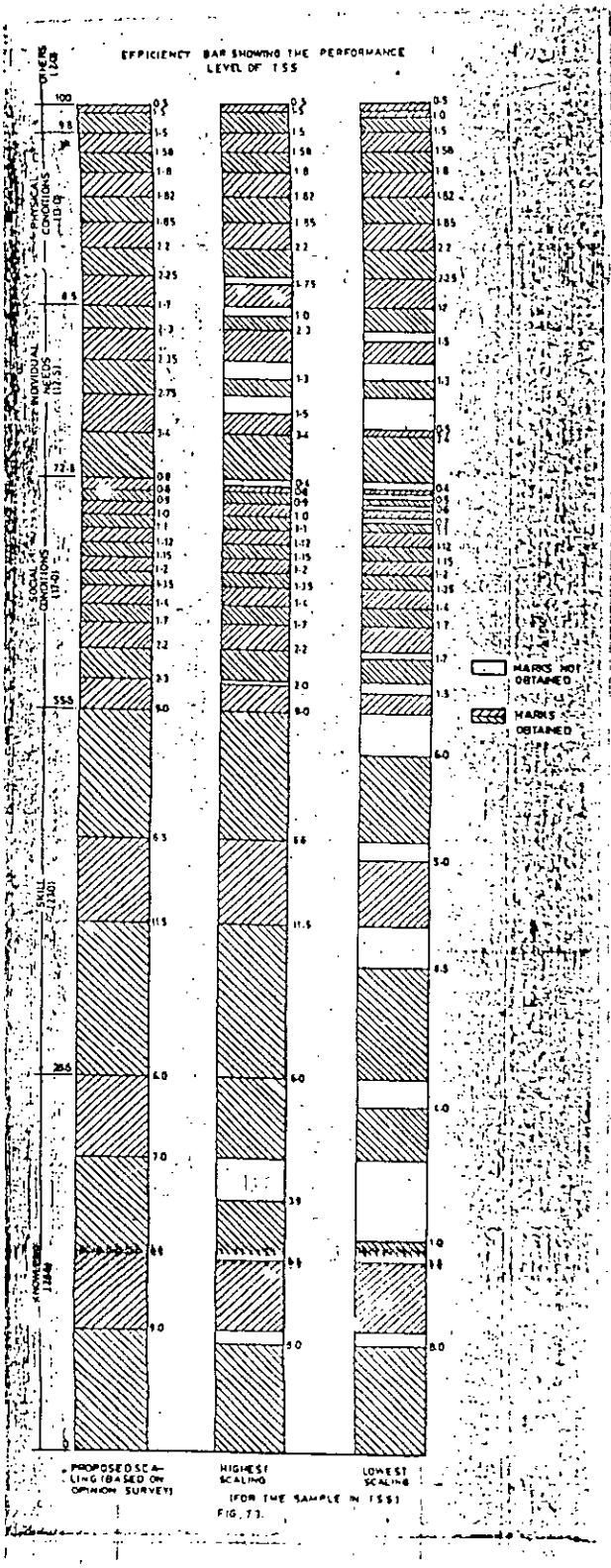
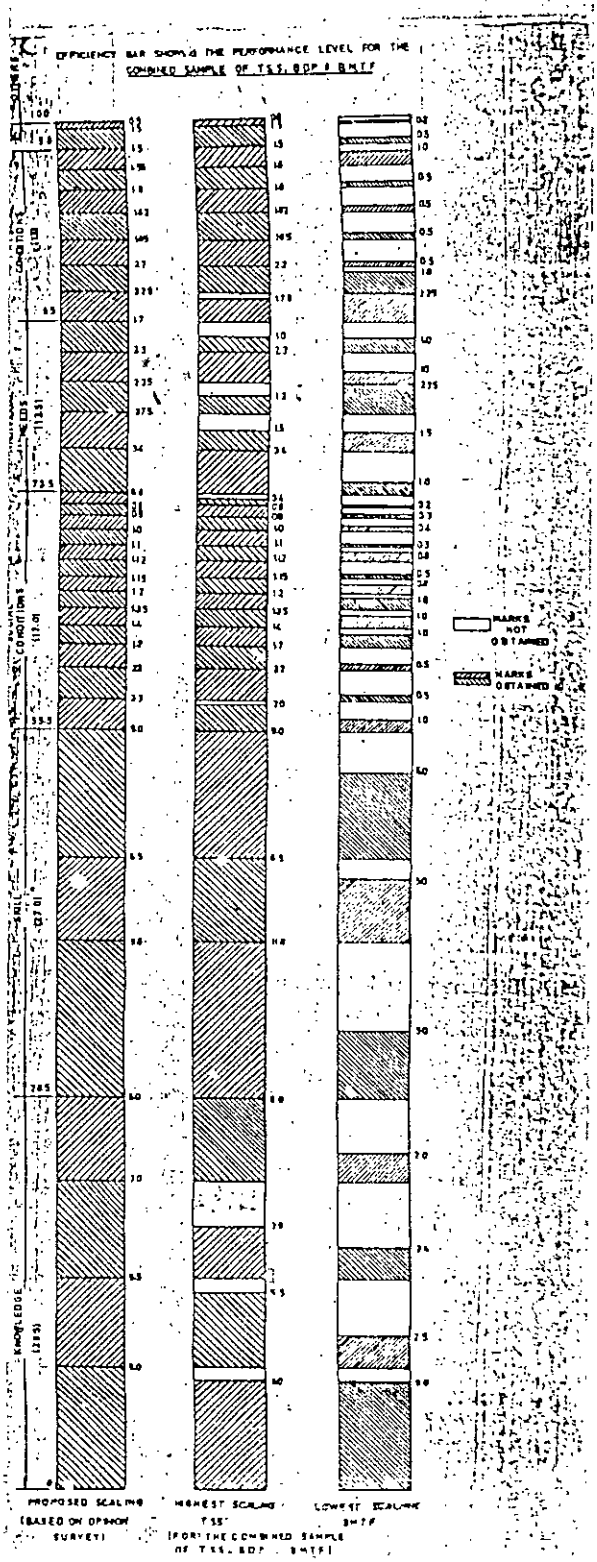

EFFICIENCY BAR SHOWING THE PERFORMANCE LEVEL OF TSS
MARKS NOT OBTAINED
MARKS OBTAINED
PROPOSED SCALING (BASED ON OPINION SURVEY)
HIGHEST SCALING
LOWEST SCALING
(FOR THE SAMPLE IN TSS)

FIG. 7.3.


EFFICIENCY BAR SHOWING THE PERFORMANCE LEVEL FOR THE COMBINED SAMPLE OF TSS, BOP & BMTF
MARKS NOT OBTAINED
MARKS OBTAINED
PROPOSED SCALING (BASED ON OPINION SURVEY)
HIGHEST SCALING TSS (FOR THE COMBINED SAMPLE OF TSS, BOP & BMTF)
LOWEST SCALING BMTF

which affect the working environment such as lighting, temperature, ventilation and other related variables are maintained at acceptable level through careful adjustment. This created a satisfactory condition for maintaining a high and acceptable level of performance. Under this prevailing working conditions the workers of the TSS plant were assigned high marks for the variables "Social Conditions", and "Physical Conditions". In contrary BMTF workers' have been suffering from traditional inherent weaknesses regarding management policies in terms of social conditions and unacceptable working conditions prevailing in the plant. Thus, performance of the workers are significantly affected under such conditions.

The workers of the BMTF plant have better academic and training capabilities compared to the workers of the TSS plant yet they were unable to achieve satisfactory level of performance. Among other reasons, one possible reason might be due to existance of improper social condition and unacceptable physical conditions in work areas. The author, from his observations during the visits to the plant, believes that the situation could be improved by taking appropriate management action in the standards of the above two factors. It has been revealed from the survey and the discussion sessions with the management executives of BMTF that the technological factors which relate to the overall labour productivity need, effective considerations and action for their improvement upto the highest possible level; yet the human factors and their improvement should be given the

priority. A timely warning may be imposed in the context that if proper attention is not being extended in both of these areas, it would result in dramatic ineffectiveness in labour performance.

The existing social conditions and physical conditions of the Bangladesh Diesel Plant could be designated as fair. Because of improved social and physical conditions the workers of BDP have been graded with much higher marks in comparison to the workers of BMTF.

The regression equations, developed for the three plants in the present work, are not considered to be generalized. This is the limitation of thepresent work. However, a pointer for the extension of these models for all manufacturing units and their generalized applicability has been given in the recommendation of future work. Yet effort was given to generalize the application of the models with some modifications as given in art. 7.2 .The causes of lower productivity have been investigated in the present work. The shortcomings could be reflected in the bar-charts. But the author strongly believes that managements of these manufacturing units should evolve and bring in new generation of management thoughts, polices and actions which would develop, strengthen and help in sustainance of growth of human relations and management. This would need establishment of research and development(R & D) departments in the plants to carry-out effective research works on human relations and productivity.

The outcomes of the researches would help identifying the factors impeding the labour performances and the overall labour productivity of the total systems to attain acceptable levels and thereby implement effective measures to remove them. Following are the general recommendations:-

i. Continual basic education of the worker

ii. Implementation and establishment of appropriate in-plant training network. Continual training may also be given through-out side agencies, if it has more cost-effectiveness compared to in-plant training facilities.

iii. Build up of quality control(QC) circle. The workers should voluntarily participate in assessing and setting quality control levels.

iv. Proper assessment and evaluation of the aptitudes of the workers could be made through periodic aptitude test conducted by the Human Relations Research Department. This would help identify the weaknesses and strengths of the workers and develop their skills.

v. Organization structure would be such that it allows close supervision and more active participation of the supervisory personnels, create more informal organizations amongst the workers and better human relations between supervisory personnels and the workers.

vi. Application of Industrial psychology should be more effective so that efforts be given to increase 'job enrichment' and to make the jobs more challenging and interesting to the workers.

vii. Selection and hiring procedure for the workmen recruitment should be scientific and proper. The recruiting authority should be right and honest to select the right people for the right jobs.

viii. Proper placement of the workers for the proper job is necessary.

ix. Workers' participation in floor-level management should be recognised.

x. Implementation of appropriate incentive schemes and effective piece-rate system.

xi. Other motivators such as honorium, certificates of honour may be awarded to the efficient workers'. These would thereby give recognition to the services of the workers.

xii. A balanced wage structure should be introduced after proper evaluation of the jobs. This evaluation process would take into consideration such aspects as degree of difficulty in the job, respondibility etc.

xiii. There should be good and improved communication between workers and management.

xiv. Rules , regulations and laws must be well defined so that

no confusion and ambiguity exist.

xv. The management should be efficient and honest.

xvi. Procurement and supply of right raw materials at right time may be maintained.

xvii. Proper maintenance of the machineries and equipments.

xviii. Recreation, accommodation and medical facilities should be extended.

7.2 Scope of Future Work:

The quantitative approach regarding the human aspects of the works and their quantification is not free from some degree of subjectivity leading to variability and possible controversy. Thus elimination of these limitations would require further study on the following aspects:

1. The regression models as developed in the present work need test and verification in similar plants. Thus any modification if necessary may be incorporated. The quantification scales may necessarily require adjustment accordingly, in terms of the principal factors and sub-factors.

2. The labour performance Index could be ascertained through micro-level observations purely on a specific job basis(product). In this case productivity can be defined as "the total no. of minutes(or hours) needed for the production of a well-defined product(s) by an operator using a standard machines". Considering the inherent complexity, interactions and interrelationships

existing in a production system, the suggested micro-level studies should initially be undertaken with simple but representative sub-systems(comprising of turning station,milling station etc.). For the comparison of performances between different plants in the industry, identical sub-systems with identical production facilities on similar production output might be considered. The basic data might be taken during the study as follows:

a. Work-sampling study,

b. A more detailed study of time used, tools and number of operations.

c. Standard times required for hand operations, machine operations, initial machine set-up and the total production time required to finish the job.

On successful completion of micro-level studies of the sub-systems, a micro-level study for the whole system could be undertaken. The expected result would be a single model for the system as a whole.

3. In the present study a correlation matrix has been obtained for the six principal factors. Another correlation matrix can be formed by taking performance as the dependent variable and all other sub-factors as independent variables. Thus correlation coefficients could be found out and the relative importance of the sub-factors (Quantitative values as

obtained through the present research work) could be justified at various level of significance.

4. It is possible to find out the Overall Labour Productivity Index(OLPI) if the unaccounted lost time be charged to the supervisor(s) and the omitted man-hour be charged to the management and these time elements could be ascertained in real terms. The effect of these time-factors are inherently related to the technical factors such as machine utilization, utilization of raw materials, production planning system, design and method, job layout, marketing, capital intensity etc. It must be borne in mind that it is a difficult task to ascertain as in the context of the developing countries like Bangladesh, where the fundamental primary and secondary informations are rarely and scarcely obtainable in usable forms.

REFERENCES

1. Planning Commission Ministry of Finance and Planning — " The Second Five-Year Plan 1980-85" Planning Commission, Ministry of Finance & Planning, Government of the People's Republic of Bangladesh, May, 1983.

2. Sutermeister, R.A. — " People and Productivity", Mc Graw-Hill, Inc., New York, 1963.

3. Argyle, M. G. Gardner & F. Cioffi. — "Supervisory Methods Related to Productivity, Absenteeism, and labour Turnover", Human Relation, Vol. 11, No. 1 Feb, 1958, P. 24.

4. Chandy, K.T. — "Factors which Hinder or Help Productivity, Improvement", Country Report- India. APO Basic Research, October, 1980.

5. Liu, T.Y. — " Factors which Hinder or Help Productivity Improvement" Country Report- The Republic of China, APO Basic Research 31 January, 1980.

6. Ahmad, M. — " Factors which Hinder or Help Productivity Improvement" Country Report- Pakistan, APO Basic Research.

7. Norman, R.G. & Bahiri, S. — " Engineers' Measures of Productivity", Productivity Measurement and Incentives, Chapter 4, P.27, Butterworth & Co., London, 1972.

8. Bahiri, S. & Martin, H.W. — " Effective Management through Productivity Costing", "Industrial Commercial Techniques"(In-Com-Tech.), London(1968).

9. Dudley, N.A. — " Work Measurement: Some Research Studies", Macmillan, London, 1968.

10. Nishikawa, S. Sazanami, Y. Yamada, S. — " Interpretation and Objectives of Measuring Productivity", "Productivity Measurement Manual" Chapter 1, P. 1.

11. Ouh,Y.B, E.P.Clarance and Y.K. Chang of Soog Jun University Team & D.K. Choi, Y.C. Chang H.J. Kwon of Korea Productivity Centre Team. " Factors which Hinder or Help Productivity Improvement" Country Report-Korea APO Basic Research, 1980.

12. Mayo, E. " Hawthorne Investigations", " Writers & Organizations",Edited by D.S. Pogh, D.J. Hicksons & C.R. Hinings, Penguin Books,P.126. 1971.

13. Mundel, M.E., " Improving Productivity and Effectiveness" Asian Productivity Organization, Prentice-Hall, Inc., 1983.

14. Matsumoto, K. "Organizing for Higher Productivity -An Analysis of Japanese Systems and Practices". Asian Productivity Organization 1982.

15. Chin Hock O. & Ting, G. " Productivity in Singapore", Workshop on Productivity Measurement (Papers), 25th-29th June,1973, Singapore, Asian Productivity Organization.

16. Kurosawa, K. " Measuring Value added Productivity at Enterprise Level", " Workers' Productivity, Its Measurement Control" C III.

17. Sasmal, P.K. " Productivity Measurement & Control at the Firm Level", "Productivity Measurement: Theory & Practice in Asia" selected papers from APO Symposium and Workshop, 1975 and 1979, P. 103 Asian Productivity Organization.

18. Barkat, A. Ahmad, S. & Hossain, M. — "Assessment of Trained Manpower Needs for Agricultural Planning & Project Analysis in Bangladesh", "Bangladesh Institute of Development Studies", May, 1983.

19. Azim, M.A. — " Ascertaining causes of Lower Productivity : A case Study", A Research Project Sponsored by University Grants Commission of Bangladesh.

20. Bangladesh Management Development Centre, Dhaka. — Final Report on " Production Incentive Scheme" (for Spinning and Back Processing Departments of Bangladesh Jute Mills Corporation), Vol. V, December, 1982.

21. Islam, Mir Shahidul — " Housing and the Quality of Life: An Analysis of Regional Variations in Urban Delhi ". Unpublished Ph.D. Thesis, Centre for the Study of Regional Development, School of Social Sciences, Jawharlal Nehru University, New Delhi, June, 1982.

APPENDIX - I

SUTERMEISTER'S PRODUCTIVITY MODEL

Sutermeister developed a model of productivity considering the technical factors as well as human factors and developed a scientific and logical expression of different human factors and sub-factors. He mainly dealt with those factors which have great significance from human resource as well as management point of view. He further mentioned that besides technical factors "workers job performance" has the greatest influence on labour productivity as well as overall productivity of industrial units.

Sutermeister claimed that " technical factors" are all those other than workers performance which can affect output per man-hour. They include such factors as technological development(the machinery and equipment workers have to work with), the quality of raw materials, the layout of the work and methods and techniques. In industrial plants technological development will often be the most important factor influencing productivity, as illustrated in Fig.A.1.1. On the otherhand, in a department store , the degree of technology would have relatively little effect on productivity, except perhaps, if automatic equipment were in use in the office. The segments in the diagram for a department store might be similar to those shown in Fig.A.1.2.

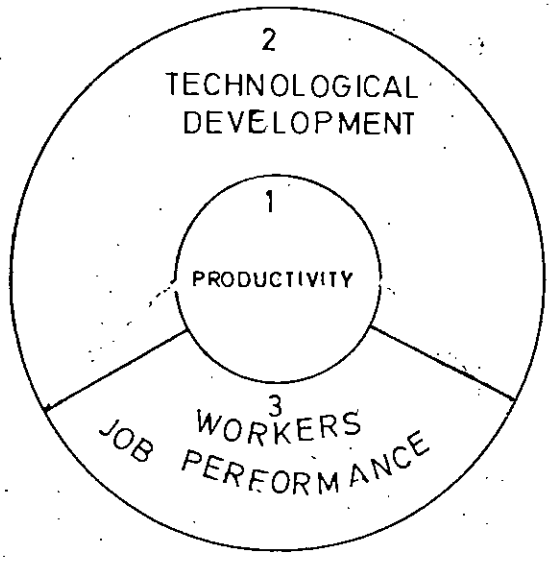


Fig. A 1.1

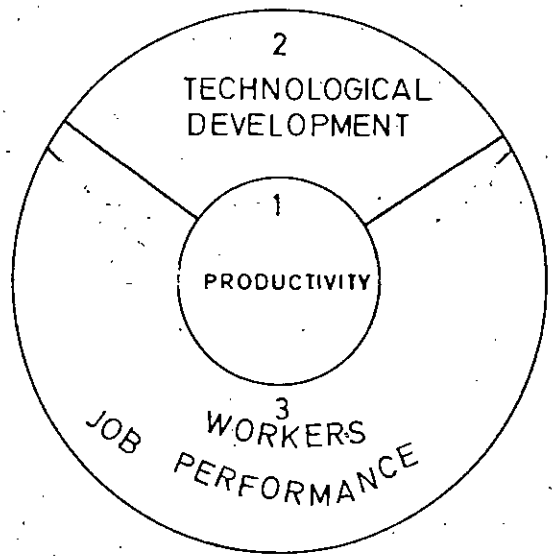


Fig. A 1.2

Sutermeister productivity diagrams

There are also other technical factors which have a bearing on productivity such as(i) the plant characteristics: its size, capacity, the percentage of capacity utilized(ii) The product-its design, quality-related to research and development work (iii) The product mix- the proportion, in which they are combined, will affect the overall productivity of the plant without any change in the productivity of any individual item(iv) Plant and job lay-out-work flow and methods(v) Design of machines and Equipment, (vi) Degree of Integration of production process-partly processed raw materials may give higher output of finished product(vii) Uti-lization of power-output per man-hour is usually increased with

increased use of power (viii) Raw materials- should be of good quality and have adequate supply (ix) Percentage of indirect workers' employed(x) Degree of application of scientific Management-with its emphasis on better planning and co-ordination, simplified methods, standardization, efficient organization structure, time and motion study, reduced waste and spoilage, contribute notably to increased productivity and also to pay attention in motivating the workers.

Sutermeister stated that all these technical factors are deemed to be included in sigment '2' of the diagram labled "Technological development". He also stated that there are some interrelation between this segment and segment'3' (Workers' Job Performance). But he did not mention the relative weightage or comparative frequency distribution in between "Technological development" and "Workers' Job Performance" in both the cases of an industrial plant or a department store.

APPENDIX - II

CHANDY'S PRODUCTIVITY FACTORS

CHANDY in his country report discussed mainly on the analysis and results based on selected 169 consultancy reports out of a total of 1351 reports submitted by the experts of National Productivity Council(NPC) of India under its Productivity Survey and Implementation Scheme (PSIS). Opinions of reputed persons who are connected with productivity and management like policy makers and administrators, professional managers, industrial engineers, behavioural scientists, trade union leaders and academic experts were collected through personal interviews conducted by the NPC experts. Under the PSIS scheme the in-depth study was confined on four different industries viz power generation and distribution, fertilizers, cement and cotton textiles. The main objectives of the study were:

a. To identify the major factors that hindered or helped productivity improvement in the past and assessing the impact of such factors on productivity.

b. To evaluate the effects of gains of productivity on man-centred development and distributive justice.

c. To identify the areas of continuing research and improvements in the information system pertaining to productivity.

Table A 2.1 represents the final results of the analysis of 169 reports on the basis of the scheme mentioned above. The

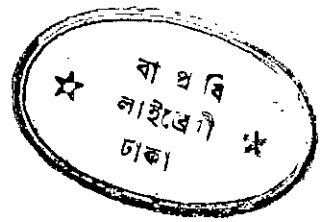
table illustrates in detail about the problem areas and the identifiable factors that hindering productivity improvement and their respective frequency of response:

TABLE A 2.1

FACTORS HINDERING PRODUCTIVITY IMPROVEMENT-NPC EXPERIENCES

	Problem areas	Frequency		Agent/Process
1.	Method of work	27		
2.	Non-financial motivators	12		
3.	Financial Motivators	18	133.00	Human Related
4.	Skills & Work Attitudes	46	(36.34%)	
5.	Relationship & Group Behaviour	30		
6.	Maintenance	23	33.00	Equipment and
7.	Choice of Design/Technology	10	(9.02%)	Machinery Related
8.	Organization structure	43	50.00	Structure related
9.	Layout-plant/office/stores	7	(13.66%)	
10.	Production Planning & Control	13		
11.	Materials Planning Control	10		
12.	Quality Control	4		Communication
13.	Cost/Budgetary Control	8	99.00 (27.05%)	& Control Process
14.	General Management Reporting system	32		
15.	Corporate Planning	32		
16.	Energy	5		
17.	Materials	6	29.00	Resource
18.	Capital/Finance	14	(7.92%)	Availability
19.	Equipment/Spares	4		
20.	Completion	5	11.00	Market Related
21.	Demand	6	(3.01%)	
22.	Governmental Interference	11	11.00	Socio- Political
23.	Political Influence on Trade Union		(3.01%)	
	Total:	366	366(100%)	

Out of a total frequency of 366 identified from 169 reports, as high as 36.34 percent are relating to human factors. The single largest problem within this group relates to skills and attitudes towards work followed by relationship and group behaviour. Factors related to control process turned out to be the second important problem area in Indian Industries. Under this major group most important independent problem areas are absence of appropriate corporate level communication and management control systems. Structural aspects appeared to be one of the major problem areas in Indian Industries. But of a total frequency, 13.66 percent are found to suffer on this account. However, the most effective factor relating to this group is the organizational structure. Problems relating to machinery and equipment are mainly confined to two aspects- first their maintenance and the second their operating conditions. Resources related problems are predominantly those connected with capital or finance.



APPENDIX - III

KOREAN PRODUCTIVITY STUDY

The joint research work of Jun University Team and Korea Productive Centre team on productivity analysis revealed the following points:

1. Productivity increases if an industrial enterprise adopt the following schemes as a means of stimulating work motivation and high morale as if the workers worked for their own business, such as:

   a) Workers share holding
   b) Housing facilities
   c) Family protection system
   d) Rewards for long continued service system
   e) Retirement grants
   f) Bonus
   g) Co-operative Society for workers
   h) Medical Insurance etc.

2. Environmental factors which reduce efficiency in working situations are many such as, illumination, colour ventilation, room temperature etc. proper improvement of these conditions appear to have achieved productivity gain.

3. In addition to the improvement of physical conditions the kinds and quality of welfare measures taken by the industiral organization for the sake of workers have direct

bearing on productivity such as various insurance plans, regular occupational safely check-ups, mutual aid fund, recreational facilities and programmes, luncheon programmes etc.

4. Productivity goes up higher in the industry where the wage level is higher among the same category of industry. Not only wage level, but daily average working hours affects productivity.

5. Productivity is lower in an industrial concern which is forced to make some adjustments such as reduction in labour force, lay-off of part-time workers, cut in wages, suggestion of promotion and salary increase, etc.

6. Labour/Management co-operation is conducive to productivity improvement. Less labour/management co-operation results in lower productivity.

7. The rate of replacement of worn-out machinery and equipment also affects productivity.

8. In all manufacturing units machinery and equipment should be installed on the basis of the production process. Balance of production in each production process in connection with plant layout should be maintained properly and regularly. If not, it will affect productivity adversely.

9. Automation as well as the technology development has a direct bearing on productivity improvement.

10. For manufacturing industries to maintain and operate economically as well as efficiently, equipment must be used with maximum effectiveness and properly maintained. Those who have followed carefully specifications for prevention and maintenance show higher productivity.

11. Economic as well as political factors and Government policies also are said to have direct bearings on productivity improvement.

From questionnaire survey and for each factor, the sensitivity of a specific sub-item, policy or industrial practice in effecting productivity in term of gross value added per capita was classified into three categories(a) high (b) medium and (c) low sensitivity. All the analysis concerning the research work were summerised in Table A.3.1. By studying the table one may see what factors are believed to be important for productivity analysis in machinery industry. 'D' values(statistical 'Z' value) are noted in the table for each productivity affecting practice or policy. 'D' value is the range and thus identifies the factors which help on hinder productivity. A large value indicates productivity is sensitive to that factor, i.e. the leverage of that factor is high.

The limitation of the research work was that opinions collected were slanted towards the supervisor, manager and owner levels i.e. top and mid-level management personnel and those of the labour side were not represented.

TABLE A 3.1

FACTORS WHICH HELP OR HINDER PRODUCTIVITY (MACHINERY INDUSTRY)

Sensitivity	A	D	B	D	C	D
Factor	High Sensitivity	Value	Medium Sensitivity	Value	Low Sensitivity	Value
Labour	Workers efficiency	3.07	Incentive system	1.44	Work attitudes	1.03
			working hours	1.39	Welfare services	0.95
			wage level	1.30	Employment adjustment	0.94
			Morale	1.25		
			Working Condition	1.21	Functional Training	0.85
					Hierarchical training	0.83
					Labour management co-operation	0.75
					Scouting	0.38
Capital	Ratio of long to short-terms loans	2.16	Capital cost	1.71	Rate of equipment replacement	1.05
			Capacity utilization	1.61		
			Ratio of total capital to total debt.	1.31		
Technology	Balance of production by process	3.16	Plant layout	1.74	Style of industrial organisation	1.07
	Automation level	3.01	supportive measures for quality control	1.48	preventive maintenance	0.99
	Inventory, material handling system	2.70	Adoption of Q.C. system	1.16		
	Ratio of R&D to net sales	2.09	Emphasis of layout	1.14		
	Technology level	2.04				

TABLE A 3.1 (Continued)

Sensitivity Factor	A High Sensitivity	D value	B Medium Sensitivity	D Value	C Low sensitivity	D Value
Management	Industry's external environment	3.15	Top manager's background	1.45	Criterion for placement, promotion	0.61
	Independent division of management system	2.68	Ration of workers to supervisors	1.44		
	Delegation of authority & division of work	2.24	Establishment of Industrial Engineering Department	1.42		
			Process of decision making	1.26		
			Forms of communication	1.14		
Others			Distribution of productivity gains	2.01		
			Transportation conditions	1.25		
			Government policies	1.24		

APPENDIX - IV

QUESTIONNAIRE TYPE-I FOR TOP AND MID-LEVEL MANAGEMENT EXECUTIVES

Name of the Interviewee :

Designation :

Organisation:

A. Please identify according to the hierearchy of importance (by placing number's 1,2,3,... ... in order of importance) the following factors which you consider to be important for evaluation of workers' job performance(labour efficiency-related to overall labour productivity) of your factory workers.

Also allocate 100 marks amongst the factors in order of importance.

	Factors	Sl.No. (In order of importance)	Marks Allocated
1.	Knowledge		
2.	Skill		
Motivation 3.	Social conditions		
4.	Individual needs		
5.	Physical conditions		
6.	....		
7.	....		

Note: The term" workers " used here means the worker's mainly involved in job-shop level of manufacturing.

If you may like to make any other comment or if you like to add any other related factors regarding workers job performance then please put your statement above and allocate the marks accordingly (say in the row 6, 7 and so on).

B. Please identify, according to the hierarchy of importance (by placing number 1,2,3,4--- ------ in order of importance as before) the following sub-factors under the headings of the main factors in accordance to the statement(A) which you consider to be important for performace analysis.

Also allocate 100 marks amongst the sub-factors in order of importance considering the marks allocated previously.

		Total Marks
1. Knowledge:-		
	Sl.No. (In order of importance)	Marks Allocated
a) Basic education		
b) Experience		
c) Training		
d) Interest		
e)		

If any other,

2. Skill:

Total marks

	Sl.No. (In order of importance)	Marks allocated
a) Aptitude		
b) Personality		
c) Accuracy		
d)		

3. Social conditions:

Total marks

	Sl.No. (In order of importance)	Marks allocated
a) Organization structure		
b) Organization efficiency		
c) Leadership climate		
d) Job content		
e) Selection and placement		
f) Norms		
g) Wage and salary level		
h) Incentive		
i) Job evaluation		
j) Communication		

k)	Relationship with superior		
l)	Leadership		
m)	Performance ratings		
n)	... ...		

4. Individuals Needs :

Total marks

		Sl.No. (In order of importance)	Marks allocated
a)	Level of aspiration		
b)	Job satisfaction		
c)	Perception of the situation(adaptability)		
d)	On job and off-job activities		
e)	General economic conditions		
f)	....		

5. Physical conditions:-

Total marks

		Sl.No. (In order of importance)	Marks allocated
a)	Lighting		
b)	Temperature		
c)	Ventilation		

d)	Clean lines		
e)	Rest periods		
f)	Safety		
g)	Health		
h)	....		

Note: If you like to add any other related sub-factors' under the headings of main factor's as stated before, then please put your remakrs on the respective dotted lines(as shown above) and allocate the marks accordingly.

C. What are the different corrective measures and how(your suggestions) these can be implemented in your factory to raise the overall labour productivity .

QUESTIONNAIRE TYPE II
FOR FLOOR-LEVEL WORKERS

1. Your name :

2. Age : ☐☐

3. Name of your organization:

4. Section/Department/Workshop:

5. Designation:

6. (a) Your Qualification:

   (b) What in your opinion should be the minimum(least) qualification of a worker ? ☐

   1. Upto Class VIII ?
   2. Upto S.S.C.(Matriculation)
   3. Upto H.S.C.(Higher Secondary)
   4. H.S.C. and above

7. Do you have any training on any technical field ?

   1. Yes .2.No ☐

   a) if yes, Answer the following

No	Field (Subject)	When			Period (Duration)	Place (Institute)
		Pre-Service	In-Service	Month/ year		

b) Do you feel that you need further training to raise your efficiency ? (1) Yes (2) No ☐

c) If yes: Answer the following :

i) Your proposed field of training

ii) How long (months) ☐☐

iii) Where(Institute)

d) Whether your training is job related

1) Yes 2)No ☐

i) If yes, Answer the folllowing ☐

Because, (1) I am able to do my job in a better way.

(2) I can finish my job much quicker than before

(3) I am happy with my training

(4) Others

(5) ....

ii) If No. Answer ☐

(1) Management authority does not like me.

(2) I have no good terms over my superiors.

(3) Previously I was not interested about my field of training.

(4) My present job is my field of interest

(5) Others....

e) Do you think that training should have the utmost importance?

1) Yes 2) No ☐

i) If yes, Answer , because: ☐

(1) I may be perfect about my job

(2) It develop's skill

(3) It is necessary to get job out side Bangladesh (I need the training certificate only).

(4) I get some training allowance as well as I may be released from my regular duty during training period.

(5) Others.

8. Your technical experience:

(a) About job mobility:

No	month/year From	to	Where (Name of the Industry)	Designation	Salary	Why left the job

(b) Do you think that you are experienced enough to perform your job as per job description 1) yes 2) No ☐

9. a) Do you like your assigned job always: 1) yes 2) No ☐

i) If yes: Answer :- ☐

Because : 1) of interest
2) of affection on machineries
3) of learning
4) of satisfying the boss
5) others ....

ii) If No. Answer

Because: 1) I am misplaced
2) I do not understand machineries
3) I have no training on the particular m/c which I handle.
4) I do not like my boss
5) I am physically as well as mentally week.

b) Do you like your boss ? 1) Yes 2) No

i) If yes, then why ?

Because:
1) He is gentle and co-operative
2) He knows about m/c's
3) He is able to understand my problems
4) He seeks overtime for me
5) He is my relative or others... ...

Remark's (for tally)

ii) If no, then why ?
1)
2)
3)
4)
5)

c) How many sub-ordinates you have ?

i) Please comment on some particular sub-ordinates
1) Who are highly skilled(name of the workers)....
2) Who are semi-skilled or less-skilled
3) Who are disliked by you

d) Do you like your sub-ordinate ? 1) Yes 2) No

i) If yes, then why ?

Because:
1) He is gentle and co-operative
2) He is regular and punctual
3) He is skilled one and know's about m/c's
4) He is able to understand my problems:
5) Others ... ...

ii) if No, why ?

1)
2)
3)
4)
5)

10. Do you involve in any workers' committee or Trade Union? [ ]

1) yes 2) No

i) If yes , Answer:

a) Name of the Trade Union

b) In what position : [ ]

1) I am the member of the executive committee.

2) I am active member but notin the executive committee.

3) I am a ordinary member.

c) Why ? because : [ ]

1) It fight's for economic benefits

2) It saves me from unemployment

3) The leader love's me very much

4) It does not support either employee or employer illegally.

5) Others ... ...

ii) If no, Answer: [ ]

Because :

1) I do not believe in Trade Union

2) Trade-Union can do nothing for general workers'.

3) Member's of the executive Committee(Trade Union) are self-centered.

4) Trade Union member's are directed by influential political leaders.

5) Others ... ...

11. What is your opinion about the organization structure you belongs to ? [ ]

1) It is defective
2) It is perfect
3) It is difficult for me to say anything
4) It is OK, but needed to certain change(mention the field of change)
5) Others ... ...

12. Description of your job:

a) Please state your formal official job description for which you are responsible:

... ...

b) What you do actually(regularly) :

i)
ii)
iii)
iv)
v)

c) From time to time do you involve in any such a work which is not defined in your job description? [ ]

1) Yes 2) No

If yes, please state the nature of the job

d) Do you work overtime ? (1) Yes (2) No [ ]

i) If yes

1) Please state how much hrs you usually spent in a week during overtime ?

2) (a) What type of job you do during overtime ? Whether it is the same as above ? (according to your given job description)

1) Yes 2) No

b) If no, please state about your job concerning overtime

3) Why, because :

1) I need money to run my family.

2) I like my job and I like to involve myself towards my work for most of the time.

3) Usually I have no such heavy work out side my regular duty.

4) For nothing, I have an intention to seek overtime always.

5) Others ....

ii) If No, why ?

Because :

1) I do not need money as I do work outside.

2) I use to go to market for my family purpose.

3) I have other social works for which I cannot give time for overtime .

4) I am physically weak .

5) Others... ... ...

13. a) (i) Do you feel that you are in appropriate place ?

i) Yes 2) No

(ii) If no , stats the name of the place where you would be appropriate :-

b) (i) Do you feel that all your sub ordinates are in the appropriate places: ☐

1) Yes 2) No

(ii) If no, what should be the placement structure of the subordinates ?

14. Information about your wage:

a)

Wage (per hour) if any	Wage (per output i.e. piece rate) if any	Wage (per hour in over time)	Total wage	
			Wage per month	Wage per month + over time

b) Are you happy with your present salary ? ☐

1) Yes 2) No

i) If no, please state what should be your monthly wage salary ? ☐☐☐☐

ii) Why ? Because :

1) For the same job other industry pays more. ☐

2) My wage is to little to run my family.

3) My qualification is enough for getting more wage-salary in this workshop/Deptt.

4) I am skilled and experienced worker.

5) Others ....

15. Incentive scheme :

a) At present what incentive you are getting for better performance :

1. Group or individual

2. Material incentive (including Bonus)

3. Morale incentive (status, promotion)

b) Do you have any thinking about the re-structuring of incentive mechanism!

16. Do you do any other job(off job activities-part-time or regular, social, voluntary, etc) 1) Yes 2) No ☐

i. If yes, answer the following :

1) Item (type of activities) ... ...

2) Remuneration (if any)

17. (a) How much you are earning monthly ☐☐☐☐
(Monthly salary + other sources of income)

(b) How many family members you have ? ☐☐
(including male & female)

(c) All of your family member's are dependent on you ?
1) Yes 2) No ☐

i) if No, then,

1) How many earning members you have in your family ? ☐

18. Are you satisfied (happy) with your own job ? ☐
1) Yes 2) No

i) If yes answer : ☐

1) The facilities which I am getting here are impressive and are not available in other industry.

2) The job is perspective.

3) Job is well secured (less fear of being unemployment)

4) ... ...

5) ... ...

ii) If no, then why ?

1) ... ...

2) ... ...

3) ... ...

4) ... ...

5) ... ...

19. Do you believe that active participation of worker in decision making policies at floor level management will solve many critical problems as well as enhance the overall output of the worker:

1) Yes 2) No ☐

i) If yes, answer ; ☐

1) All workers' should participate.

2) Some elected representatives of the worker's should participate.(say, two elected representatives of the M/c shop will take part in decision making management policies of that shop only).

3) Some experienced and senior worker(nominated by the management personnel of that particular shop) should participate.

APPENDIX - V

In this appendix the various significance distributions of the principal factors are given in tabular forms:

TABLE A 5.1

SIGNIFICANCE DISTRIBUTION OF PRINCIPAL FACTORS INFLUENCING LABOUR PERFORMANCE

1: Factor has major influence

6: Factor has minor influence

Principal Factors	Percentage of respondents assigning ranks						Total
	1	2	3	4	5	6	
Knowledge	50.00	29.09	9.26	4.0	0	0	92.35
Skill	35.19	43.64	7.41	6.0	0	0	92.24
Social Conditions	11.11	9.09	27.78	26.0	23.69	40	137.67
Individual Needs	00.00	7.27	31.48	34.0	28.94	20	121.69
Physical conditions	00.00	9.09	24.07	26.0	47.37	20	126.53
Others	3.70	1.82	00.00	4.0	00.00	20	29.52
Total:	100.00	100.00	100.00	100.00	100.00	100	600.00

TABLE A 5.2

SIGNIFICANCE DISTRIBUTION OF DIFFERENT SUB-FACTORS UNDER THE PRINCIPAL FACTOR " KNOWLEDGE"

1: Factor has major influence

5: Factor has minor influence

Sub-factors	Percentage of respondents assigning ranks 1	2	3	4	5	Total
Basic education	56.60	18.18	14.89	6.82	0.0	96.49
Experience	18.87	27.27	23.41	27.27	50.0	146.82
Training	15.09	23.64	27.66	36.37	0.0	102.76
Interest	7.55	30.91	24.04	27.27	25.0	124.77
Others	1.89	0.0	0.0	2.27	25.0	29.16
Total:	100	100	100	100	100	500.00

TABLE A 5.3

SIGNIFICANCE DISTRIBUTION OF DIFFERENT SUB-FACTORS UNDER THE PRINCIPAL FACTOR "SKILL"

1: Factor has major influence

4: Factor has minor influence

Sub-Factors	Percentage of Respondents assigning rank				Total
	1	2	3	4	
Aptitude	73.08	18.87	4.44	0.0	96.39
Personality	1.92	22.64	75.56	100	200.12
Accuracy	25.00	52.83	20.00	0	97.83
Others	0.0	5.66	0	0	5.66
Total :	100	100	100	100	400.00

TABLE A 5.4

SIGNIFICANCE DISTRIBUTION OF DIFFERENT SUB-FACTORS UNDER THE PRINCIPAL FACTOR "SOCIAL CONDITIONS"

1: Factor has major influence

13: Factor has minor influence

Sub-factors	Percentage of respondents assigning ranks													TOTAL
	1	2	3	4	5	6	7	8	9	10	11	12	13	
Organization structure	18.97	6.58	1.76	14.55	3.64	1.96	8.51	4.65	11.42	5.88	00	8.70	5.56	92.18
Organizational effieiency	12.07	13.16	7.02	12.73	3.64	5.88	10.64	4.65	8.57	2.94	00	4.35	5.56	91.21
Leadership climate	6.90	2.63	10.53	7.27	10.91	5.88	4.26	11.63	8.57	14.71	3.57	8.70	11.11	106.67
Job content	3.44	5.26	5.26	9.09	10.91	13.73	8.51	11.63	17.14	5.88	3.57	4.35	00	98.77
Selection & Placement	10.35	9.21	12.28	7.27	7.27	11.77	8.51	4.65	2.86	8.82	3.57	00	00	86.56
Norms	1.73	3.95	3.55	3.64	5.46	3.92	19.15	4.65	8.57	8.82	14.23	8.70	22.22	108.61
Wage & salary level	29.31	10.53	12.28	10.90	5.46	00	4.26	2.33	00	2.94	00	13.04	5.56	96.61
Incentives	12.07	22.37	19.30	9.09	3.64	5.88	2.13	2.33	2.86	00	00	00	5.55	85.23
Job-evaluation	00	5.26	14.04	3.64	14.54	9.80	10.64	6.97	5.72	8.82	17.86	00	5.55	102.85
Communication	00	6.58	1.75	9.09	10.91	9.80	2.12	16.28	5.72	8.82	10.71	4.35	11.11	97.24
Relationship with superior	1.72	3.95	1.26	5.46	14.54	5.88	10.64	20.93	2.86	11.78	17.86	8.70	5.56	115.09
Leadership	1.72	5.26	5.26	5.46	1.80	11.77	8.51	4.65	14.29	8.82	10.71	17.38	11.11	106.75
Performance ratings	1.72	5.26	1.75	1.81	7.27	13.73	2.12	4.65	11.42	11.77	17.86	21.73	11.11	112.20
Total:	100	100	100	100	100	100	100	100	100	100	100	100	100	1300.00

TABLE A 5.5

SIGNIFICANCE DISTRIBUTION OF DIFFERENT SUB-FACTORS UNDER THE PRINCIPAL FACTOR "INDIVIDUAL NEEDS"

1. Factor has major influence

6. Factor has minor influence

Sub-factors	Percentage of respondents assigning ranks						Total
	1	2	3	4	5	6	
Level of aspiration	5.88	33.33	20.0	28.0	7.90	0	95.11
Job satisfaction	62.75	15.78	12.0	0	0	0	90.53
Perception of situation	9.80	24.56	26.0	28.0	13.16	0	101.52
On job and off-job activities	0	10.53	18.0	26.0	55.26	0	109.79
General Economic Condition	21.57	14.04	24.0	18.0	23.18	0	101.29
Others	0	1.76	0	0	0	100	101.76
Total:	100	100	100	100	100	100	600.00

TABLE A 5.6

SIGNIFICANCE DISTRIBUTION OF DIFFERENT SUB-FACTORS UNDER THE PRINCIPAL FACTOR " PHYSICAL CONDITIONS "

1. Factor has major influence

8. Factor has minor influence

Sub-factors	Percentage of respondents assigning ranks								Total
	1	2	3	4	5	6	7	8	
Lighting	12.07	16.46	10.72	16.67	20.93	8.57	7.69	0	93.11
Temperature	8.62	15.19	19.65	16.67	9.30	14.29	15.39	0	99.10
Ventilation	10.35	15.19	21.43	12.50	13.95	17.14	3.84	0	94.40
Clean-liness	5.17	11.39	12.50	14.58	23.26	25.72	19.23	0	111.85
Rest period	0.0	11.39	12.50	20.83	16.28	20.00	34.62	0	115.62
Safety	31.03	11.39	16.07	12.50	6.98	8.57	0.0	50	136.54
Health	31.03	18.99	7.14	6.25	6.98	5.71	15.38	0	91.48
Others	1.73	0	0	0	2.32	0	3.85	50	57.90
Total:	100	100	100	100	100	100	100	100	800.00

APPENDIX VI

SOME RELEVANT INFORMATIONS AS OBTAINED FROM QUESTIONNAIRE TYPE-II SURVEY

TABLE A 6.1

EDUCATIONAL BACKGROUND OF THE SELECTED WORKERS

Basic Qualification	No. of Workers	Percentage from total sample size
Below Matriculation	7	20.00
Matriculation(SSC)	23	65.72
Higher Secondary level	5	14.28
Total:	35	100.00

TABLE A 6.2

TECHNICAL QUALIFICATION OF SELECTED WORKERS AND THEIR RELATIVE DISTRIBUTION

Technical Qualification	No. of workers	Percentage from total sample size
Trade course certificate holder	20	57.14
No Trade course	15	42.86
Total:	35	100.00

TABLE A 6.3

A SIMPLE FAMILY STRUCTURE OF THE SELECTED WORKERS

Average age(year)	Average family members	Earning members
32.12	6.34	1.428

TABLE A 6.4

LONGITUDE OF TRAINING OBTAINED BY THE SELECTED WORKERS' ON THE DIFFERENT FUNCTIONAL AREAS OF WORKSHOP PRACTICE

Area of Training Time	M/C Shop Practice	Fitting practice (including bench fitting)	Lathe m/c practice	Milling m/c practice	Granding m/c practice	Welding practice	Total No.	% from the total	Cumulative
2-3 week									
3-week-1-month					1		1	2.22	
1-2 month	1			1			2	4.45	6.67
2-month			2				2	4.45	11.12
3-month	3				1		5	11.11	22.23
3-6 month	5	1	2				8	17.77	40.00
6-9 month	2						2	4.45	44.45
12-month (1 year)	2	2				1	5	11.11	55.56
18-month	7	2	1				10	22.22	77.78
24-month	8	2					10	22.22	100.00
Total:	28	7	6	1	2	1	45		
% from Total	62.22	15.56	13.33	2.22	4.45	2.22			100.00

TABLE A 6.5

LONGITUDE OF TRAINING OBTAINED BY THE WORKERS BY DIFFERENT TRAINING CENTRES

Training Time	T.T.C. Mirpur	Bangla-desh German Tech. Centre Mirpur	BMTF (m/c Tools)	BITAC	BDP	TSS	Barisal Poly-techn.	Dhaka Poly-Tech.	Other Centres	Total No.	% from Total	Cumula-tive
2-3 week												
3-week 1-month			1							1	2.22	2.22
1-2 month		1	1							2	4.45	6.67
2-month		2								2	4.45	11.12
3-month				4		1				5	11.11	22.23
3-6 month		1	7							8	17.77	40.00
6-9 month			1						1	2	4.45	44.45
12-month			2			1		1	1	5	11.11	55.56
18-month	7				2				1	10	22.22	77.78
24-month	2	1					3	1	3	10	22.22	100.00
No.of Training	9	5	12	4	2	2	3	2	5	45		
% from Total	20.00	11.11	26.67	8.88	4.45	4.45	6.66	4.45	13.33	100.00		

APPENDIX - VII

THE CALCULATED VALUES OF THE Y(LABOUR PERFORMANCE INDEX) OF 35 CASES FROM THREE SEPARATE PLANTS

TABLE A 7.1

A TYPICAL EXAMPLE FOR CALCULATING THE VALUE OF LPI (Y-VALUE)

Name of Parts	Name of operation	M/c used	Total standard time(planned time in hours)	Total actual time of operation in hours
Cylinder Head	Milling	Milling	72.55	75.00
SilencerBox	Milling	Milling	7.05	7.50
Cam Shaft	Milling	Milling	72.68	97.50
			152.28	180.00

Hence ,

Labour performance index i.e. LPI = $\frac{\text{Standard time for work done(in hrs)}}{\text{Actual time taken to do the work (in hrs)}}$

i.e. $Y = \frac{152.28}{180.00} = 0.8460.$

TABLE A 7.2

CALCULATED VALUES OF DEPENDENT AND CORRESPONDING INDEPENDENT VARIABLES-AS USED IN MULTIPLE REGRESSION ANALYSIS

No. of case	Value of the Depent. variable Y	Values of the corresponding explanatory variables (Independent variables)					
		X_1	X_2	X_3	X_4	X_5	X_6
1	0.8460	25.50	27.00	12.75	10.20	9.65	1.70
2	0.8400	24.20	27.00	12.75	11.25	9.65	1.70
3	0.8450	20.90	27.00	12.70	10.20	9.65	1.70
4	0.8190	21.70	25.50	12.10	10.65	9.65	1.70
5	0.7400	18.40	22.50	10.50	11.25	9.15	1.70
6	0.7395	18.80	22.50	10.50	10.20	9.65	1.70
7	0.7145	22.40	19.50	10.80	8.55	9.15	1.20
8	0.7320	20.40	19.50	11.20	8.50	9.65	1.20
9	0.7138	18.40	19.50	10.30	8.50	9.65	1.20
10	0.6790	18.40	16.50	10.80	8.85	9.65	0.70
11	0.7020	14.40	19.50	11.20	9.55	9.65	1.20
12	0.8015	25.30	27.00	11.20	9.65	8.35	1.70
13	0.7900	25.70	27.00	11.55	9.55	7.55	1.70
14	0.8010	24.70	27.00	11.55	7.80	8.35	1.70
15	0.7960	25.70	27.00	11.55	8.30	7.85	1.70
16	0.7385	24.30	25.50	10.90	9.00	7.05	1.70
17	0.6916	21.40	22.50	9.00	8.50	8.35	1.20
18	0.5860	19.40	16.50	8.80	5.85	8.35	0.70
19	0.6750	22.40	22.50	9.70	7.85	7.05	1.20
20	0.6125	21.40	18.50	9.80	7.60	7.05	1.20
21	0.5485	17.50	19.50	8.50	7.05	6.55	0.70
22	0.5975	22.30	19.50	9.00	6.35	6.55	1.20
23	0.5060	14.90	16.00	8.30	6.85	7.05	0.70

TABLE A 7.2 (Continued)

	Y	X_1	X_2	X_3	X_4	X_5	X_6
24	1.152	20.50	27.00	16.12	10.70	13.00	2.00
25	1.144	23.40	27.00	16.32	9.50	12.50	2.00
26	1.120	18.50	27.00	15.32	9.50	13.00	2.00
27	1.110	19.00	27.00	15.02	10.00	13.00	2.00
28	1.122	22.30	27.00	15.32	9.65	13.00	2.00
29	1.090	19.50	25.50	16.12	10.70	12.50	2.00
30	1.060	19.50	24.00	15.32	10.20	12.50	2.00
31	1.105	23.30	22.50	16.32	10.70	13.00	1.50
32	1.065	19.00	25.50	15.52	9.50	13.00	1.50
33	1.070	17.50	21.00	16.32	8.55	13.00	1.50
34	1.050	19.90	19.50	16.02	8.00	13.00	1.50
35	0.990	18.50	19.50	14.42	8.40	13.00	1.50