CAPACITY UTILIZATION IN MULTIPRODUCT INDUSTRY –AN ANALYTICAL STUDY

Thesis

Submitted in partial fulfilment of the
requirements for the degree of
Doctor of Philosophy

By

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Dilani (Rajasthan)

1978

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CERTIFICATE

This is to certify that the thesis entitled Capacity Utilization in Multiproduct Industry - An analytical Study and submitted by YASHPAL KEDIA ID No. 75HB7501 for award of Ph.D. Degree of the Institute, embodies original work done by him under my supervision.

Signature in full of the supervisor: R Bandyopadhyay

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Dated: 16.10.78

PREFACE

1. In selecting, 'Capacity Utilization in Multiproduct Industry - An Analytical Study', as a research project for my Ph.D. work, I had a compelling reason. During my fourteen years of involvement with Industry, I had always felt the absence of proper methods of measuring performance of various manufacturing divisions and subsequent formulation of the plans for improvement. So, given the opportunity for Industrial Research, the choice of the above mentioned topic was almost natural. I, am quite happy at the choice. The confusion, in understanding the term 'capacity' as applied to Industry is really startling. Methods of estimating capacity utilization both at macro and micro levels are defective and it is no wonder that these methods hardly provide any guidance for improvement, and, improvement in the levels of capacity utilization seems to be a must to solve the problems of shortages and inflation and to reverse the trend of our shrinking percentage of world export and to ensure adequate rate of economic growth.

2. In estimating capacity, an effort has also been made to look beyond the present set of adverse circumstances and constraints within which the individual firm or the Industry as a whole may be operating. Taking a general and more comprehensive view of the circumstances affecting the operation of the industry, a six stage model has been developed which is expected to be more useful in improving the quality of decisions regarding capacity utilization in future. In suggesting this model and subsequent analysis of capacity

utilization at macro and micro level, I have drawn on all areas of knowledge; operations research, industrial engineering, economics, statistics, accounting and behavioural sciences. Suitable techniques like linear programming, multiple regression and correlation analysis, ratio analysis, group technology, work sampling and load centre costing etc. have been used or referred to as required at appropriate places. I strongly feel that an 'Integrated approach', as used in this analysis is very essential for understanding the problems of capacity underutilization.

3. The data used for analysis at Macro level has been taken from the 'Annual Survey of Industries' volumes from 1960 to 1969, 1969 being the year of the latest publications. Despite many shortcomings of the data, a number of important conclusions could be drawn. The data for micro analysis was collected through visits to many firms in private and public sector and through correspondance. Various difficulties had to be encountered in collecting this data. Many firms do not maintain complete data. Many times, the data is not reliable. Retrieval of past data was difficult in many cases due to improper storage. Lastly, there was a significant reluctance on the part of the firms to part with information. Still, through discussion with senior executives, enough data could be collected for a reasonable analysis. However, for more intensive research in this area, not only firms have to agree to give more information, they have also to be persuaded to maintain data in a more systematic manner.

I am also aware that the outcome of the present work is like the tip of an iceberg and much more work needs to be done. I have myself drawn attention to the many areas needing further attention. For Indian Industry to become healthy and competitive in international market, research on large scale and with active involvement of Industry will be very essential. Hopefully, this work will prove a catalyst in this direction.

Chapter scheme can be seen at a glance at figure 1.6 at the end of Chapter-1. A select Bibliography is attached at the end and for reference to the various books and, articles consulted, the number of the reference in the bibliography is mentioned within a brabket in continuation to the narrative. Author's name and pages of book or article, where relevant, have also been included.

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ACKNOWLEDGEMENTS

Dr.R.L. BANDYOPADHYAY, Adjunct Faculty, B.I.T.S. and Professor, National Institute of Bank Management.
for agreeing to be my supervisor despite his busy schedule and for inspiring me towards excellence.

Dr. C.R. MITRA, Director, B.I.T.S.
for initiating me into the exciting world of teaching and research, for his encouragement and for his keen interest in my work.

PROF. T.S.K.V. IYER, Dy. Director, BITS, PROF. V.KRISHNAMURTHY, Dy. Director, B.I.T.S., Dr. R.C.SHARMA, Dean, B.I.T.S., Dr. S. VENKATESWARAN, Dean, B.I.T.S., Dr. V.K. TEWARY, Dean, B.I.T.S., Dr. V.V. MANDKE, Dean, B.I.T.S., PROF. I.J.NAGRATH, Dean, B.I.T.S., PROF. K.V. RAMANAN, Dean, B.I.T.S., Sri A.N. BHARGAVA, Registrar, B.I.T.S., Sri H.C. MEHTA, Librarian, B.I.T.S.
for all possible help and encouragement during the progress of my work, both in their official and personal capacities.

Directorate General for Technical Development, New Delhi, Central Statistical Organization, New Delhi, Bureau of Public Enterprises, New Delhi, Federation of Indian Chamber of Commerce and Industry, New Delhi and the Managements of Kirloskar Pneumatic Ltd., Kirloskar Oil Engines Ltd., Bharat Forge Ltd., Richardson and Cruddas, Indian Telephone Industries, Triveni Structurals Ltd., Trivani Engineering Ltd., Bharat Steel Tubes Ltd., General Electric Co. Ltd., K.G. Khosla Compressors Ltd.
for permitting me to collect the necessary data.

Sri A.K. KHANNA, GM Prod., Triveni Structurals Ltd., Sri A.K. MUKHERJEE, Chief,Mechanical Engineer, CLW, Sri KASI IYER, Advisor, Bureau of Public Enterprises.

for their help in clarifying my ideas.

Dr. H.C. MISRA, B.I.T.S.

for helping me in the writing and running of computer programs and for offering very useful ideas on the subject.

Mr. V.G. PATWARDHAN, B.I.T.S.

for helping me in writing and running the computer programs.

Dr. BIRBAL SINGH, B.I.T.S.

for his help in designing the necessary stastical programs.

My colleagues at B.I.T.S.: Dr. G.P. AVASTHI, Dr. D.N. GURTOO, Dr. J.K. Mittel, Mr. C.A.S. NAIDU, Dr. S.N. PRASAD, Dr. S.K. PORWAL, Mr. C.K. RAGHUPATHY, and Dr. R.K. SINHA,

and my colleagues and friends in the Railways: Mr. RAJNISH, Mr. N.K. SRIVASTAVA, Mr. A.J. KUMAR, and Mr. L.K. SINHA

for their encouragement and for clarifying my ideas through discussions and through offering critical comments.

BANWARI LAL SAINI, B.I.T.S.

for his patience in going through my handwriting and still making a good job of typing this thesis.

My sister Mrs. SAJOJ GUPTA, Lecturer Lady Sri Ram College, New Delhi, my brother-in-law MAHESH GUPTA, Economist, American Embassy, New Delhi, my brother-in-law Wing Commander P.N. BAJAJ (IAF) and G.K. BAJAJ, Manager(design), Bharat Pumps and Compressors, Allahabad, Sri D.P. Gupta - economist in the Institute of Agricultural Economics, New Delhi.

not only for their considerable help as near relatives but also for offering useful suggestions throughout the preparation of this work.

Finally, my wife MEENA, and my daughter, SIMI and GUNJAN, for adjusting their schedules to my priorities and considering this a family project. Words can't express my true feelings in this regard.

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CHAPTER 1

CAPACITY UTILIZATION ANALYSIS - IMPORTANCE, NEED FOR STUDY AND OUTLINE

1.0 Better Capacity Utilization holds the key to faster economic growth and improved profitability of individual firms. Yet, only recently, have the planners, economists, administrators and industrialists started paying attention to this important subject. In this chapter, first, the effect of capacity utilization on economic growth of the nation and on the profitability of individual firms is considered. Reasons for indifference to underutilization are then discussed and finally need and scope of the present study are mentioned followed by a detailed scheme of analysis.

1.1 Capacity Utilization and Economic Growth:

Underutilization of capacity in Industry has been very high. (Refer Table 1.1, 1.2 and Appendix 1.1). There are reasons to believe that this is the position despite an unrealistic estimation of the capacity in the Industry (more discussion in Chapter-2).

Table 1.1 Percentage Capacity Utilization in Industry

Industry	Year	No. of Industries having percentage capacity utilization		
		Over 75	50 -75	Below 50
Engineering Industry	1975-76	7	15	8
	1976-77	11	11	8
	1975-76	34	36	14
Total Industry	1976-77	46	23	15

Table 1.2 Percentage Capacity Utilization in Public Sector

Year	No. of units having percentage capacity utilization		
	Over 75	Between 50 - 75	Less than 50
1973-74	45	23	16
1974-75	54	27	16
1975-76	69	28	15

Ref: (12- pp 120)

Classical economists had pointed out, and subsequent economic development models emphasized that Economic Development primarily depends upon additions to stock of capital. Savings could be harnessed for investment in more tools (capital) which could employ more people at greatly increased levels of productivity and thus create more savings, after meeting the present needs. In other words, it was pointed out that the underdevelopment of developing countries is due to the vicious circle of non-availability of capital resulting in less employment, less productivity and hence less savings and consequently less availability of capital. And, when, capital is available and is not fully utilized, and that too in the face of continuing unemployment, continuing unimpressive rate of economic growth, there is a general feeling of anxiety, and the paradox assumes greater significance. It was perhaps assumed by the economists that since scarcity of capital is at the root of poor economic growth, full utilization of the capital available will present no problem and hence, ignoring many other valid complications, one could say:

$g = k S$, where

g = rate of economic growth

k = marginal output to capital ratio (number of units of output produced by one unit of capital)

S = marginal propensity to save.

This of course, assumes that the rate of economic growth is the same as rate of growth of output. More relevant is the rate of growth of consumption. However, for sustained growth of consumption and for meeting the objective of providing employment, particularly in an overpopulated economy as ours, Growth of Capital Stock is a necessary condition (Chakravarty 13 - p 62). Most of the development planning models concern themselves with the determination of desirable and possible saving rates, with a view to obtain a rate of capital accumulation so as to maximise some social utility function. The fact that the existing stock of capital is not utilized fully, has not been given complete recognition.

Now, it appears quite certain that 100 percent or optimum utilization of accumulated capital is a myth. A number of important factors interject to convert the utilization rate to something lower than 100 percent and therefore the rate of economic growth stands modified as under:

$g = h k S$ (Marris - 62)

where additional h = rate of utilization of assets.

There are thus two basic ways of improving economic growth rate:-

(i) Through further expansion of capital base by means of more investment through the increased saving.
(ii) Through improved utilization of existing installed capacity.

A long term growth strategy must take recourse to both of these methods. While one can go into the question of growth, saving rate, increased capital formation in detail, and this itself is a very complex area of study, primary concern here is not with this aspect but with number (ii). To the extent, utilisation of existing capacity is dependent on further capital formation reference to the problem of type (i) above will be made from time to time.

1.2 Capacity Utilization and Profits of an Individual Firm

Profits depend on the rate of capacity utilization. The question can be discussed under two types of market conditions;
(i) Competitive
(ii) Monopolistic competition.

Under pure competition, situation is as shown in Fig. 1 (Cohen and Cyert 15 - pp 96). Average fixed cost per unit as well as total cost/unit goes down as total production goes up till a certain point. Most of the firms in India appear to be working in a region where there is a lot of scope of increasing capacity utilization and thus improve their profits. In Figure 1.2 (Cohen and Cyert 15 - pp 105) average variable

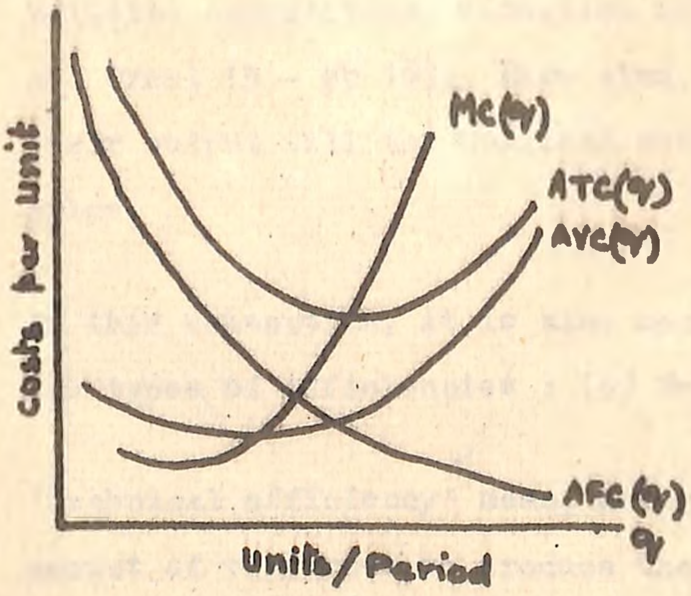


fig 1.1

ATC : Av. Total Cost
AVC : Av. Variable Cost
AFC : Av. Fixed Cost
MC : Marginal Cost

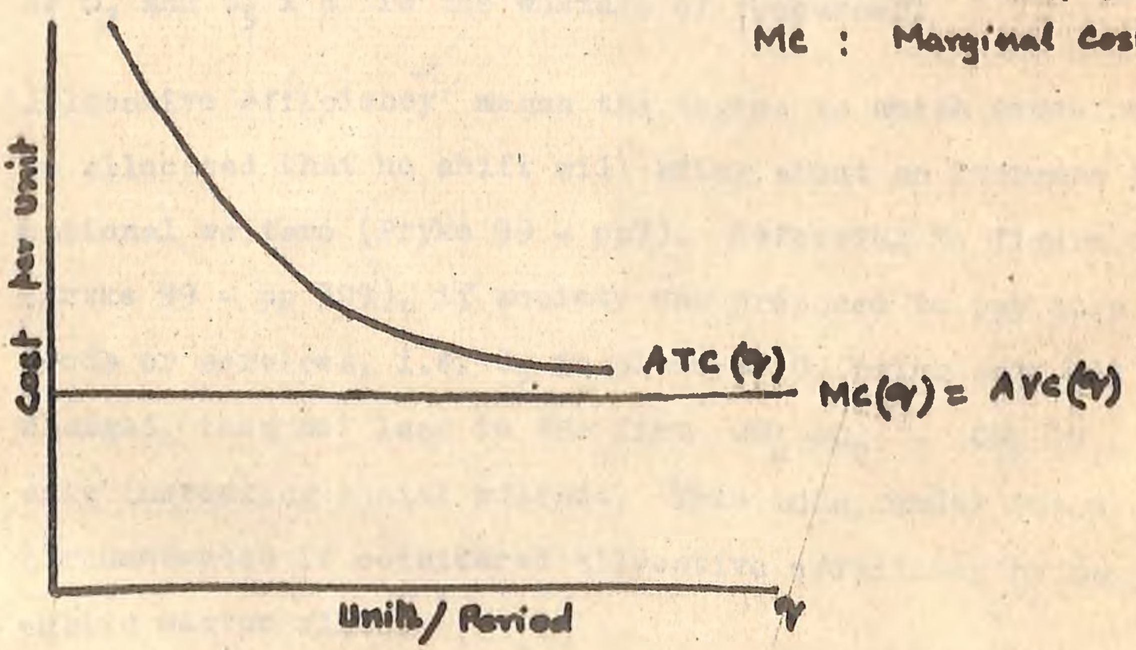


fig 1.2

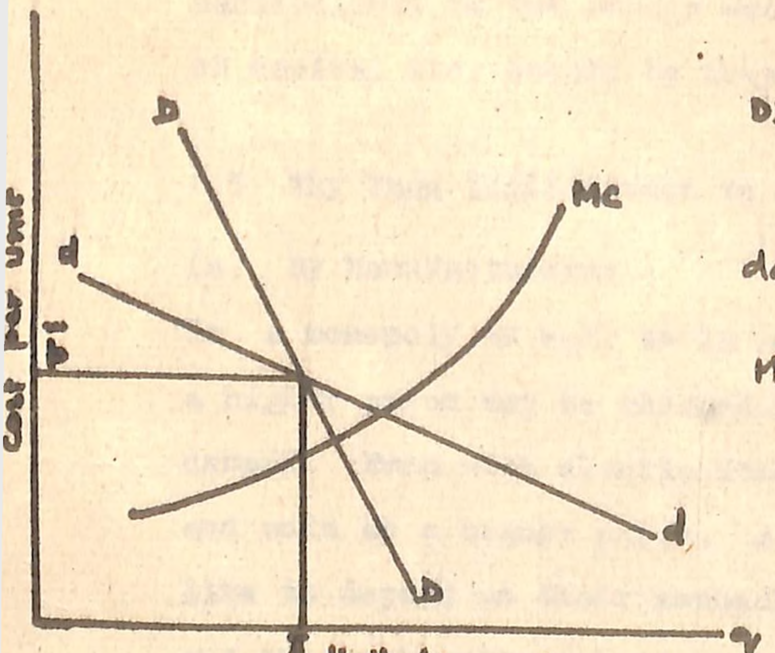
cost is considered constant and even in this case due to reduction of average total cost, the profits will tend to increase with increased capacity utilization. Under monopolistic competition, situation is shown in figure 1.3 (Cohen and Cyert 15 - pp 16). Here also, all firms could improve their output till the marginal cost is equal to the market price.

In this connection, it is also necessary to distinguish between two types of efficiencies : (a) Technical (b) Allocative.

'Technical efficiency' means using the smallest possible amount of resources to produce the goods and services which they have decided to provide (Pryke 99-pp5). Loss due to lower technical efficiency can be seen at figure 1.5 (Pryke 99 - pp 399). Here cost of production per unit is C_3 instead of C_2 and C_3 x R is the wastage of resources.

'Allocative efficiency' means the degree to which resources are so allocated that no shift will bring about an increase in the national welfare (Pryke 99 - pp7). Referring to figure 1.4 (Pryke 99 - pp 399), if society was prepared to pay more for goods or services, i.e. C_2 in place of C_1 being actually charged, then net loss to the firm $OM_2\,eC_2 - OM_2\,bC_1$, is only increasing social welfare. This loss, under these circumstances is considered 'allocative efficiency' by many public sector firms.

Thus, often, there is an attempt to cause confusion regarding the true significance of the term capacity utilization by



DD :- Demand curve assuming that Competitors prices are same as for firm under analysis

dd : Demand curve when Competitors prices are fixed

MC : Marginal cost.

fig 1.3

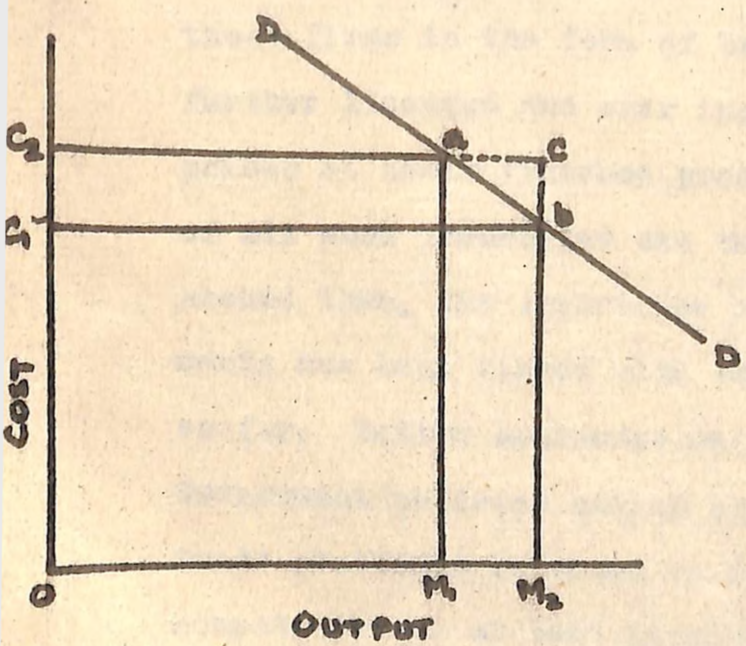


fig 1.4.

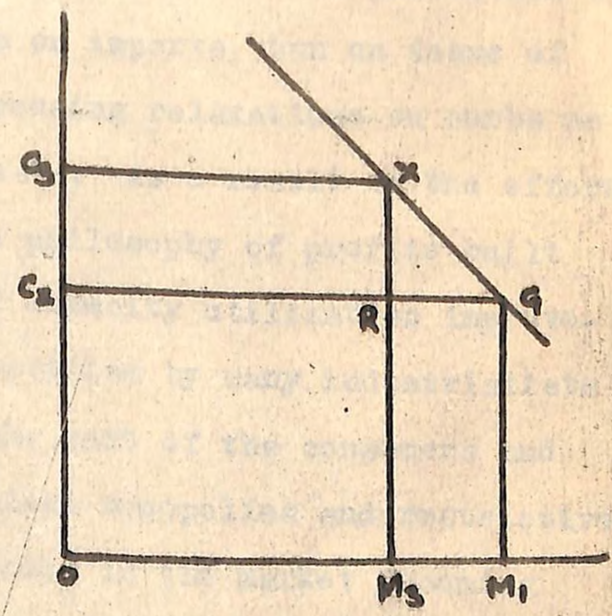


fig 1.5

mixing technical and allocative consideration together, particularly in the Public Sector. Questions of social value of capital etc. should be treated completely separately.

1.3 Why Then Indifference to Underutilization of Capacity ?

(a) By Manufacturers:

In a monopoly as well as in a Duopoly and Oligopoly situation, a higher price may be charged in the market having more inelastic demand. Even with elastic demand, the output may be curtailed and sold at a higher price. A number of manufacturers still like to depend on their monopolistic position to earn profits and this naturally retards any efforts to improve capacity utilization and reduce costs of production. Prominent amongst these are not only firms in Private Sector but also in the Public Sector. There is a constant clamour for protection by these firms in the form of ban on imports, ban on issue of further licenses and ever increasing relaxations on curbs on prices of their finished products. As a result of the effort of all such industries and the philosophy of profits built around them, the importance of capacity utilization improvements has been viewed with skepticism by many industrialists so far. Better awareness on the part of the consumers and Government policies acting against monopolies and restrictive trade practices is bound to result in the market becoming competitive or at best involving product differentiation.

Refering to workshop on 'Capacity Utilization and Growth Prospects' arranged by FICCI on 12.7.75 (Appendix 1.2) the following points mentioned in the list released by FICCI, are of relevant interest in this context.

1. Capacity utilization in the large scale sector has also been affected because certain items had been reserved for manufacture in the small scale sector such as Diesel Engine, Matches etc. policy

2. In some cases, a cause for under utilization of capacity is due to consumer perference for quality and resistance to higher prices. In order to step up demand it would be advisable for industry to have proper quality control and market studies. Internal

3. It would be advisable to rationalise the excise duty and other levies as the incidence of indirect taxation forms a sizeable proportion in the cost of production.

4. It is desirable not to attenuate export incentive schemes at this particular stage.

5. Government purchases had gone downsteeply and this has affected demand of certain items.

Majority of these recommendations are in the way of improving capacity utilization by means other than improvement in internal working of the enterprises.

However, the 'workshop' gave due importance to the subject of under utilization and mentioned the causes for the same. From the firm's point of view there can be 'external' and 'internal' causes leading to underutilization of capacity. FICCI workshop concentrates on external causes and leaves the internal factors of management untouched. It can however be proved (Chapter-4) that Management shortcomings are most of the times responsible for capacity under-utilization. Even in the annual convention of FICCI 1978, two main factors leading to capacity underutilisation were identified as power shortage and labour inefficiency. However, this was not accepted as the complete explanation by the Government as well as many others (39).

(b) By Government

The Government indifference is attributed to the philosophy of economic development that has pervaded the thinking of planners largely due to the economists having missed the importance of utilization of capacity in the development models. Many other loosely held notions like social justice, prevention of economic power accumulation, have also contributed to this. However, the recent changes in licensing policy underscore the importance that is now being given to the subject of capacity utilization.

Problems of Analysis:

Capacity defies a clear definition. While the number of studies on the subject is not large, the difference of approach in the studies undertaken is startling. The point has been discussed in detail later (Chapter 2). The problems are such that the estimation of capacity utilization not only becomes difficult but in the absence of a clear methodology and a clear definition of parameters on which the estimation is based, the exercise becomes futile. This has also been a reason for the indifference.

1.4 Need and Scope for Study

Study of capacity utilization in its entirety is therefore very much important. Economic growth and profitability depend on capacity utilization as seen before. Moreover, despite some attention in the recent past, the conceptual base of under-standing remains weak, and in the absence of empirical evidence, every concerned party is blaming the others for the continuing under-utilization of capacity.

A proper study of capacity utilization therefore must pay attention to the following:

1. Estimation of actual output, capacity and capacity utilization. Actual estimation has to make do with the existing data only, however inadequate, inaccurate, and unreliable it may be till such time a better data base is available. A conceptual base must however be built, which should hopefully be standardized in course of time and an effort should be made to recommend the ideal data base required to enable proper accurate and timely analysis.

2. Analysis of factors causing underutilization has to emerge out of better analysis of the data available and ad hoc pronouncements must be discounted. Analysis needs to be

made of those factors also which cannot be easily quantified and whose analysis borders on sensitive area i.e. an area which can cause misunderstanding or confrontation between management and labour, Government and Industry or Industry and consumer.

3. Recommendations for improvement should emerge out of the analysis.

1.4.1 Hence the major objectives of the study are as follows:

1. To critically study the methods used in the past for the estimation of output, capacity and capacity utilization and to pinpoint the advantages and shortcomings of the same.

2. To evolve a suitable model to understand and estimate capacity and its utilization.

3. To evolve a systematic way of estimating capacity utilization and identifying variables causing underutilization of capacity at the Macro level.

4. To evolve a systematic way of estimating capacity utilization and identifying variables causing underutilization of capacity at the Micro level.

5. To recommend ways and means to effect improvement in the level of capacity utilization both at the macro and the micro levels.

1.4.2 This study has largely concentrated upon internal factors i.e. those factors which are largely within the control of the managements of the individual firms. Even for aggregate analysis, the importance of these factors has been underscored. Market conditions and external factors outside the control of managements have however been included at some places, where considered necessary. The study concentrates more upon the systematic estimation of the capacity underutilization and the underlying causes rather than turn out hasty recommendations for improvement. It is the contention of the study that a well drawn out structure of analysis automatically leads to the desired course of action for improving capacity utilization.

In this study, only multiproduct Industry has been considered. Unlike process industries Multiproduct Industries manufacture a variety of products and have the following characteristics:

1. Quantity of products produced are not entirely 'technology' determined. Alternative processes of manufacture are available and the time required for and cost of manufacture vary with type, vintage and condition of machinery and plant and with that of the skill of labour and quality of management.

2. Facilities are common to many products and at any point of time, facilities can compete for products to avoid idleness and products can compete for facilities to avoid failure of delivery dates.

3. Range and sizes of products prevent any simplistic aggregation in physical quantities.

4. Product Mix changes are very fast. Any description of

capacity in terms of a particular product mix get outdated fairly fast.

5. Process of manufacture of a single product can be reduced or increased by sub contracting parts of the assembly or by reloading the parts for manufacture in the shops respectively. Most of the industries manufacturing metal products, machinery electrical and other than electrical and transport equipment are covered by the broad category of 'Multi Product Industries'.

The complexity of accountal of products, and facilities and ever changing product mix are challenging problems that need to be solved to assess the performance of firms engaged in such manufacture. Importance of the study of capacity utilization for such an industry is all the more in view of the lack of such studies undertaken in the past for such industries.

1.5 Scheme of Analysis

Based on the above the following scheme of analysis and presentation will be followed:

1. Methods used in the past for estimation of capacity and analysis of underutilization as well as the past studies relating to these will be reviewed. Strong and weak points of the methods and studies will be brought out. This will be done in Chapter-2.

2. In Chapter-3, a six stage conceptual model of capacity is presented. Capacity at each stage roughly corresponds to the level of decision making authority affecting this. Capacity losses at every stage have been analysed in detail,

under the following heads:

1. Capacity loss due to suboptimum purchase of fixed assets.

2. Capacity loss due to downrating of equipment firstly due to defects and wear and tear of equipment and secondly due to errors while fixing time standards.

3. Capacity loss due to working lesser number of shifts than desirable.

4. Capacity loss due to constraints on sale of products and due to constraint of inputs like power and raw materials.

5. Capacity loss due to interruptions in input like unscheduled stoppage of machinery due to absenteesm, power failures, break down etc.

3. Capacity estimation has been done using output-capital ratio method and variations in capacity utilization have been analysed using multi-regression and correlation analysis for the following in Chapter-4.

1. For industry manufacturing 'Equipment for generation, transmission and distribution of power including transformers'.

2. For industry group manufacturing 'Machinery other than Electrical machinery'. Emphasis is on methodology. Results obtained have been compared to these expected as a result of the application of logic and macro-economic theories.

4. Firm level data has been used to estimate Theoretical Maximum, planned and budgetted capacities and actual production has been compared to these. Constraints and

factors leading to underutilization have been identified as a result of this analysis. For the application of the above, some engineering firms, producing variety of products have been selected. This analysis forms part of Chapter-5.

Results of a questionnaire survey on the attitude of top business executives over capacity utilization and allied matters also forms part of Chapter-5.

On the basis of available information, a justification for introducing 'Capacity Audit' has been made out as a part of Chapter-5.

5. Conclusions of the study and recommendations for improvement are included in Chapter-6. This chapter also includes recommendations for studies that may be undertaken in future.

Contents of various chapters and their interlinkages are indicated in a summarised form in Figure 1.6.

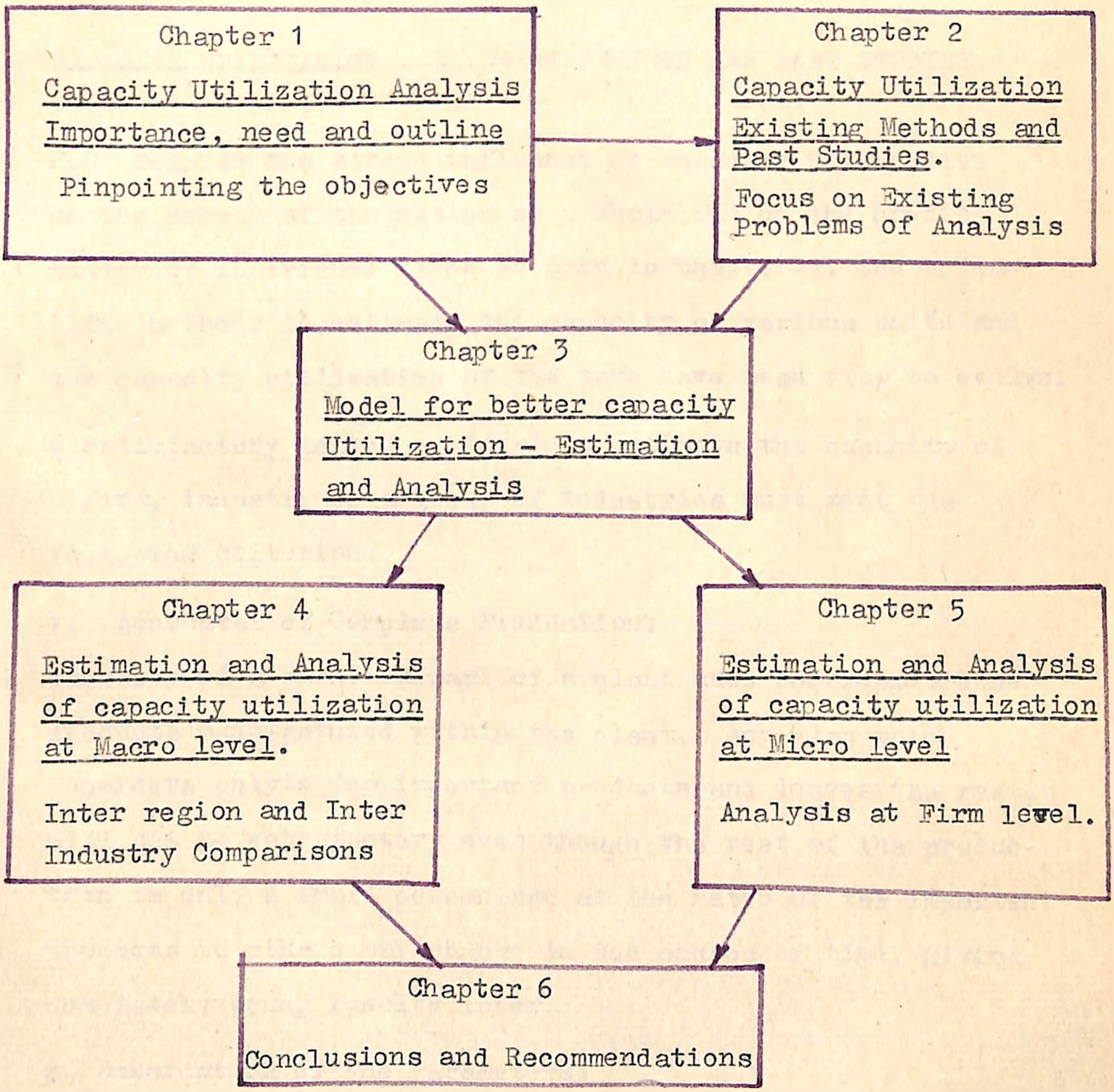


Fig. 1.6

Outline of the thesis: Capacity Utilization in Multiproduct Industry - An Analytical Study.

CHAPTER 2

CAPACITY UTILIZATION - EXISTING METHODS AND PAST STUDIES

2.0 Despite the strong influence of capacity utilization on the growth of the nation as a whole and on the profitability of individual firms as seen in Chapter-1, the scientific methods to estimate the capacity of various units and the capacity utilization of the same have been slow to evolve.

A satisfactory method or model to estimate the capacity of a firm, industry or a group of industries must meet the following criterion:

1. Accountal of Complete Production:

Capacity of a plant or part of a plant must consider all the products manufactured within the plant. Any plan which considers only a few important products and leaves the rest, will not be satisfactory even though the rest of the production is only a small percentage as the ratio of the important products to others may change in the course of time, giving completely wrong results later.

2. Description of the Parameters:

The parameters on the basis of which capacity is estimated must be described fully. The details of, shifts worked for various components of the plant, of inclusion or exclusion of certain obsolete equipment, the rate fixing methods, and of other policy decisions impinging on the estimation of capacity must be laid down clearly. Temporal and inter unit comparisons can only be facilitated if the basis of capacity determination is known.

3. Adequacy of Basis

Not only should the basis be known, the same should be found adequate. The basis should not be arbitrarily selected and should consider all aspects responsible for the determination of capacity.

4. Scientific and Justifiable 'Aggregation'

Adding the output of different components of the plant should preferably be done on the basis of effort spent on these as reflected in the costs (assuming the existence of a fairly accurate system of costing). Other basis of adding through physical attributes like weights, numbers etc. may prove to be highly unsatisfactory.

5. Dynamic in nature

Overall capacity of a plant is not like the capacity of a tank. Management policy, Changes in Product Mix, Changes in input, Make-buy decisions and addition of equipment tend to alter the capacity rating of a plant itself. Hence the model for determination of capacity should be capable of considering these and many such allied factors.

6. Simplicity

The method should not be very cumbersome in computation. However, having simplicity only is no great virtue.

7. Facilitating Analysis

Capacity utilization should be determined in such a manner that the factors affecting capacity utilization can be easily identified during the process of determination of capacity utilization.

Satisfactory or otherwise, many methods have been tried in the past to estimate capacity and its utilization, in India and elsewhere and in this chapter, the different methods so tried, have been described bringing out the admantages, disadvantages and scope of application of each method. The summary of the salient features along with the advantages and disadvantages of each is given at Table 2.0. A review of ~~the~~ some specific studies undertaken in the past has also been made along with a critical evaluation of the results obtained.

2.1 Estimation of Capacity and Capacity Utilization

Most of the studies undertaken in the past have dealt with the problem of estimation of capacity utilization at the Macro level. Many methods have been developed and a small description of each is given below. Summary of the method is given at Table 2.0.

2.1.1 'MSP' method (29)

This method is adopted in the 'Monthly Statistics of Production' of selected industries in India.

Steps for estimating capacity

1. Capacity for production of an item is measured in simple

Table 2.0 Summary of methods - estimation of capacity

Sr. No.	Method	Accountal of complete product	Description of Parameters	Adequacy of basis	Scientific aggregation	Dynamic in nature	Simplicity	Facilities analysis
1	2	3	4	5	6	7	8	9
1.	MSP:Monthly Statistics of Production (i) Desirable shift working level for each product fixed. (ii) All firms requested to advise production capacity for each item separately based on number of shifts decided for this product at step1. (iii) All capacities to be shown in specified physical units like numbers, kilograms etc.	×	✓	×	×	×	✓	×
2.	Multishift Method: As method number one. Desirable shifts for each product fixed at a higher level.	×	✓	×	×	×	✓	×
3.	Potential output method: (i) Potential production is defined as equivalent to the highest production index in the past month with 1960 index equal to 100. (ii) Potential utilization is defined as a percentage of actual production to potential production.	×	✓	×	×	✓	✓	×
4.	Wharton School Method: Same as 3 above except that quarterly peaks							

1	2	3
	in place of monthly peaks are considered to estimate potential production.	
5.	Minimum capital/output ratio method:	
	(i) All addition to capital are corrected for price rise as compared to a base year.	
	(ii) Deflated total capital (fixed employed in any year is found.	
	(iii) Output and material consumed are similarly corrected for price rise.	
	(iv) Ratio of capital (2) to output (3) is found out for each year. Minimum ratio is indicated.	
	(v) Capacity for the present capital is determined using the min. output to capital ratio.	
	(vi) Capacity utilization is thus the	

4	5	6	7	8	9
✓	×	×	✓	✓	×
×	×	✓	✓	×	×
✓	×	×	×	✓	×

1	2	3
7.	Planned Optimum Utilization. (i) The number of shifts to be worked is selected on the basis of least cost/piece or for the point when marginal cost/piece is equal to sales price/piece. (ii) Capacity for this level of shift working is then calculated.	
8.	USAID Method: (i) Wherever possible, MSP method is revised to the extent that the actual number of shifts is considered while estimating capacity. (ii) More detailed cause wise analysis is done by extracting data through personal interviews.	x
9.	McGraw Hill Method: (i) Continuous surveys of selected	x

4	5	6	7	8	9
✓	✓				

Other facts will depend on the method chosen to work out capacity.

4	5	6	7	8	9
✓	×	×	×	✓	✓
×	×	×	✓	×	✓
×	×	×	×	✓	×

physical units like number, weight, meters etc. No weightage is given to the size, quality, or complexity of different models of the same item.

2. All the items whose production capacities are required, are divided into three categories:

1. Products whose production capacities are estimated on the basis of 'one shift' working.
2. Products whose production capacities are estimated on the basis of 'two shift' working.
3. Products whose production capacities are estimated on thebasis of 'three shift' working.

For each category, number of working days per year is also decided in advance and ranges from 115 to 330. Sugar Mills and other industries having seasonal character work only for 115 days in a year.

3. (i) All firms are required to estimate their capacities based on the number of shifts for their products as decided above, even though their actual working shifts may be different

(ii) Estimates of capacities are provided only by the firms themselves on the basis of the decided number of shifts for that product. No further effective audit or check is made.

(iii) These capacities are expressed in physical units of product e.g. 1000 pumps, 5000 bicycles and 50000 tonnes of alloy steel etc. etc.

Comments on the MSP Method

(i) The criterion on which the decision of different shift working for industries is based is not clear. A survey in 1968 (Kotti - 48,49; Krishna - 51) revealed that only 36 percent of the firms in the list of firms reported in MSP and having calculated their installed capacity on the basis of one shift, were actually working in one shift. Others were all working in shifts more than one. Since actual production was reported as based on actual number of shifts worked, sometimes the capacity utilization was found to be more than 100 percent. Such data thus fails to indicate the true picture as obtaining in Industry.

(ii) The basis of estimating capacity by individual units is not standardised. There is no audit to control over/under reporting of the capacity. This has also been confirmed through a study by the United States Agency for International Development (USAID). According to this study official MSP figures of capacity in Vanaspati and Domestic Refrigeration Industries were underestimated.(Nancy Slochum - 89).

(iii) Installed capacity figures are available only for a few products and constructing composite indices of capacity becomes difficult. The fact that a firms' considerable capacity may be used for items other than main products, is ignored.

(iv) Simplistic measures of production adopted, have no relation with the effort required to produce different models of the same product.

(v) Since the firms generally never produce only one product, the resulting method does not reflect the true utilization or otherwise of resources as the same may be shifted from one product to another (see also the example of Section 2.2.1).

2.1.2 Multishift Basis of Estimating Capacity

This method is adopted by the National Council of Applied Economic Research (NCAER).

(i) NCAER (71) calculated capacity utilization based on the MSP data and the same number of shifts. They however reworked capacity on the assumption that working more number of shifts is possible and desirable as given below:

Total number of industries covered by NCAER was equal to 140. NCAER recommended 102 industries out of 140 to be worked on the basis of 2 shifts and 38 industries out of 140 on the basis of 3 shifts. Capacity was not determined on the basis of the actual number of shifts being worked by different units. They also considered that for firms working in two shifts, efficiency in 2nd shift = 80 percent of the first shift and for firms working in three shifts efficiency in 2nd shift = 90 percent of first shift and efficiency in 3rd shift = 80 percent of first shift.

Comments on the NCAER modifications

(i) This estimation of capacity is perhaps better than that worked out by MSP but the method still displays a lot of adhocism. Under or over utilization thus shown, consists of two components.

(i) Rated capacity (based on desirable number of shifts)	Vis-a-vis	Planned capacity (based on actual number of shifts worked)

(ii) Planned capacity vis-a-vis actual production.

Understanding both the components calls for different type of analysis and combining the two does not serve any useful purpose.

(ii) Working efficiency as decided for various shifts is also arbitrary.

(iii) Most of the other shortcomings of MSP method still remain.

2.1.3 Potential output Method (Reserve Bank of India Method)(22)
The method may be described in terms of the following steps:

Steps:

1. For 1960, maximum monthly production for an industry is considered = 100 (another base year may be selected).

2. Indices for other months are worked out in relation to this reference only.

3. Potential capacity utilization or Potential utilization $= \dfrac{\text{Average production during the month}}{\text{Potential production}}$

where potential production is equivalent to the highest monthly production index attained in any month prior to the month under consideration.

4. Production units are the same as in the previous two cases, i.e. 2.1.1 and 2.1.2.

Comments on Potential output Method

1. Adhocism is absent. Potential production is the best that the Industry could do under the prevailing circumstances and if the shortfall from this achieved value could be analysed, a lot of improvement is possible.

2. Potential production can be very much lower than the capacity (planned utilization rate) and even further lower than the theoretically rated capacity (Both described in Chapter-3). The element under analysis for poor utilization may not be of very serious significance when the chunk between potential production and rated or planned capacity is being ignored. There may be no serious interest in analysing this figure.

3. Individual peaks of production units may not be coincident with the industry peak and hence aggregation taking unit peaks of the past will be a better description of capacity. Suppose n firms comprise an industry. At any particular time under consideration,

Total potential production $= \text{Max}_t$ of $\sum_{i=1}^{n} x_{it}$ where x_{it} = amount of production of production unit 1 at time t.

If unitwise maximum is considered then potential production

$$= \sum_{i=1}^{n} \text{Max}_t \text{ of } x_{it}.$$

However, firmwise data is not published and hence this method can make use of only the Industrywise maximum.

2.1.4 Wharton School Method

Steps: 1. This is similar to RBI method but differs from it as follows:

(a) Quarterly peaks are considered in place of monthly peaks.

(b) Peaks are joined together and capacity in any month between the two peak points is represented by the point on the line and calculated through linear extrapolation.

(c) Once a peak has been obtained, other peaks lower than this one are ignored.

(d) Same data as monthly index of production is used and seasonal adjustments are also made.

(e) Weighting method for the calculation of the index is the same as used by MSP.

Comments on Wharton School Method

The shortcomings of RBI method are hardly removed. Perhaps a gradual increase in potential production is more valid and represents the position better than that obtaining through RBI method. However, a very significant chunk of capacity loss is not being analysed. (This is the difference between potential production and the rated capacity - described in more detail in Chapter 3). Capacity underutilization generally calculated is not very significantly related to our anxiety of retarded economic growth at Macro level and profit maximization at the unit level. Peak production determined for the Industry as a whole is not a true representation of potential production.

2.1.5 Minimum Capital/Output Ratio Method(Almariam-76, Hickman-36)

Steps: 1 (a) From the latest year work backwards and find the investment in a year and convert it to fixed prices of a base year say 1950-51.

(b) Add the deflated investment of year 51-52 to the total fixed assets at the end of year 1950-51 to get capital stock for 51-52 and so on for years 52-53 and later. The adjustment due to prices is made using combined machinery and plant and construction index.

2. Gross value added is found by subtracting deflated value of material consumed from the deflated value of the Gross Production. For Gross Production, output price index and for material consumed, Industrial Raw Material index is used.

3. (1) divided by (2) gives capital/output ratio for each year.

4. In whatever year prior to the calculating year, this ratio is minimum, the same ratio is selected for calculating capacity.

5. For a particular year if fixed capital = K (as calculated at (1))

$$\text{Then capacity} = \frac{K}{\text{Min. capital/output ratio}}$$

6. Capacity utilization $= \dfrac{\text{Actual output}}{\text{capacity as calculated at (5).}}$

Advantages: (i) Balance sheet data can be used.

(ii) Directly measures the utilization of resources deployed.

Disadvantages: (i) Many inconsistencies as under remain:

(a) Block capital or depreciated capital to be considered remains a matter of controversy.

(b) M/c and plant and construction, individual as well as composite, indices, are insensitive to the m/c and plant and buildings mix in a particular plant.

(c) Depreciation policy of individual units varies considerably.

(d) Improvements, changes and modifications in technology vitiate, to some extent, the comparisons.

2.1.6 Estimate Through Machine Hours

This method is followed by the National Productivity Council.

Steps: 1. Total number of m/c hours available are worked out by giving due allowance for

(a) breakdown

(b) absenteeism

(c) other miscellaneous reasons.

This is considered as the capacity.

2. Capacity utilization $= \dfrac{\text{Hours actually worked}}{\text{Capacity as determined at step 1.}}$

Advantages

If machines are of the same type the difference in the types of products manufactured do not affect the definition of capacity and this gives a very simple measure of capacity utilization.

Disadvantages

1. Machines are never of the same type and machine differences are not considered. Apart from the fact that all m/c hours don't have the same value, no differentiation has been made in machines of different vintage/condition and usefulness.

2. Machine hours may be utilized but this does not mean that the production is proportional to hours worked. Inefficiency of workers, who may take more time to complete a given job is not taken into consideration at all.

3. At best, availability of machines for working is considered and this may be one of the least problems of management.

2.1.7 Planned Optimum Utilization (Leuw - 55)

All the previous methods of estimating capacity are either based on ad hoc determination of the number of shifts desirable to be worked or are just based on past short-term peak production and precisely for this reason are unsatisfactory for complete analysis.

The ideal number of shifts to be worked is one when the cost/piece should be the least or the marginal cost is equal to the average cost/piece. Capacity of the plant, based on such a level of shift working is called the 'planned optimum capacity'.

Whenever working of a fixed plant is extended into the second or third shift, some costs/piece of production will come down and amongst these will be included the following:

1. Interest on capital
2. Depreciation on capital
3. Supervisory and managerial costs particularly belonging to staff functions.

Against this, the following costs tend to increase

1. Higher wage rate during 2nd and 3rd shifts due to inducing staff to work in hours of the day not preferred by members of the society.
2. Reduced output and efficiency during 2nd or 3rd shifts. This may be due to reduced supervision, workers' unwillingness, and not as good a 'work environment' as in day shift. Workers may not be psychologically oriented for maximum efficiency as achieved during the day.
3. Special allowances payable for nonavailability of public transport.
4. Increased costs of coordination as the utilization rate approaches 100 percent.

Further factors inhibiting entrepreneurs in utilizing capacity can be identified as follows:

1. Increased possibility of idleness if demands fall in subsequent years.
2. Increased possibility of labour trouble (on the mistaken belief that labour trouble is directly proportional to number involved.)

These factors cannot be ignored and in an uncertain situation, optimality consideration can only be fulfilled by assigning costs to the entrepreneur fears and by the consideration of probability for the demands sustaining or otherwise.

The fact that these calculations are difficult to make in the absence of precise data should not stand in the way of a sincere effort to understanding and analysis. Progress in Quantitative analysis has also made the computation within reach, Conceptually however, the model, if any available, is not clear particularly in the Indian conditions beyond very broad and general terms.

The selection of the number of shifts less than the optimum (on whatever consideration) unfortunately puts an upper limit to the output expected or capacity and any analysis which considers the reasons for reduced output vis-a-vis this upper limit, while not completely valueless, is definitely of limited use as the greatest chunk of capacity available may have just been lost due to the wrong fixation of the number of shifts worked, resulting in reduced profits while the fact does not forcefully emerge in the ratios of capacity utilization determined.

The method thus emerges as a conceptually correct method of estimating capacity though it can create computational difficulties.

2.1.8 Usaid Method

This method was followed by a study conducted by the United

States Agency for International Development. Nancy Slochum (89) in an effort to estimate capacity in a more realistic manner, added information obtained through personal interviews to the information available through Monthly Statistics of Production. However, hardly any change was made to the estimation of capacity and capacity utilization. If number of actual shifts were different from the ones considered in official estimates, the actuals were considered. As a result of personal interviews, the causes of underutilization could be brought out in more detail but this also suffers from the fact that many individuals even in higher positions in Government and Industry have preformed notions of the causes of poor capacity utilization and thus the picture that emerged could not be considered as unbiased.

2.1.9 McGraw Hill Method (76)

McGraw Hill department of economics compiles the figures of capacity through their Annual Surveys of business plans for new plants and equipment. Information about addition to capacity compared to last year, rate at which companies are operating and the rate at which they were likely to operate is compiled.

The main advantage is the year by year record of additions/deletions from capacity and removal of bias which is likely to creep in if recording is done infrequently.

Disadvantages:

There is no effort to define capacity and bias exists towards defining capacity in terms of final products i.e. leaving spares etc. Moreover measurement of output is not based on effort involved in producing each item of output.

2.1.10 Method Followed by Directorate of Technical Development

1. Targets of production are laid down for each year for each industry in terms of physical units. These are based on past production, economic conditions, demand forecasts etc. (This confirms to the budgeted capacity described in Chapter-3).

2. Actual production is then compared to this target.

Comments

While this indicates variances with budget, no idea can be had of the actual capacity utilization (See Appendix 2.1).

General Comments

1. All these methods try to find the aggregate capacity for the entire Industry/Economy. In view of difficulties of data collection, poor reliability of data and of aggregation difficulties, efforts have been made to be as near the truth as possible. All these methods, except for RBI and Wharton School method, tend to accept the unit's version of capacity and actual production. While unit working is complex because of manufacture of many products in different designs, models and capacities as well as of spare parts etc., the data

collected from these firms is in simplified form and in most cases loses its value and is not of any practical significance. A lot more needs to be done.

2. Many methods other than those given above with small variations have been tried by many other authors and since the basic structure falls within one of them, these have not been described here.

2.2 Measurement of Output

Mention has been made in the preceeding paragraph to the difficulties of measurement of output. In this section, some measures of output have been described along with their advantages and defects.

Five series (methods) of computing production have been mentioned by G.C. Beri (7). A brief discussion of this is first taken up.

2.2.1 Physical Output (Volume, Number, Weight, Length)

No correction of changes in price are required and these relate directly to what is required to be measured. These are simple and hence one likes to use these. The extent of their popularity can be seen from the number of industries for which production is measured in physical units as mentioned in Table 2.1

Table 2.1

List of Industries whose capacity is indicated in physical units

Items of production	Units of measurement
Machines, drills, pumps, diesel engines, storage batteries, locomotives, cars, jeeps, wagons, bicycles, footwear, tractors, lamps tyres and tubes.	Numbers
Chemicals, cement, coffee, tea, castings, metals, refractories.	Weight tonnes/kg.
Arc welding electrodes, conduit pipes, sheet glass, cloth etc.	Metres
Electric motors	Horse Power
Transformers	KVA

Defects of the Method

Defects are obvious and are as follows:

1. Problems of Additivity:

(i) Within the same firm two pumps of different capacities produced in quantities x and y cannot be considered as equal to x + y as work done for each is not the same.

(ii) Even for the same type, the effort spent can be different depending on percentage of purchased components for each type.

2. Incomplete Accountal

(i) Work in progress is neglected and this can be considerable in some industries.

(ii) Spare parts manufactured and general work done are also neglected. These can also form substantial percentage of work done. Taking an example of Air and Gas Compressors, whose output is considered in numbers, it is seen that most of the sophisticated air compressors requiring machining operations on expensive machines are equated with small air compressors whose capacity and efficiency may not be high. Such type of output can be quite misleading as the value of a product can be quite different depending on its quality, design and presence of controls of various types.

2.2.2 Deflated Value Series

Next method to consider is the value of the products as adjusted by price indices. This gets over some of the objections of measuring the output in physical terms but introduces many more serious errors. Intermediate product values are not available and inventories or work in progress may not be taken into account. Value still does not take into account the incidence of purchased components. Price indices may not truly deflate the value increases due to price rise and lastly in a situation when full capacity is utilized, what value should be given to the output can only be derived as extrapolation of the prevalent prices which may be incorrect as the sales price on enhanced supply

(as a result of better utilization) may change.
Gross value added (sales price - cost of purchased raw material and semi-finished components) takes care of the incidence of purchased components.

2.2.3. Material Input

In some industries when the industries' output to raw material consumption is fixed, the method of computing output can be based on the measurement of raw material consumed. However, in case of multiproduct industry, where a number of important raw materials are used for the manufacture of various diverse items, the method has its obvious limitations.

2.2.4 Energy Consumption Series

If the relation between the consumption of energy and output is the same in an industry, the method of computing output can be based on the measurement of energy consumed. However, the pattern of energy consumption for the same product may be different for different industrial units thus making it unreliable to aggregate. Pattern of energy loses of energy consumed per unit of ourput may also change in course of time.

In a multiproduct industry, the energy consumption cannot give an idea of the product mix of the output and the total output will not be proportional to energy consumed.

2.2.5 Employment Series

Manpower spent on a job is indicative of the amount of work done. So output can be measured in terms of manpower consumed.

While this distinguishes between various models of the same item in terms of work done, it fails to consider other costs which are relevant like equipment (where manpowers are spent) depreciation, interest, maintenance and energy consumption costs.

Man hour costs also vary for various load centres depending on the degree of skill required.

General Comments:

Inaccurate measurement of actual production and capacity in simplified but unrepresentative units can substantially dull the eagerness to analyse or improve capacity utilization.

On the other hand, the unclear units represent a serious behavioural problem and the production shops may be eager to enhance production of only those products which will show the performance of the unit in better light (as represented through the production methods selected). Accumulation of balance orders and imbalances thus created may be the cause of future poor utilization (measured in the same terms) even though the effort spent is progressively much more. The following example illustrates this.

Example

A shop repairing wagons is probably judged by the number of wagons repaired/month. If light repair wagons are allowed to wait, firstly the facilities created to tackle heavy wagons will remain idle and a day will come when only heavy repair wagons will be left and for the same or even enhanced efforts, the actual production will be much less. Not only that, in an effort to turn out more of light repair wagons, some sections are bound to be working at low efficiency and their idleness may not come to light.

It is clear that a 'simple' measure of production will never do justice to the production being measured. In any case, the greatest justification of simple measures is in terms of ease of aggregation only. But more often than not, such aggregations are not valid scientifically. As a measure of efficiency and control or an instrument of policy decision at the industry or unit level, the measure can mislead more than guide.

2.2.6 What Should be the Measure of Actual Production:

Gross valued added = sales value - (cost of raw material + services obtained from outside)

= Gross + fixed expenses + labour cost.

Since it will be better to measure production and keep prices out of it, the following adjustment in the definition of 'value added' is recommended.

(i) Exclude profits out of the reckoning.

(ii) For each item manufactured in the plant find fixed expenses and labour content.

(iii) Considering the 'expenses + labour' of the standard product (standard product can be selected in an arbitrary manner but should be the same for the entire industry) as 100, the percent of the 'expenses + labour' for all other products should be expressed as a ratio of the standard product. This is the weightage factor of the item i and is termed as W_i. Therefore,

$$W_i = \frac{\sum_J \text{(Expenses + labour cost on ith product) for load centre j}}{\sum_J \text{(Expenses + labour cost on standard product) for load centre j}}$$

where labour cost is proportional to the time consumed by labour.

Here it is necessary to distinguish between

1. Time allowed for the job
2. Time taken for the job.

For the purpose of calculating weights (W_i), time allowed can be taken assuming that normal efficiency of working will be the same for all load centres and to avoid inefficiently performed jobs from getting more weightage.

(iv) Now these adjusted or converted ratios for each product can be used to evaluate total production as follows:

Actual production $= AP = \Sigma X_i W_i$

where X_i = number of product i.

This may be called Equated or Equivalent Productioh.

Advantages:

1. This index of production for a factory measures the production as proportional to labour and expenses incurred

on the production of the job.

2. All items produced (upto the smallest parts) can be considered for computing the actual production which is the real production, anyway.

3. OH rates or Fixed expenses distribution rates are departmental based and take into account the type of machinery and plant and thus distinguish between the time consumed on expensive and less expensive equipment, which is, of course, desirable.

Defects and Comments

1. 'Labour cost + fixed expenses' are taken as 'spent' and not as should be normally spent if the manufacturing process is correctly carried out. In fact the more, the manufacture of an item is inefficiently planned more will be its value in the above process. Defective as this procedure is to this extent, it is presumed that inefficiency of planning are uniformly applied to all production items, and no particular product is segregated for undue inefficiency.

In case this happens, this will reflect in increased Sales price or reduced profit and this will either result in proper adjustment of labour cost + expenses or at least reduction in the level of production of this item and thus reducing the distortion on this account.

2. Fixed expenses absorption by various items of production is not always correct and rational. Here the cost accounting system tries to make a balance between accuracy and practi-

cability of maintaining detailed accounts. To this extent, the effort of improving the methods of correct allocation of overheads must continue and in the meantime, this method of distinguishing between products on the basis of existing procedure is the best.

3. Method is not applicable unless proper time standards for various operations on all jobs processed in the plant are available and unless proper costing systems are in use. Recommendation here is that for those units of enterprise where these standards are not available, even a judgemental calculation of W_i will be better than nothing at all. If small components are manufactured as fixed percentage of the main products, these can be attached to the main products as a percent expenditure for simplification.

2.2.7 Difficulties of Capacity Utilization Determination in a Multi-product Firm.

(i) There is serious objection in estimating capacity utilization when capacity is considered productwise. As, a company manufacturing a number of products can have common and sometimes overlapping manufacturing facilities and underutilization of various products can be different and when collectively considered, the utilization may be very different compared to projection on the basis of one product. This can be explained as follows (Fig. 2.1). Suppose for product A and B, some facilities are common and some are special to products.

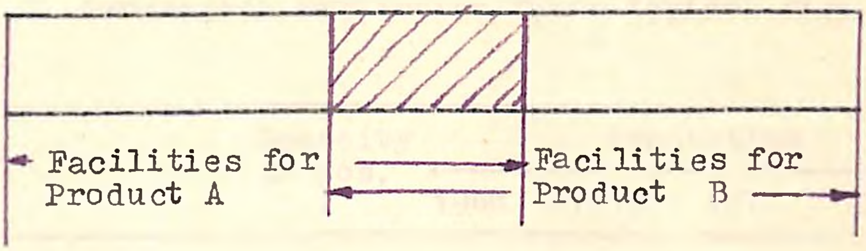


Fig. 2.1

Overlapping of manufacturing facilities

Shaded area is overlapping. Facilities may not be available exactly as added by the requirements of announced capacities for A and B. But there may be provision on the practical assumption of $(A + B) < (A) + (B)$ generally. Over time may be planned if production $(A + B)$ approaches $(A) + (B)$ where (A) and (B) are capacities of A and B separately.

Taking the case of a typical manufacturing unit, its production over the year may consist of

(a) Air compressors (reciprocating) : 10 - 200 cfm range

(b) Air compressors (centrifugal): 500-5000 cfm range

(c) Pumps: of many varieties.

(d) Spare parts: for all the above.

(e) Partsfor maintenance: for self consumption.

(f) Other lines of production like blowers, special compressors, pneumatic equipment made to order.

Production plan will have to be drawn to suit customers. Licenses have been issued for a fair range of sizes within the main product.

Table 2.2 Production Statistics for a typical firm.

Product	Capacity in Nos.	Production				
		1968	1970	1972	1974	1976
Air Compressors	720	239	529	310	496	363
Rock Drill and rubber legs	4380	610	3301	2436	2859	3996
Other Pneumatic equipment	2160	153	326	1479	2034	3731
Components for above	-	-	-	-	-	-

Source: |95|

For the data given in table 2.2 questions required to be answered are:

(a) Are the facilities for the various products common to each other and consist of some overlap ?

(b) Basis of capacity calculation is single shift or multishift ?

(c) Is any standard product mix. assumed ?

(d) If production of air compressors in 1972 = 310

Is underutilization of capacity in 1972 $= \dfrac{720 - 310}{720}$

$= 410/720$ or 57 percent.

Was it more than one obtaining in 1970 when production was 529 and underutilization $= \dfrac{710 - 529}{710} = \dfrac{181}{710} = 25$ percent.

Perhaps it was compensated by production of more Pneumatic equipment and capacity underutilization in 1972 was not more than that obtaining in 1970.

These problems need to be solved before any comment on the underutilization can be made.

Normal practice of taking one product in isolation for working out the capacity utilization is not correct. Also see Appendix 2.2 for evidence of overlap. This information was received from Kirloskar Pneumatic Ltd.

Another important objection is in the process of aggregation. Following makes the point clear:

A firm manufacturing iron castings may have the melting units as cupolas. In a foundry set up tb produce simple castings, the biggest investment will be that of melting units and the total investment of a foundry having cupolas as melting units may be having really a low level of investment. A 6 ton cupola worked continuously for 15 hours/day and worked 10 days in a month will have working capacity of melting about 10,000 tonnes/annum and taking a yield of 60 percent, 6000 tonnes/annum of good castings.

Total investment may be about 2 lakhs. Against this, another factory may use 'The Induction Furnace' having a capacity of 2 tonnes/hour giving a total of 2 x 15 x 20 = 600 tonnes/month = 7200 tonnes/year. (Assuming working of 15 hours/day and 20 days/month).

Assuming 60 percent yield (actually it will be lower for amall castings).

$$\text{Capacity} = \frac{7200 \times 60}{100} = 4320 \text{ tonnes.}$$

Investment will be almost of the order of Rs. 25 lakhs.

Suppose the capacity utilization of first firm = 40 percent and capacity utilization of 2nd firm = 100 percent. Then

$$\text{total production} = \frac{6000 \times 40}{100} + 4320 \times \frac{100}{100}$$

$$= 2400 + 4320 = 6720 \text{ Tonnes.}$$

$$\text{Aggregate capacity utilization (MSP method)} = \frac{6720}{10320}$$

$$= 65 \text{ percent.}$$

Yet it can be seen that from the point of view of investment,

$$\text{utilization} = \frac{2 \times (40/100) + 25}{27}$$

$$= \frac{25.8}{27} > 90 \text{ percent.}$$

Aggregation of facilities of this nature are common. The bias, because of the bulk of inferior products is to show capacity utilization as lower than actual.

In any case it is less serious if obsolete and less costly equipment is less utilized as compared to more costly and uptodate equipment. Non consideration of this fact leads to wrong interpretation.

Another important matter relates to the calculation of rated capacity. If the variety of products required to be manufactured is large, then, due to special equipment required for some of these varieties and because of indivisibility of this equipment, overall idleness will tend to increase. Reduction of variety to improve utilization or have less differentiated equipment may reduce 'market effectiveness', one of the many important objectives of any enterprise. Net result of all these is the overstatement of capacity and hence that of capacity underutilization.

2.3 Weak Data Base:

(a) 'MSP' (Monthly Statistics of Production) states only the installed capacities and actual production of different products manufactured by different firms reporting to DGTD. As reported above, when a firm manufactures many other products, and manufacturing facilities are common between them, the ratio of actual production of a product to the rated capacity of a product gives the shortfall of production of that product and not necessarily the percent utilization of capacity. This fact tends to over estimate capacity.

(b) Annual survey of industries: Records the total production of an Industry but then it fails to record the total capacity of the Industry and hence gives no idea of the capacity utilization in that Industry.

2.4 A Review of Past Studies:

Past studies, their methodologies and the results and the analysis are of special interest in understanding their impact.

Morris Budin and Samuel Paul (10) used the data provided by the Monthly Statistics of Industrial Production (MSP

Method) and concluded that for the 75 Industries considered capacity utilization was 75 percent in 1951 and rose to 92 percent in 1959.

Lobel and Das (23) calculated capacity not on the basis of (MSP) but on the basis of three shifts, 300 days in a year and allowing 10 percent to allow for maintenance and other enforced idleness of machinery plant. While the industries covered were not the same, the conclusions about capacity utilization, recorded for year 1954 were as follows:

Consumer Industry	→	utilization 54 percent
Producer goods	→	utilization 34 percent
Others	→	utilization 10.7 percent

(2)

What a big difference between (1) and (2) !

Lobel and Das study came very near the working out of capacity utilization in the real sense. Though the estimated figure may have other errors due to inadequacy of complete data on actual production etc., comparison is brought home in an extremely significant manner.

Even the study by C.N. Vakil (16) put the figure of utilization around 50 percent during 46 - 53 as compared to 75 percent calculated by Morris, Budin and Samuel Paul (above). It is quite clear that (MSP method), based as it is on hypothetical shift working, has given an overestimate of capacity utilization.

These differences may have been very much highlighted because the Industry groups considered by no two investigators were the same. Aggregation of different groups whose capacity has been estimated on the basis of same number of shifts worked, can yield different figures of capacity utilization if the weights attached to the production of these industry groups are different.

This was amply clear from the NCAER study (71). It first worked out capacity utilization for different industry groups (140 numbers) based on actual shifts worked which turned out to be as follows:

102	Industries :	Single shift
6	Industries :	Double shift
32	Industries :	Three shifts

On desirability basis it reworked out capacity utilization assuming the following:

102 Industries: Double shift working

38 Industries: Three shift working. The change from 1 shift to two shifts meant capacity increase by 80 percent and 1 shift to three shift meant capacity increase by 170 percent (90 percent for 2nd and 80 percent for 3rd shift) and 2 shift to three shift meant capacity increase by 80 percent.

The results as obtained are mentioned at Table 2.3.

Table 2.3 Yearwise NCAER (A) and NCAER (D) results on underutilization.

Year	Overall percent underutilization of capacity	
	On present working schedules	On desirable working schedules
1961	10.9	18.6
1962	9.4	17.8
1963	11.0	19.3
1964	10.5	17.7

The difference was not very significant. It is contrary to logic. However, it was explained that Textile products, basic metal and food products accounted for 67.5 percent by value added of the entire group of 140 Industries considered and out of 27 Industries in the three groups, 12 were already working in three shifts and remaining 15 working in single shift were recommended only for double shift. Notwithstanding this aggregation, for the same Industry group, the difference in CU or underutilization by considering capacity on the basis of desirable shift working was found very significant as in Table 2.4.

Table 2.4 Industrywise NCAER (A) and NCAER (D) results on underutilization.

Sr.No.	Industry Group	Approximate range of under utilization on present working schedule	Average under-utilization on desirable multiple shift working
1.	Leather and Leather products	20-25	57
2.	Chemicals and Chemical products	20-35	56
3.	Nonmetallic Mineral products	20-22	35
4.	Metal products	20-40	55
5.	M/c except Electrical machinery	10-30	31
6.	Electrical machines and appliances	10-20	43
7.	Transport equipment	10-33	42

While the significance of working more shifts in terms of drastically reduced capacity utilization is evident, the desirability criterion are still not indicated and one may ask why desirable limit for 102 Industries is 2 shifts and not more than 2 (say upto 3 shifts).

It is however strange that NCAER found 102 Industries out of 140 actually working on single shift. Since only 129 replies were received, the generalization that most of Industries work on single shift may not be fair.

Gokhale Institute Survey in 1967-68 (49) indicated that large number of factories were working more than one shift even though (MSP) calculated their installed capacity on the basis of single shift. Table 2.5 is quoted from this survey.

Table 2.5 MSP vis-a-vis actual basis of shift working

MSP basis (No. of shifts)	Survey basis						
	Average no. of shifts						
	1.0	1.1-1.9	2.0	2.1-2.9	3.0	NA	Total
1	24	9	14	9	28	-	84
2	2	-	-	1	2	-	5
3	7	2	-	2	1	3	15
	33	12	14	12	49	3	123

Futility of calculating capacity based on MSP data is quite obvious.

Reserve Bank of India (22) method applied to work out the level of Potential Utilization ratio and as compared to the level of capacity utilization (MSP method) is given at Table 2.6 and 2.7.

Table 2.6 Comparative MSP, RBI, NCAER(A), NCAER(D) results on CU for Mfg. industry.

For manufacturing Industries (as a whole)						
Method of calculation of CU	Wt.	Percentage capacity utilization				
		1960	1961	1962	1963	1964
MSP Method	63.80	85.68	84.75	83.67	83.45	86.53
RBI Method	82 no.	87.70	88.90	88.50	86.70	87.60
NCAER(Actual working condition)	NA	-	89.10	88.60	89.00	89.50
NCAER(Desirable)	NA	-	81.40	82.20	88.70	82.30

Given the system of weighting (based on value added in each industry in 1950-51) and the system of getting data and the fact that even MSP data excludes a number of industries even in large sector and complete small sector, it is doubtful that the differences as given above from year to year or from method to method are significant for the entire economy so as to invite any particular Government attention.

Table 2.7 Comparative MSP, RBI, NCAER(A) and NCAER(D) results on capacity utilization for basic metal industries.

	Wt.	Capacity Utilization in				
		1960	1961	1962	1963	1964
MSP	6.79	134.17	78.46	91.96	105.42	105.01
RBI	10.02	84.60	89.70	85.90	90.50	88.00
NCAER(A)	-	-	86.70	95.50	94.70	92.10
NCAER(D)	-	-	78.90	88.70	89.20	88.90

Source (22,71)

It is quite clear that in this group, some industries are working in double shift but its capacity has been worked out on single shift basis. However the number is not very big. Lowest estimates of capacity are given by NCAER (Desirable) basis. Lowest utilization occured in 1961 except in RBI method. When capacity is created, its effect may be felt in more production with a time lag. All methods show best utilization in 1963. differences due to NCAER (Actual condition) and MSP method can be due to inclusion of data of different firms and sampling errors. In NCAER (Actual) method, capacity utilization in 1963 was less than that in 1962 while for all other methods, capacity utilization showed an increase.

Underutilization for a few given products/industries for 1962 is given by NCAER at Table 2.8.

Table 2.8 NCAER results on capacity utilization for a few specific industries.

	Working in Single shift	Double shift	Three shifts	Average
Power Driven pumps	37.5, 38.5, 70.4% Three firms included.	36.1	-	55.0
Sugar Mill Machinery	90, 100	-	89.2	93.1
Coal Mining Machinery	-	70.0	-	70.0
Machine tools	66.7, 95.3	78.00 81.3	62.5	74.4

In contrast - Average level of Potential under utilization ratio for industrial machinery for 1962 = 16.1.

What a vast difference again !

1. The significance of different methods for calculating capacity or potential utilization ratios may be noted. Idleness of shifts is not taken into account by RBI method. As the comparison is made from a sector to a group to an industry, the difference becomes more and more accute.

If the capacity of a plant is to produce 100 units and maximum production so far has been 40 units and the current period production is 35 units. Then capacity utilization = 40 percent. But potential utilization = $\frac{35}{40}$ = 87.5 percent. (Defn. at para 2.1.3).

2. Within an Industry, capacity utilization differences of individual plants are glaring. Basic assumption of planners that whatever capital is produced and acquired by units will automatically be put to 100 percent use is not proved. Policy, economic and market variables are common to every industry, in a particular year yet the capacity utilization are markedly different. This aspect needs much more attention than given hitherto by the economists/engineers trying to analyze capacity utilization.

3. Underutilization is heaviest in the capital producing industries, a fact which is again very much against the conventional theory of development where scarcity of capital is assumed to be the main cause of poor economic growth.

4. All the studies make it difficult beyond very broad generalisations to treat the subject analytically or hope to come up with any possible recommendation.

US AID Study (89):

In this study, the data as provided by MSP was verified, augmented and improved by personal interviews by the author. It was necessary to obtain an in-depth analysis and it was possible through personal interviews in preference to questionnaire method or depending entirely on official statistics. Comparison of estimates of capacity under-utilization are given at Table 2.9.

Table 2.9 Differences in NCAER and US AID results of underutilization.

Product		Under utilization in			
		1961	1962	1963	1964
Vanaspati	NCAER	37.5	35.5	31.4	38.1
	USAID	39.5	34.0	31.5	38.2

The data is roughly the same. Causewise analysis has been made in detail through the study of various factors for 1946 onwards and on the basis of the author's feeling, the causes have been finally listed in order. Performance by size of the firm and by regions was also investigated. The conclusions are however, not very clear e.g. 'The causes of under-utilization, are a somewhat complex inter-mingling of problems. Basic long run cause is low productivity, stagnant growth and fluctuating production of the groundnut crop'. No effort has been made to apportion the blame in a statistical manner. Qualitative analysis is likely to leave the position untouched. Variety of reasons belonging to the enterprise, the Government and the raw material supplier do not give directions for improvement.

In short no new concept on estimation of capacity or capacity utilizations have been given but the investigation of causes of underutilization is more exhaustive though non-quantitative.

There are hardly any other studies in capacity estimation. Writeups of special interest and pertaining to specific Industries keep drawing attention to the aspect of under utilization but there is hardly ever a detailed mention of the methodology adopted to work out capacity utilization. Causes of underutilization are invariably mentioned and there are ample pleas to improve supply of power, raw material, and reductions of excise duties etc. to stimulate demand. No yardsticks are laid down to analyse the effect of any steps on the extent of capacity underutilization. To start with, the extent of underutilization worked out and its basis is perhaps not clear.

CHAPTER 3

MODEL FOR BETTER ESTIMATION AND ANALYSIS OF CAPACITY UTILIZATION

3.0 It was clear from Chapter-2 that the conclusions of various studies were not comparable due to the many defects in the estimation of capacity from which these studies suffered. Most important of these defects arises from the fact that the basis of estimation is neither made clear in any method nor is the basis adequate.

In this chapter, therefore, a six stage model has been described followed by details of the extent of and the reasons of the loss of capacity at each stage. The problem has become more acute as a result of non-standardisation of the terminology and due to the existence of differing definitions and treatments of the subject. The problem arises mainly because of the fact that one definition of capacity is not adequate for complete analysis.

3.1 Six Stage Model:

A six stage model is presented here and hopefully this will clearify the concepts as well as the methodology. The model indicates six clear cut concepts of capacities. Brief description of each is given below:

(o) Maximum Capacity of Available Resources:

This is the maximum theoretical capacity that can be purchased in terms of fixed assets using a fixed sum of investible funds. For the given funds, fixed assets can be purchased in a variety of ways. Degree of automation, quality etc.

can vary widely and the wrong choice of fixed assets can lead to creation of:

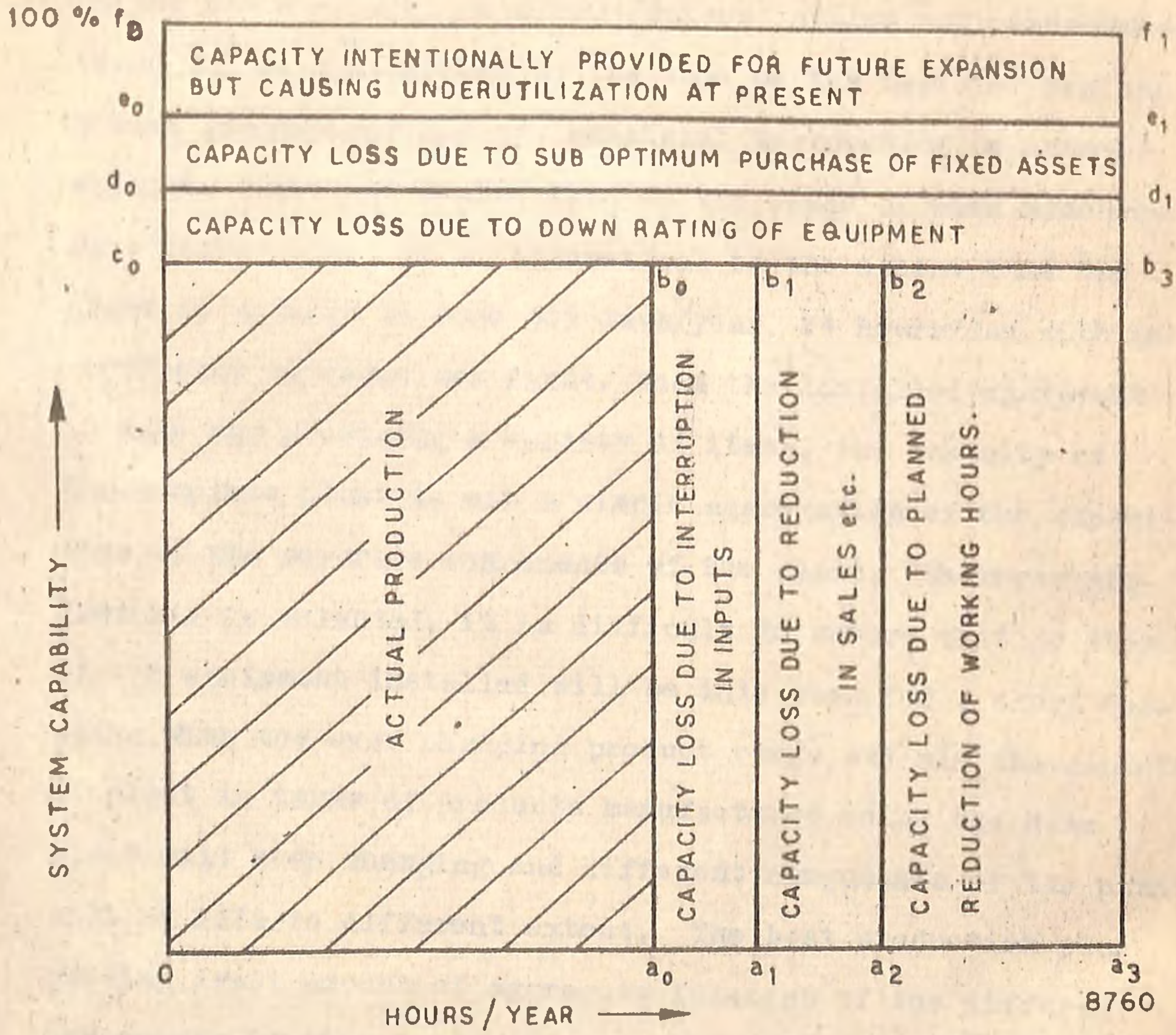
(i) Wrong Capacity: This is basically due to wrong design or need estimation or deliberate provision of excess capacity to have flexibility or slack. 1. e.g. an induction furnace of 2 MT melting capacity per hour against a requirement of 1/2 MT/hour. 2. A lathe to accommodate a job of far bigger dimensions than would ever be expected to be manufactured. 3. A 10 ton crane where 5 ton would have been sufficient or vice-versa.

(ii) More capacity than required at some load centres.

(iii) Less capacity than required at some load centres. This will in turn cause other load centres to remain idle. This is a case of mismatch of capacity in multiload centre plants.

(iv) Unnecessary more expensive capacity as compared to work in hand, e.g. Purchase of milling fixtures in milling machines, taper fixture in a lathe or purchase of a high quality lathe for roughing work etc.

The sum total of all these is 'Capacity loss' between what could be procured and what was procured. The loss can be divided into two parts: (a) provisions for future expansions: calculated provision of over capacity to allow for future expansion (ii) accidental creation of over capacity as a result of poor choice of assets and poor decision making. In fig. 3.1 total theoretical capacity of investible funds is depicted as $o\,a_3 f_1 f_o$ and the two components of capacity loss as $e_o\ e_1\ f_1\ f_o$ and $d_o\ d_1\ e_1\ e_o$ respectively.



MAXIMUM THEORETICAL CAPACITY OF RESOURCES = AREA $Oa_3f_1f_0$
MAXIMUM THEORETICAL INSTALLED CAPACITY = AREA $Oa_3d_1d_0$
MAXIMUM THEORETICAL RATED CAPACITY = AREA $Oa_3b_3c_0$
MAXIMUM PLANNED CAPACITY = AREA $Oa_2b_2c_0$
BUDGETED CAPACITY = AREA $Oa_1b_1c_0$
ACTUAL PRODUCTION = AREA $Oa_0b_0c_0$

FIG.3.1

Graphic Representation of Various Capacities

A. Maximum Theoretical installed Capacity:

Represents the capacity of purchased fixed assets calculated on the basis of collaborators'/makers' claims and recommendations and in the absence of the same on the basis of the unbiased recommendations of Industrial Engineering Department which is likely to evolve data on the basis of work measurement techniques. It is theoretical to the extent that the plant is assumed to work 365 days/year, 24 hours/day with no constraint on sales our input. When the installed equipment is used for producing a variety of items, the capacity of the complete plant is not a simple aggregation of the capacities of the separate components of the plant. Whatever product mix is selected, it is difficult to ensure that no item of the equipment installed will be idle even for a short duration. With the ever changing product range and mix, the capacity of plant in terms of products manufactured using the same plant will keep changing and different components of the plant will be idle to different extent. The best production plan causing least amount of aggregate idleness of the different components of the plant will be called the 'Maximum theoretical installed capacity' and can be calculated using the Linear Programming model. Before describing the model, an idea of load centres ~~is~~ along with their characteristics is given below:

Load Centres:

(a) Load centres can be described as one where jobs, operations and machines are interchangeable. Suppose there is a set of 5 D.C. welding sets of the same technical specification. These will form one load centre.

However, if one of the welding sets is not preferred due to its age, condition, design or any other limitations this must form another load centre as idleness of the plant is not as costly as at others and hence the capacity of this set is not the same as of others. Similarly if an equipment is preferred because of its characteristics like better production capability, reliability, accuracy and so on, this must form another load centre.

(b) Critical load centre will be one where idle time is zero.

(c) It is clear that but for a few load centres, all others will be idle to some extent or the other.

(d) Load centres can include designing department also in case designing is an integral part of most of the jobs, as in Structural Industry. Similarly, capacity of a plant may be limited by Inspection, Quality Control, Testing etc. All these must be included as load centres.

Unused Capacity:

A number of load centres must necessarily remain idle. The idleness can only be reduced by:

(a) Smoothing of non-utilization: Accepting additional orders for those products as do not require capacity on critical load centres but only on idle load centres. The difficulty of getting such orders is obvious and in addition such an effort may be suboptimum in as much as it may tax the capacity of auxiliary departments like sales, Development, Processing etc.

(b) Extra Investment: Improving capacity of critical load centres which in short means extra investment.

(c) Purchasing Policy: Purchasing parts/components manufactured on critical load centres. This again can divert Management Attention.

Linear Programming Model:

Let X_i = Number of products i to be manufactured during a given time, where i includes spares and i=1,2,..n.

j = Load centre number, where j=1,2,...,m

V_i = Gross value added in product i

= Sales value of i -(cost of raw materials and purchased components).

X_{ij} = Number of product i going through load centre j

t_{ij} = Standard time for job i on load centre j assuming labour efficiency of 100 percent.

t_{sij} = Setting time for job i on load centre j.

k = Number of settings required for job i during a given time period (say 24 hours).

C_j = Capacity of load centre j, considered in this case, at the rate of 24 hours for each working day and no holidays etc. throughout the year.

W_j = Cost per hour of load centre j. This cost includes direct and overhead expenses.

Now idle time on load centre j during a given time period.

= capacity of load centre - standard time of products manufactured on this load centre

+ standard time required for setting the jobs.

$$= C_j - \sum_{i=1}^{I \in n} (x_{ij}\, t_{ij} + kt_{sij})$$

where I is a subset of n = no. of products manufactured on load centre j.

Cost of idleness of load centre $j = \left[C_j - \sum_{i=1}^{I \in n} (x_{ij} t_{ij} + kt_{sij})\right] W_j$

Cost of idleness of all load centre

$$= \sum_{j=1}^{m} \left[C_j - \sum_{i=1}^{I \in n} (x_{ij}\, t_{ij} + kt_{sij})\right] W_j$$

Objective function can thus be defined as selecting a set of x_i ($i = 1,2,..\ n$) so as to Minimise total cost of idleness i.e.

$$\text{Minimise} \quad \sum_{j=1}^{m} (C_j - \sum_{i=1}^{I \in n} (x_i\, t_{ij} + kt_{sij}))\ W_j$$

Subject to the following constraints:

$$\sum_{i=1}^{I \in n} (x_{ij}\, t_{ij} + kt_{sij}) \leq C_j \text{ for all js}$$

Capacity in terms of product No. 1

$$= \sum_{i=1}^{n} x_i \frac{\sum_{j=1}^{J \in m} t_{ij}\ W_j}{\sum_{j=1}^{J' \in m} t_{1j}\ W_j}$$

Where J is a subset of m load centres through which job i passes and J' is a subset of m load centres through which job 1 passes.

Some Comments:

(1) Capacity: Describing capacity in terms of a physical attribute of the product like no., Horse power, Weight, Length etc., is on the face of it wrong as capacity of Machinery and plant consumed is not proportional to these attributes. Describing capacity in terms of standard hours is not justified as standard hour of one load centre may not be equal in cost and value to that of another. Hence load centre hours duly weighted in terms of the cost of the load centres has been preferred and expressed as physical units in terms of any standard and popular product. This can give a realistic value to the capacity.

B Maximum Theoretical Rated Capacity:

The following features can reduce the theoretical installed capacity:

(i) Standard Time: Standard time permitted for a job i as decided by the collaborators or Industrial Engineering Department (t_{ij} for operation and t_{sij} for setting) may have to be revised upwards and in rare cases downwards. Upward revision can be necessitated as a result of :

1. Defects found in equipment as a result of which speed of operation has to be reduced.

2. Poor design of method or sequence of operation.

3. Poor conditions of working like climate, and inadequate provision of facilities for personal requirement of operators.

4. Poor availability of cutting tools, implements etc.

5. Inadequate rate fixing knowledge or its applications.

6. Worker's pressure towards more liberal standard times to enable them to earn incentive Bonus despite minor irritants like work interruptions or as a result of some group perception of as to what constitutes fair day's work.

Downward revision can be brought about by:

1. Better machine maintenance
2. Improved work tools
3. Improvements in methods, technology etc.

(ii) Worker Efficiency: Worker efficiency was assumed, while calculating theroetical installed capacity, as 100 percent. (workers efficiency $= \frac{\text{time taken}}{\text{standard time}} \times 100$, (more details at 3.4.1)). However, this efficiency may be consistently less than 100 percent. While the target should be maintained as 100 percent, for short term, the maximum efficiency attained during the past may be considered to normalise the theoretical capacity as in any case the capacity available is less.

Model: Model of the theoretical capacity is still valid after the following modifications:

1. t_{ij}' replaces t_{ij}
2. t_{sij}' ,, t_{sij}
3. x_{ij}' ,, x_{ij}
4. n_{ij}' ,, n_{ij} (Taken as 100 percent)
5. x_i' ,, x_i

Objective function will be to minimise

$$\sum_{j=1}^{m} \left(C_j - \sum_{i=1}^{X\epsilon n} \left(x'_{ij}\, t'_{ij} + K\, t_{s'ij} \right) \right) W_j$$

subject to the constraint:

$$\sum_{i=1}^{I\epsilon n} \frac{x'_{ij}\, t'_{ij} + K\, t'_{sij}}{n'_{ij}} \leq C_j \quad \text{for all } j\text{s}$$

Capacity in terms of product 1

$$= \sum_{i=1}^{n} x'_i \; \frac{\sum_{j=1}^{j\epsilon m} t'_{ij}\, W_j}{\sum_{j=1}^{J\epsilon m} t'_{1j}\, W_j}$$

If $t'_{ij} > t_{ij}$

and $t'_{sij} > t_{sij}$

$n'_{ij} < 100$ percent

Then $x'_{ij} < x_{ij}$ for all x_is

C Planned Capacity:

While capacity may be rated as at (B), a decision may still be taken not to work even the most critical equipment for 8760 hours/year.

The following are excluded (in order of preference)

1. Sundays
2. Holidays for festivals, national holidays
3. Third shift completely or partly

4. Second shift completely or partly
5. 1st shift partly.

The decision to work less than the maximum is based on many factors some of which are mentioned here:

Idea of Optimum working:

Some costs like depreciation, interest on borrowed capital, are reduced as a result of more working of fixed assets. Other costs tend to increase. It is clear that minimum cost point will be somewhere between 0 working and working 8760 hours a year. The exact point is a function of the cost functions which are in turn based on the nature of the Industry, region, the economic policies at that point of time and the management quality.

Sufficiency of Profits rather than maximum profits as objective function:

Even though a point of minimum cost is determined, the actual working hours may be much less because of the fact that the objective is not maximization of profits. While economic theory is based on the fundamental assumption, there are many entrepreneures who will consider working more hours as risky and may be content with less than maximum profits.

Risks of enhanced working:

More labour engaged for working hours can reduce management capability, increase union strength and group effectiveness and can be a serious liability in times of depression.

4. Second shift completely or partly
5. 1st shift partly.

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Risks of enhanced working:

More labour engaged for working hours can reduce management capability, increase union strength and group effectiveness and can be a serious liability in times of depression.

Reduced efficiency, enhanced chances of accident, pilferage and indescipline in the second and third shift are other risks.

Additional Cost of Enhanced Working:

Additional payment to staff for working in 2nd or 3rd shift to overcome reluctance of staff to work during time considered unworkworthy from social point of view like sundays, holidays night etc. and additional chances of rejections during the 2nd and third shift have been considered as deterrent to working additional shifts by some.

Model: Model as at B works if

C'_j replaces C_j

where,

$C'_j = C_j -$ hours lost due to not working sundays holidays, third shift or second shift or part thereof

$$\text{Capacity now} = \sum_{i=1}^{n} X''_i \quad \frac{\sum_{j=1}^{J\in m} t'_{ij} W_j}{\sum_{j=1}^{J'\in m} t'_{1j} W_j}$$

where x''_i is now production of product i as a result of C_j being replaced with C'_j.

D. Budgetted Capacity:

In working the model upto (B) no constraint has been placed on the sales of product i or on the minimum requirement of producing a particular product. The actual market, dynamic as it is, may make it necessary to -

1. Restrict production of certain products even though these are highly profitable.

2. Produce certain products even through these are unprofitable.

Changes may also be necessary due to non-availability of sufficient power, raw materials etc.

Model: Yearly capacity is determined by placing such restrictions as under:

(i) $x_i'' \leq x_i''$ for certain values of i

or $x_i'' > x_i''$ for other values of i

(ii) $C_j'' \leq C_j'$ capacity restraint in face of known power shortage or other constraints.

(iii) $x_i'' - s_i \leq I_i$

where s_i - sales of product i

I_i - Maximum permissible inventory stock of product i

This places a restriction on building of inventory stock in times of depression

$$\text{Capacity: } \sum_{i=1}^{n} x_i'' \quad \frac{\sum_{j=1}^{J \in m} t_{ij}' \, W_j}{\sum_{j=1}^{J' \in m} t_{ij}' \, W_j}$$

Comment:

1. Budgetted capacity can be set higher than planned capacity also through the mechanism of

(i) sub contracting critical items

(ii) overtime working

(iii) recruiting temporary labour

2. Actual decision on one of the above alternatives involves optimising extra costs of production because of hiring cost, overtime costs and additional costs of purchasing vis-a-vis expected extra revenues.

E. Actual Production:

Results after the net effect of interruptions in inputs like power, raw materials and absenteesm, actual working efficiency, breakdowns of equipment have been considered in calculating the actual production.

Actual production in terms of product 1

$$= \sum_{i=1}^{n} Y_i \frac{\sum_{j=1}^{J \epsilon m} t'_{ij} W_j}{\sum_{j=1}^{J' \epsilon m} t'_{ij} W_j}$$

where Y_i is the actual production of product i

Fig. (3.1) depicts these capacities and capacity losses graphically. p63

3.2 Capacity Utilization Estimation:

Can be defined as E/D, E/C, E/B or E/Q or E/O. The selection of a particular ratio will depend on the purpose on hand and the major confusion that prevails in the literature on the subject has arisen out of the existence of many valid ratios as mentioned above, each with some justification.

E/O = E/A x A/O E/A, = E/D x D/C x C/B x B/A.

E/O is not an absolute measure. It can be used only for comparing different ~~of~~ units in the same industry.

A/O ratio is also difficult to compute and is more or less to be used for comparisons.

E/A is an absolute though a bit theoretical concept. B/A element out of this is very significant but may be extremely difficult to compute. B/A element, moreover, need not come into focus all the time since improvement of B/A is a sustained job. The loss due to this must be kept in mind by top management as far as possible. This element can also be called 'capability' element.

Element C/B is extremely significant and a most relevant question that is required to be answered is : Why does an Entreprenuer decide to work his equipment less than 3 shifts ? Of course, purely on cost consideration, it may not be desirable to work all the 3 shifts for 365 days in a year. As it may increase the marginal cost per piece beyond the sales price primarily due to more maintenance, Cost and increased breakdowns of equipment etc. (Also see Chapter-2). But does he work upto the most optimum number of shifts, through which his total profit can be increased both due to increased profitability and increased output?

~~2.1.7~~ Element D/C is perhaps justified in a small run optimization and conservation of expenditure in the face of sudden market changes ~~or forces~~ or changes in inputs.

Element E/D or E/C have found lengthy mention in literature and most of the authors concentrate on this loss of capacity as a result of unauthorised absenteesm, unusual breakdowns, unpredicted power failure and many other reasons.

It can be clearly seen from figure (3.1) that Actual Production can get reduced through -

(i) Artificial or real reduction in the capabilities of equipment or through.

(ii) Reduction in working hours of equipment; planned by the management or forced upon the management.

3.2.1 Advantages of the Model:

Improvement in capacity utilization at each stage is the responsibility of a different level within the enterprises. The model segregates the influence of each level in the achievement of capacity utilization and hence improvements can be tried on a systematic basis.

Unitwise Estimation:

Individual units can estimate their capacities rather correctly, if there is already a system of rate fixing, time standards etc. in vogue. The following problems are however, to be noted.

1. A unit producing a variety of products can fix the capacity in physical units only for a particular product mix. We have seen that the product mix calculation depends very much on factor W_j i.e. weight due to working on load centre j. Changes in wages and other costs can result in changes in W_j and in that case ideal product mix can change or product mix depends upon 'Factor Prices'.

2. In a complicated set of products and spares being manu-

factured, optimization as worked through linear programming model may be difficult of computation.

3. Availability of W_{js} (based as these are on accurate cost records) may not be ensured as many firms don't maintain cost data at all and those who do maintain some records, may not be keeping it in details enough to compute W_{js} fairly correctly.

4. If only some products out of the product mix are manufactured in the accounting period, capacities may be expressed in terms of one or two or more products and in such a case there will be danger of duplication. If a plant has a capacity for manufacture of 10 lathes per month or 6 planers/month. Any aggregation may consider 10 lathes 6 planers as the capacity whereas the actual capacity is either 10 lathes or 6 planes. Therefore, it is best to define capacity in terms of one product only.

5. If time studies are not available, any such computation will be difficult.

3.2.2 Existing Situation:

The situation, as existing, is far from satisfactory:

1. Firms indicate installed capacities for various products without indicating the number of shifts worked, the over lapping or common facilities employed. In a particular case, product A and product B can be produced to the extent of 100 units each but never both at one time. These anomalies can only be removed through detailed studies.

2. Simplistic measures of production in numbers and tonnes etc. is misleading. Even in textile industries, the length of cloth produced in meters, requires different amount of labour and expenses for different qualities of cloth. Combining these together without mention of product mix can be quite misleading. In Engineering Industry, the products may require far different labour and expenses.

3. Productwise capacity utilization as calculated through the monthly statistics of production is no indicator of utilization of capital or labour as all the firms have the facility of shifting the use of both to other products. To get a more accurate idea of the working of the firms, it is necessary to resort to more detailed computations as mentioned before. As the Industrial products become more sophisticated, there will be no escape from this if better quality investment decisions are required or if profitability of the firms is to be increased. Application of the methods given before can also suggest application of more advanced techniques for improving productivity like Group Technology, value Engineering, and simplification.

Computers are becoming common and time has come to be prepared to make use of the same to enable our industry to become more competitive in local as well as international markets.

Conclusions:

1. In a multiproduct industry simplistic measures of production to indicate capacity or actual production are

not adequate.

2. Since capacity depends upon product mix. and market conditions, it is basically a dynamic concept and no measures of capacity is valid for all occasions.

3. Six measures of capacity are clearly defined. Each measure is identified through the level of Management holding the responsibility for the measure and through clearly identifiable factors.

4. Capacity utilization measured at every stage will also indicate a clear line of action for improvement.

5. Linear programming techniques have to be used for quick and correct computation.

6. Correct time studies and costing techniques are a prerequisite of accurate estimation of capacity utilization.

3.3 Loss of Capacity Through Sub-optimum Procurement of Fixed Assets:

3.3.1 Decision basis Behind Investment:

First characteristic of investment is durability which means its services stretch over many future years. Future is highly uncertain and a decision on investment is choice in the face of a lack of sufficient knowledge and therefore is the study of conjectural appraisal and assessment (Shackle 86- p77). Besides, uncertainty the investment decision must allow for deferment of the gains which it pursues. Discounted cash flow and calculation of pay off periods are an attempt to provide the businessman with a single number as the measure of the value to him of his proposed investment. Such calculations are dependent upon the assumption of a fixed output capital ratio based perhaps on the experience of existing firms. Such an idea is itself a total denial of the very essence and spirit of modern business and is also potentially dangerous for the businessman. Firstly the ratio may not come about by itself unless the specific conditions of the sample are known and even if it is achieved in future, the same may be grossly inefficient compared to the ratios achieved by other investors who probably made different and novel choices, took a calculated risk and hit upon better mode of investment. Given this difficult decision making situation, the investor has to pass in review all imaginable systems of facilities for producing each product selected. The probability of an outcome of a profitable decision will naturally depend on the mental makeup of the investor, his experience and his inclination to try for bigger success and his bent towards novelty. Even within his circumscribed field of already existing designs of tools,fit for his purpose, a businessmans' selection borders on conjecture only. It is therefore highly probable that a number of investment decisions made to-day prove unprofitable and disastrous in future and wrong decisions continuously lead to loss of capacity utilization.

Nature of Decision on Investment:

Decision on investment requires decision on the type of technology, type of scale and the timing of investment. The first two may lead to over capitalization for a given output, existence of bottlenecks and surplus capacity on different load centres side by side with redundancy, obsolescene and inefficient use of the durable assets, the third one by nature is likely to result in poor utilization of resources during the intervening periods.

Result of Investment Decisions:

Output is a result not only of investment decision but also of a series of operating decisions as well. Segregating the effect of these two is a difficult task. However output capital ratios of different firms having the same type of operation can be compared and some idea of the quality of durable assets procured can be made. An absolute 'efficiency coefficient' cannot be calculated. For a plant, however, the following can be determined.

1. Percentage idleness of equipment due to lack of work which indicates the unsuitability of the equipment to present day product mix or excess procurement of equipment for present day requirements.

2. Perpectual low output from a machine as compared to similar machines of other makes and origines. This indicates the inbuilt design and technology defects in the equipment.

3. Perpectual breakdowns of equipment indicating poor reliability of the system or sub-system used and in general indicates defects of technology and design.

4. Perpectual queues on certain load centres which indicates insufficient provision of certain equipment, even though

many other load centres are idle.

5. Continuous lower labour efficiency for all types of jobs in output as well as quality again indicating design and technology defects.

6. Continuous breakdowns of equipment with non-availability of maintenance spares indicating incomplete procurement without adequate spares as well as poor standardization of parts used in the equipment.

7. Necessity to break a complete operation on a job into various elements and taking certain elements out of the manufacturing schedule of the equipment. This is necessitated as a result of non-procurement of standard accessories with the equipment.

8. Time equipment idle due to non-divisibility of equipment even though its inadequate use was known.

A careful study of these aspects can give a fairly good idea of the inadequacies of investment decision made earlier. Some comparisons made from time to time by different authorities are given below.

3.3.2 Comparison of Fixed Capital availability between a public sector firm (A) a private sector firm (B) a foreign firm (C) manufacturing similar products, is given at table 3.1 (78).

Table 3.1 Equipment Comparison Between Firms.

Item	Firm A	Firm C	Firm B
Production output.	Gen. structures Medium and heavy	Sophisticated structures	Pressure vessels, heat exchangers, structures medium and heavy
Tonnage/month	500	more than 2500	500
Covered area(M^2)	20000	33500	23700
EOT Cranes number	15	26	17
Compressed air (cfm)	2500	-	3050
Number of compressors	3	-	11
Portal flame cutting m/c	2	2	-
Profile cutting m/c	2	2	4
Plasma arc cutting m/c	2	2	2
Circular saw	2	5	-
Shearing m/c	4	4	2
Edge planing m/c	1	3	1
Press Brake	2	4	4
Drilling m/c	6	12	22
Heavy duty drilling m/c	4	11	1
Horizontal boring m/c	2	5	7
Vertical boring m/c	1	5	4
Heavy duty planing	2	6	2
Centre lathe	5	15	45
Welding machines all type	8	38	20
Welding sets	78	250	268

One can see that the foreign firm has less than proportionate requirement of equipment for 5 times the production. It was ascertained that all the firms work in two shifts and hence the time utilization rate is the same.

In foreign countries where labour cost is higher, fixed capital costs may be incurred at a higher level so as to ensure utilization of staff. Despite this, their proportionate investment in fixed capital is much lower than the Indian firms in both sectors. As indicated before, three factors are important in discribing this difference:

(i) Economies of scale in the case of the foreign firm

(ii) Higher production rate from the same machine due to better labour efficiency (for definition of labour efficiency see Chapter 3.4.1).

(iii) Procurement of assets in an optimal manner.

It is difficult to segregate the effects of the three factors but a glance at the idle hours of the equipment at the Indian firms clearly indicates that at the project stage, lavish expenditure on buildings and equipment was made without connecting this to future requirements in an adequate manner. Data

3.3.3 Suboptimum Purchase of Equipment:

3.3.3.1 Inadequate Demand Forecasting: In any firm, a number of equipments can be found to be illfitted to the present product mix under production. The amount of such equipment is more in Public sector units where planning was done for a particular product mix. And, even during the procurement and installation of fixed assets, the nature of product mix changed. Conversion of equipment to suit the new product mix was at best suboptimum and at worst, the equipment was rendered.

completely idle. Demand levels anticipated were very high and machinery was also liberally procured on the basis of this demand. When demand didn't materialise, the machinery naturally became idle. Better would have been to procure the equipment on a carefully planned phase basis. Following quotation from the report (internally circulated) of a leading pump and compressor manufacturing firm explains the point mentioned above:-

'Recently, there have been changes in the technology for construction of fertilizer plants which are considered as the major customers for our reciprocating compressors. For the new units, some of the foreign consultants have recommeded the use of centrifugal compressors in place of reciprocating compressors consequently, there is a tendency for new fertilizer projects to go in for high capacities of centrifugal compressors rather than reciprocating compressors. This situation has led to a slight slump in the market for the reciprocating compressors.'

The tragedy is that the plant was incorporated only a few years ago and yet failed to anticipate the changes in technology used by the potential consumers.

The main figures of performance for this firm are summed up in Table 3.2 (77)

Table 3.2 Plant capacity and actual Production

Product	Capacity inyear		*Figure in bracket in actual prod.		
	73-74	74-75	75-76	76-77	77-78
CP	170(10)	350(3)	600(13)	660(84)	660
RP	30(-)	50	65	65	65
RC	30(-)	50	60	60	60

CP - Centrifugal pump

RP - Reciprocating pump

RC - Reciprocating compressor

3.3.3.2 Inadequate Phasing out of Equipment Purchase:
In the face of this underutilization, there was no reduction in or phasing out of capital expenditure on equipment, machines, jigs, and fixtures. Even those machines which had no problem of indivisibility were purchased in the number required for full capacity. For number of centre lathes, turret lathes, boring machines, drilling machines purchase could be postponed.

3.3.3.3. Inadequate Investment Analysis:
Following excerpts from the report of the committee on public undertakings (58) on Heavy Electricals (India) Ltd., Bhopal underscores the point made above.

'...If the cost of township is excluded from the total investment, the investment - output ratio of the Bhopal project with an annual output of Rs. 15.5 crores would work out to 3.2 : 1 and for an anticipated annual output of Rs. 25 crores to 2.2 : 1. The committee were informed that for a similar newly established undertaking in the U.K., the investment output ratio would be of the order of 1.7 : 1 or 1.8 : 1 in the early life of establishment. An electrical equipment manufacturer told the committee that the ratio should be 1 : 1.5 in a heavy electrical factory. It is also notworthy that the investment to sale ratio in the case of AEI is

1 : 1.5. It is thus evident that Bhopal project is over capitalized and its investment output ratio is low. The committee regrets that due importance was not given to the economics of the project initially. It is well known that higher capital investment increases the cost of the products and adversely affects the competitive position of the undertaking'. Government's reply leaves much to be desired.

Reply is quoted 'it is accepted that higher capital investment has the effect of increasing the cost of production which also adversely affects the competitive position. Every effort is therefore made to achieve maximum economy in capital costs and also suitable phasing thereof before the projects are approved for implementation' (58 - p 27).

Another quotation from the same report emphasizes the point:

1. 'The estimates of capital cost of comparable items furnished by AEI in June 1955 rose from Rs. 15.90 crores to Rs. 28.16 crores in November 1956 i.e. by about 77 percent in a period of 18 months. It would appear that the estimates of cost submitted by AEI in 1955 were not examined in any detail before sanctioning the project or appointing them as consultants. The committee are constrained to observe that the project was sanctioned on the basis of estimates which have later on been termed as 'intelligent conjectures' (58 - p24).

2. 'The committee regrets to observe that neither the ministry nor HEL could furnish information regarding the capital cost of establishing a comparable heavy project elsewhere. The

committee consider the collection of such date very necessary. In the absence of such data it is difficult to determine the reasonableness of estimates given by the consultants (58 - p26)'.

These quotations indicate that neither the estimates are scrutinised, nor compared with other countries and the resulting overcapitalization is evident.

3.3.3.4. Incorrect Choice of Technology:
The point is strengthened by quoting from an article written by an officer of the Bureau of Public Enterprises (44 - p878).

'Incorrect choice of Technology:
Experience shows that this is by far the largest single reason which leads to perpetual problems of underutilization of capacity. There are instances when newly developed technology which was still to be conclusively proven elsewhere in the world, was purchased by our country without careful analysis with reference to the working environment and other inputs. Under these circumstances, plants enter problem areas which are very difficult to resolve subsequently. An examination of enterprises which have yet to cross a respectable level of capacity utilization in the public sector would reveal that many of them suffer the scars of incorrect choice of technology'

3.3.3.5. Incorrect timing of purchase of Assets.
Timing: In the absence of proper control charts like GANTT the PERT, A lot of equipment can lie idle because buildings are not ready or vice versa. This represents loss of revenue earning capacity on durable assets already procured. Instances

of this can be found in almost all the reports of the Lok Sabha Committees on Public Sector undertakings. The same can also be noticed in private sector undertakings when their completion of plants are compared with the plans.

3.3.3.6. Expansion Before Stabilization:

Extracts from the report by the committee on HEC(56 -p15-21) adequately explain the point:

'Besides numerous complexities that have been created due to changes in schedules of commissioning, cost estimates etc., there is little doubt that if the revised capacities had been planned from the initial stages, various delays and extra expenditures on civil works and other items would have been avoided'.

It was also noticed by the same committee that the Namrup project of the FCI was delayed for one year due to changes in rated capacity. It appears therefore that expansion before full rated capacity of the plant already installed has been achieved, leads to delay of the original plant achieving its full capacity. Expansions should follow stabilization of existing assets otherwise capacity under-utilization will become a regular phenomenon.

3.3.3.6. Inadequate Planning of Replacements:

An extract from the report by the committee on the Hindustan Yard (57 - p25) explains this point:

'...The shipyard had not till recently made any investigation to assess the extent of low utilization of machinery and the impact on low productivity due to machinery being old and worn out. The programme for replacement of old and worn out machinery was also not initiated in time. It is therefore, not surprising that the shipyard should have accumulated over a period of time old and worn out machinery with very low utilization. The committee suggest adoption of regular system of periodical assessment of machinery with a view to replacing inefficient and outmoded parts and machinery in time without allowing the efficiency of the shipyard being impaired.

Conclusions:

1. Optimum procurement of durable assets is difficult due to uncertainties of future. Optimality is further lost as a result of

(i) Inadequate demand forcasting

(ii) Inadequate phasing out of equipment purchase

(iii) Inadequate investment analysis

(iv) Incorrect choice of technology

(v) Incorrect timing of purchase of assets

(vi) Expansion before stabilization

(vii) Inadequate planning of replacements.

This can therefore be a cause of serious loss of capacity.

2. Proper planning needs not only the application of the techniques of discounted cash flow, pay-back periods and other techniques of investment analysis but also requires innovative decisions.

Yes, but how? All the techniques suffer from the same defects

3. Large scale investments in Public sector have been generally suboptimal resulting in over capitalization, delays and underutilization of capacity.

3.4 Loss of Capacity Due to Down Rating of Equipment:

3.4.0. Downrating of equipment means a formal acceptance on the part of the management that an equipment will be able to give lesser output than was anticipated at the time of its purchase. Two main aspects require consideration - one belongs to the genuine defects and shortcomings discovered in the equipment and the other belongs to fixing work standard norms on the equipment.

1. Equipment Defects: The difference in the loss of capacity due to this item and that due to wrong procurement is in the fact that while in the latter, equipment is found to be to specification, the basic decision to buy the equipment and the timing of the purchase was defective. In the former case, the decision to buy the equipment based on manufacturers' claim was correct but the equipment didn't correspond to the specifications or claims of the manufacturer. Such cases lead to protracted correspondence, discussion with the suppliers and though sometimes, part of or entire machinery and plant has to be replacedby the suppliers, the fact remains that in majority of cases, the equipment is accepted with penalties to supplier. All the same, the equipment cannot deliver the promised output which has to be reworked and a lower output standard accepted. These factors are

very akin to 'procurement' ones and this point is not planned to be discussed in detail except for mentioning that all such cases need to be recorded carefully for applying correction at the earliest opportunity.

2. Fixing time standards: Fixing time standards involves many considerations and many vested interests. Downrating of equipment due to this factor is very severe, though the same can only be established through audit of time standards already fixed or work sampling techniques. Both these belong to sensitive Industrial relations field and as such very few studies have so far, been undertaken. In the following pages, a description has been given of the various forces acting during fixation of a true standard and the impact of the same on final time standard. Since time standard and labour efficiency finally determine the level of output from a given system of plant and equipment, these factors are of paramount importance in firms of the multi-product type when facilities can be used for a number of products and where time standards have to be fixed for each operation of every product on every load centre.

Unfortunately, managements fail to keep a record of the separate components of a time standard and finally it becomes impossible to perform a proper analysis. Managements are generally handicapped and times once fixed cannot be easily changed. The extent of deterioration has been witnessed by the author and same notes are given below, though, without authentification.

1. A worker on challenge and without the knowledge of management produced 26 pieces in a day when the time standard was such that he could earn the maximum incentive by making 8 pieces only in a day.

2. Time standard advised by a firm of machine tools while selling a particular machine tool for a particular job was only 20 hours but the time standard finally fixed in India was 100 hours for the same job.

3. In most of the public sector firms, the work sampling studies can easily show that actual work is done for only 30 percent of the time available.

4. In a foreign wheel manufacturing firm, one lathe was provided to turn about 60 wheels per day where as in India, about 6 machines have been provided for an output of 90 wheels or 25 percent of the rate as in foreign countries.

This particular aspect has hardly been discussed in literature but capacity losses due to this factor range from 20 to 300 percent. In part 3.4.1 an analysis of time standard is given. In part 3.4.2 a case study based on true standards and labour efficiency is given.

3.4.1 Allowed Times, Incentive Schemes and Capacity Utilization:

3.4.1.0. Introduction: Labour productivity in India is very low as compared to that in U.S.A., Europe or Japan. Figures at Table 3.3 are indicative.

Table 3.3 Productivity Comparisons

Country	Industry Production Unit Time Unit	Steel Ingot Man Year	Aluminium Ingot Man Year	Cement Tonne Man Year	Sugar Tonne Man Year
U.S.A.		218.0	200.0	1333.0	430.0
France		133.0	-	-	-
West Germany		122.0	-	909.0	-
Japan		92.0	75.0	1143.0	-
U.K.		87.0	-	1097.0	-
India		68.0	30.0	196.0	24.0
Canada		-	125.0	-	-
Porto Rico		-	-	-	392.0
Phillipines		-	-	-	119.0

Source: Productivity quarterly journal of National Productivity Council of India, Vol. XIII No.1, April - June 1972.

$$\text{Labour Productivity} = \frac{\text{Output in a given period}}{\text{Average employment of workers during that period}}$$

It is now agreed that Labour Productivity index is not a measure of labour effieiency alone but ~~y~~ is a composite index comprising of efficiency of labour as well as of capital, management and effectiveness of government policies and social and economic environment.

Average employment during a period say a year = $\frac{\Sigma x_i y_i}{1}$

where x_i = number of persons employed during period i

y_i = duration of period i

If x_1 workers are employed for 1 year

x_2 workers are employed for 3/4 year

x_3 workers are employed for 1/2 year

The average employment = $\frac{x_1 \times 1 + x_2 \times \frac{3}{4} + x_3 \times \frac{1}{2}}{1}$

The numerator is a total of man years spent for production.

Employment or presence of a person during a particular time is not indicative of the amount of effort applied by him and since time factor is important in calculating labour productivity, it is necessary to analyse the way time of a worker is employed in a given situation.

3.4.1.2. Time Balance: The following analysis pertains to a unit where incentive scheme is employed. For every job, an allowed time is fixed in such a manner that an average worker can do the job in much less time and earn a proportional incentive bonus on the time saved, or alternatively time allowed is the same as standard time but incentive bonus starts earlier than 100 percent efficiency. A more efficient worker can save more time and earn more incentive bonus.

Let Standard Allowed Time: Time so allowed on a job that a worker giving standard output can earn a definite amount of incentive bonus.

Suppose standard production is achieved by an average worker in time units $= t$

Standard time allowed $= t + 33\frac{1}{3}$ percent of t

$= \frac{4}{3}t$

If a worker gives standard output in t units then,

time saved $= \frac{4}{3}t - t = \frac{t}{3}$

and percentage incentive bonus $= (t/3)/t \times 100 = 33\frac{1}{3}$ percent.

For a worker giving standard output in time t_1, when $t_1 < t$

Time saved is greater than $t/3$ and hence,

Incentive Bonus is also more than $33\frac{1}{3}$ percent.

However, it shall be assumed here that the incentive scheme is such that no time is added for incentive bonus and since standard time allowed is based on equipment characteristics, bonus is payable on labour effieiency lower than 100 percent.

a. Standard Allowed Time (T_{ST}), Time Taken (T_{TT}), and Time Booked (T_{BT}).

$$T'_{ST} = K(T_m + T_{IE} + T_L) \tag{1}$$

$$T_{ST} = K(T_m + T_{IE} + T_L) + T_S + T_t \tag{2}$$

$$T_{TT} = T_{ST}/n \text{ or} \tag{3}$$

$$= T_{ST}/1+p$$

$$T_{BT} = T_{TT} + T_W \tag{4}$$

where, $T_{ST'}$ = Standard Allowed Time (desirable)

T_{ST} = Standard Allowed Time (actual)

T_m = Minimum permissible time required for operation and setting.

T_{IE} = Extra time allowed due to factors concerning Industrial Engineering department.

T_L = Extra time allowed due to labour factors.

T_S = Extra time allowed due to situational factors.

T_t = Extra time allowed due to temporary factors

K = A factor particular to the incentive scheme in use (assumed as 1 for this analysis)

T_{TT} = Time taken

n = Labour efficiency = $\dfrac{\text{Standard time allowed}}{\text{Time taken}}$

T_{BT} = Time booked in documents.

T_W = Time wasted to avoid showing efficiency more than ceiling efficiency.

p = percentage of incentive bonus earned.

(i) Minimum Time : $T_m = T_{m_1} + T_{m_2}$ (5)

where,

T_{m_1} = Necessary minimum time for machining or carrying our other operation and setting the job using the best practice known. This is a function of (equipment characteristics, supporting devices like cutting tools, dies, punches etc.

Ex. Machining time on a lathe is dependent on type of lathe, type of cutting tool used (H.S.S., Carbide). Setting time on a lathe is a function of automation incorporated in the machine tools, facilities given to operator etc.

T_{m_2} = Necessary minimum allowances for

1. Fatigue
2. Personal needs
3. Inspection and quality control.

This is a function of process characteristics, working conditions, plant layout and equipment characteristics.

(ii) Time due to Industrial Engineering:

$$T_{IE} = T_{IE_1} + T_{IE_2} \tag{5}$$

where,

T_{IE_1} = Extra time that has to be allowed as a result of the method of manufacture finalized being inefficient. These inefficiencies may be in terms of wrong working method, wrong routing, wrong selection of feeds, speeds and rates of operation and inclusion of unnecessary movements.

T_{IE_2} = Extra time allowed for using a manufacturing practice which is known to be inferior to the best practice available but is nevertheless used with a view to make use of the existing tools of operation and to prevent new investment in tools, gadgets etc.

(iii) T_L : Labour factors involved are as follows:

Labour efficiency at the start of the incentive scheme:
If the labour efficiency is very poor and incentive payments start at a higher efficiency, almost no worker will be able to get any incentive bonus. To avoid this situation, sometimes, the ideal average worker, kept in view for comparing the performance rating of different workers, is kept lower. This extra time allowed must be logged against this factor. Better practice is to keep the standard time unchanged and allow payment of incentive bonus at a lower level.

Sum total of T_{m_1}, T_{m_2}, T_{IE_1}, T_{IE_2} and T_L can be regarded as standard time that has to be the basis for fixing standard allowed time under the available circumstances. All the items can be calculated. It can be readily seen that there is scope for reducing or altogether eliminating T_{IE_1}, T_{IE_2} and T_L.

Since allowed time has to permit some incentive bonus even at this performance, the bonus included to be given is included by choosing a suitable factor K which can vary from 1 to 1.5 or 2.

Case 1: If K is more than 1.

Under the formula, incentive percentage $p = \dfrac{\text{Time allowed} - \text{Time taken}}{\text{Time taken} \times 100}$

If, for example, $K = 1.5$ and stand. time $= T_{ST}$

Then time allowed $= 1.5\ T_{ST}$.

If time taken by a worker is equal to T_{ST}.

Then percentage incentive earned by worker $= \frac{1.5\ T_{ST} - T_{ST}}{T_{ST}}$

$= 50$ percent.

Case 2: $K = 1$

In this case time allowed is fixed the same as the standard time. In such a case labour efficiency $= \frac{\text{Standard time}}{\text{Time taken}}$.

If standard time $= T_{ST}$

Time taken $= T_{TT} = T_{ST}$

Then labour efficiency $= \frac{T_{ST}}{T_{TT}} = 100$ percent.

Bonus can be paid according to the worker efficiency.

(iv) Situational Factors: Extra time has to be allowed due to situational factors.

$$T_S = T_{S_1} + T_{S_2}$$

where,

T_{S_1} = Sum total of times lost due to interruptions as during production many small factors can interrupt production for a very short time. Such instances are when:

(i) Power is off for a few minutes

(ii) Next job is awaited and a few minutes will lapse before it is available.

(iii) Crane out of order for a few minutes.

(iv) Crane driver not available on seat (personal needs)

(v) Tool checker not available.

(vi) Tool breaks during machining.

(vii) Some defect is found in raw material and equipment has to be switched off to take a decision.

(viii) Some instructions are required from the foreman.

Under many such situations, the time for the incident is so little that a worker cannot genuinely punch idle time card. However, in aggregate, the loss may be considerable.

Faced with this loss, the operator will tend to get this time (estimated) included in the standard allowed time. Time element, genuine to some extent is the first element of situation factor T_{S_1}.

T_{S_2} : Till now, there may be inefficiency from the enterprise point of view, the engagement of the operator to this work is almost complete. Under group pressure, union pressure, pressure of marginal and inefficient workers, pressure of men with belief of general exploitation of workers, the operator, sometimes, is forced to work less than the normal shift hours and hence challenge the standard time set earlier. This particular behaviour is a result of a family of complex factors and it is not easy to segregate the causative factors. However it can be seen that.

1. If less ~~worker~~ work is done during the shift, the work is most likely to lag behind schedule, and the possibility of booking workers on overtime increases.

2. In case, ~~of~~ standard allowed times are such that the total production of the month can be completed say in 70 percent period and the operator does not see any other work

ahead of him, then he will naturally fear that he will be booked idle. This will result in a loss to his total earnings. It is possible that the management may be able to provide alternative work to him but the operator, not wanting to take any chances, insists on the inadequacy of the standard times and tries his best to have this moved upwards.

3. If in the learning period of a new job, some extra time is taken by him and this fact is not given cognition, then the total time taken is considered as necessary and the operator pressure, to keep that extra time for the new job included, continues even though the operator has now become experienced enough.

4. Non-availability of guidance in the initial stages and presence of defects in tools, jigs, fixtures, set up etc. tend to inflate the time taken by the operator and since these times are not kept segregated causewise, the workers' claim the extra time to be genuine.

A weak management policy can give in under these pressures and standard time tends to become loose. These form a vicious circle and operator knowing about the earlier successes of their confrontation tend to challenge the standard time set by management more and more. However, as seen earlier, the blane for this situation lies with labour and management alike.

2.1.5. Temporary Addition to Allowed Time (T_t):

In addition to the previously mentioned elements of time, temporary additions to time are also necessary.

$$T_t = T_{t_1} + T_{t_2} + T_{t_3} + T_{t_4}$$

where T_{t_1} = Extra time allowed when a particular machine is temporarily under partial breakdown. This is the responsibility of maintenance department and is allowed only when certified by them.

Ex. 1 One tool head of planer not in working order.

2. One slide of boring machine not in working order.

3. Some speed ranges not effective.

4. Motor not taking load continuously.

T_{t_2} = Extra time allowed due to poor quality of incoming raw materials.

Ex. 1. Casting and forgings may have more machining allowance than designed.

2. Raw materials available are not standard.

Such times are authorised only by the inspectors posted in the shops.

T_{t_3} = Extra time allowed as a result of alternative process offered in the event of equipment and auxiliaries not being available for the original process.

Ex. Marking operation added when drilling jig not available.

T_{t_4} = Extra time allowed in the beginning because of the newness of the job, unfamiliarity of operator with the job etc.

Standard Time allowed is thus equal to -

$$T_{ST} = ((T_{m_1} + T_{m_2}) + (T_{IE_1} + T_{IE_2}) + T_L)K +$$

$$(T_{S_1} + T_{S_2}) + (T_{t_1} + T_{t_2} + T_{t_3} + T_{t_4})$$

b. Time Taken:

(i) If incentive scheme is such that, extra time is added to enable worker to earn incentive bonus, then

$$\text{Percentage bonus earned} = \frac{\text{Standard time allowed} - \text{Time taken}}{\text{Time taken}}$$

$$p = \frac{T_{ST} - T_{TT}}{T_{TT}}$$

$$pT_{TT} = T_{ST} - T_{TT}$$

$$T_{TT} = \frac{T_{ST}}{1 + p}$$

(ii) Otherwise worker's efficiency $\eta = \dfrac{\text{Standard time}}{\text{Time taken}}$

$$= \frac{T_{ST}}{T_{TT}}$$

or Time Taken $T_{TT} = T_{ST}/n$

c. Documented Time: In the documents, i.e., job card, route card etc., the time taken for any job is recorded either manually or through clock punching. Even if an operator finished his job at 13.00 hours, but clocks the finish at 14.00 hours, the time taken in documents is 1 hour more than actual time taken and for all practical purposes and calculating bonus percentage or capacity calculations, the documented time is the only valid time.

When does a worker do this i.e. punch his job card with a time lag after actually completing the job ?

Incentive Ceiling and Documented Time:

Suppose the ceiling of incentive bonus earnings of a worker

$= p$ percent

$$\frac{T_{ST} - T_{TT}}{T_{TT}} = p$$

or,

$$T_{TT} = \frac{T_{ST}}{1 + p'}$$

If p' is more than the ceiling percent p, it serves no purpose for the worker to do the work in time T_{TT}. Even if he does that, he will not punch his card out for that job. He will do it only after T_{BT} which he calculates to be equal to $T_{ST}/(1+p)$

$T_{BT} > T_{TT}$ if $p < p'$

where T_{BT} = Documented time.

$T_{BT} - T_{TT}$ Extra time taken on account of ceiling on incentive bonus.

If standard time is set very meticulously, the $T_{BT} - T_{TT}$ will tend towards zero.

Time Taken $= T_{ST} / (1+p')$

when $p' < p$ (ceiling).

$$T_{TT} = \frac{T_{ST}}{1 + p} + \left(\frac{T_{ST}}{1+p} - \frac{T_{ST}}{1 + p} \right)$$

$$= \frac{T_{ST}}{1 + p} + \left(\frac{T_{ST}}{1+p'} - \frac{T_{ST}}{1+p} \right)$$

where

$$\frac{T_{ST}}{1+p'} - \frac{T_{ST}}{1+p}$$ = extra time taken on account of worker efficiency being less then the ceiling provided

when $p' > p$ (ceiling)

$$T_{TT} = T_{ST}/(1+p)$$

$$= T_{ST}/1+p + \left(\frac{T_{ST}}{1+p} - \frac{T_{ST}}{1+p'} \right)$$

$$= \frac{T_{ST}}{1+p'} + \left(\frac{T_{ST}}{1+p} - \frac{T_{ST}}{1+p'} \right)$$

where,

$$\frac{T_{ST}}{1+p} - \frac{T_{ST}}{1+p'}$$ = extra time taken in documents as a result of ceiling on incentive earnings.

Similarly if worker efficiency is calculated with $k = 1$

and maximum efficiency permitted $= n$.

Suppose actual efficiency $= n' > n$

$$T_{TT} = T_{ST}/n'$$

but time booked $T_{BT} = T_{ST}/n$.

Time taken to rework rejected components Tr. When components are rejected on account of workers' fault or on account of the fault traceable to defective raw material, machine, instruments, drawing, or method, the components have to be remade totally or repaired. This takes extra time (Tr).

d. Time Available:

$$T_A = T_{AB} + T_{ID} + T_{BT}$$

Where,

T_{AB} = Total time during which operators are absent

T_{ID} = Total time during which workers though present and forced to be idle.

T_{BT} = Time booked.

T_A = Total time available.

The total time balance is schematically presented in Fig.3.2 summarizing:

$$T'_{ST} = K(T_{m_1} + T_{m_2} + T_{1E_1} + T_{1E_2} + T_L)$$

$$T_{ST} = T_{ST'} + (T_{t_1} + T_{t_2} + T_{t_3} + T_{t_4}) + (T_{S_1} + T_{S_2})$$

$$T_{TT} = T_{ST}/(1+p) + Tr$$

or

$$T_{ST}/n + Tr$$

$$T_{BT} = T_{TT} + T_W$$

$$T_A = T_{BT} + A_{AB} + T_{ID}.$$

3.4.1.3. Capacity Utilization Improvements:

Since utilization is inversely proportional to the time taken by various operators for various operations, improvements can be brought about by reducing the time taken by the operator and increasing the time available to him. This can be achieved

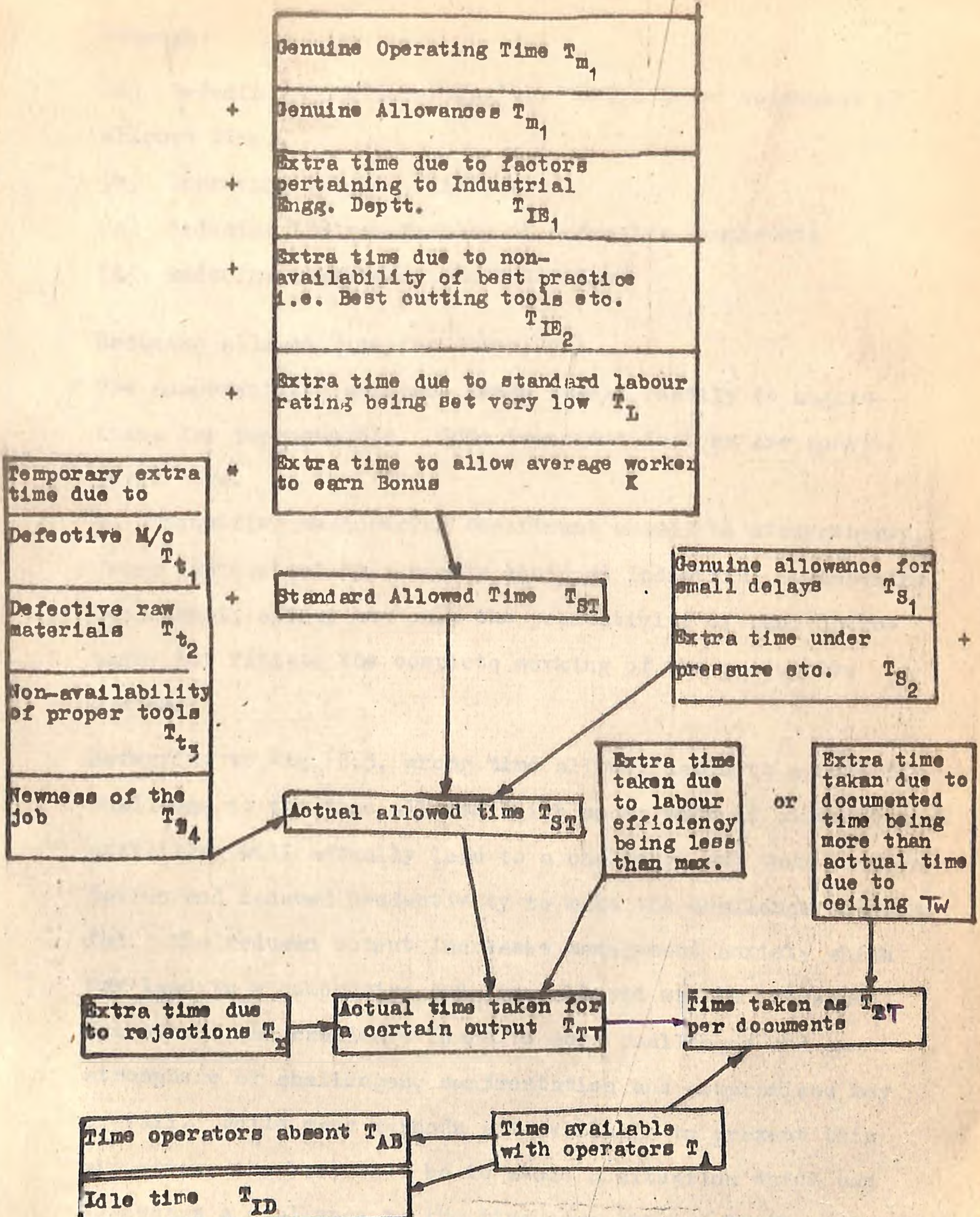


Fig 3.2

Time Balance.

through:

(a) Reducing and eliminating the 'extra time' component of allowed time.

(b) Improving labour efficiency.

(c) Reducing the manufacture of defective components

(d) Reducing absenteeism and idle time.

Reducing Allowed Time for Given Job:

The componentwise analysis lends itself readily to suggestions for improvements. Some important factors are considered here.

1. Industrial Engineering Department should be strengthened. Wrong timings set by a poorly equipped Industrial Engineering Department, affect not only the productivity of that operation, but vitiate the complete working of the productive system.

Referring to Fig. 3.3, wrong time allowed leads to a need for challenge to the time allowed which under most of circumstances prevailing will actually lead to a challenge and then confrontation and reduced productivity to make the challenge successful. The reduced output increases management anxiety which may lead to a compromise and time allowed may be increased. Success of one challenge leads to more challenges and an atmosphere of challenges, confrontation and compromises may prevail. While many methods are available to prevent this situation, the best will be to avoid a situation which can encourage a challenge to the time once allowed by the Industrial Engineering department.

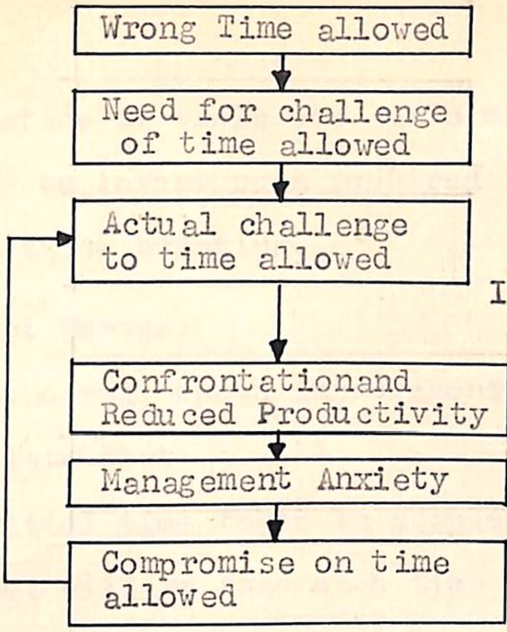
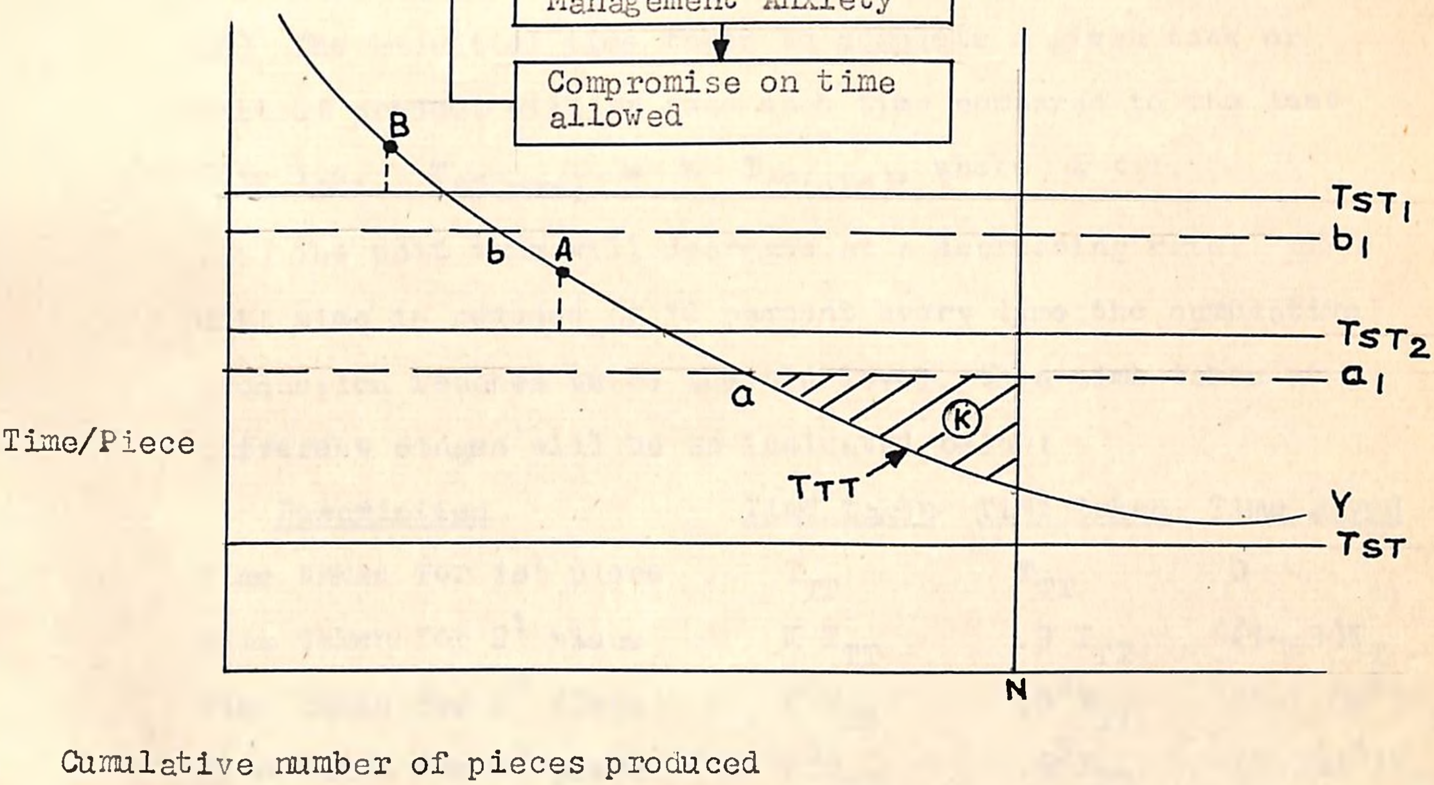


Fig. 3.3

Ill effects of wrong Allowed time.



K :- Loss due to ceiling on incentive at stage A
XY :- improvement curve - represents actual time taken/piece
bb_1 :- efficiency ceiling w.r.t. standard allowed time T_sT_1
aa_1 :- " " " " " " T_sT_2
T_sT :- Standard time unaffected by situational or other factors
T_sT_1 :- Actual time allowed at stage B.
T_sT_2 :- Actual time allowed at stage A.

Fig. 3.4

Effect of ceiling on incentives and introduction of incentive scheme at too early a stage.

1.1 Best practice of tools etc. is a management decision which is based on investments required for better tools and implements to those existing.

2. Improvement Curves:

According to the well known improvement function, it is fair to stipulate that

(i) The amount of time taken to complete a given task or unit of product will be less each time compared to the last time i.e. $T_{TT(new)} = K\ T_{TT(old)}$, where $K < 1$.

(ii) The unit time will decrease at a decreasing rate. If unit time is reduced by 10 percent every time the cumulative production reaches twice the old level, then time taken at different stages will be as indicated below:

Description	Time taken	Time taken	Time saved
Time taken for 1st piece	T_{TT}	T_{TT}	0
Time taken for 2^1 piece	$K\ T_{TT}$	$.9\ T_{TT}$	$(1-.9)T_T$
Time taken for 2^2 piece	$K^2 T_{TT}$	$.9^2 T_{TT}$	$(1-(.09^2)T_{TT}$
Time taken for 2^3 piece	$K^3 T_{TT}$	$.9^3 T_{TT}$	$(1-.09^3)T_{TT}$
Time taken for 2^n piece	$K^n T_{TT}$	$.9^n T_{TT}$	$(1-.9^n)T_{TT}$

(iii) The reduction in unit time will follow a specific predictable pattern such as an exponential function.

From the above mentioned characteristics it can be seen that, 'Allowed time' should not be fixed in too early a stage of operation and ceiling on incentive should be fixed with care. Following explanation clarifies the matter further.

a. Effect of Starting incentive schemes at too early a stage.

In relation to figure 3.4, XY is the expected improvement curve. In the initial stages, say B, the time taken by the workers is very high vis-a-vis the ideal standard time calculated for the job, say, T_{ST}. Since improvements take time, management in its hurry to improve production rate, may consider introducing an incentive scheme at the stage B. Since with respect to standard time T_{ST}, time taken is high and chances of the worker getting incentive bonus is low, there will be tremendous pressure for revising T_{ST} upwards to T_{ST_1}, both by workers and managers, and this may be actually done. T_{ST_1} will be such that working to timing at stage B, some incentive bonus will be payable to the worker. If the management waits and introduces the scheme at stage A, then upward revision of standard time T_{ST} will be less, i.e. only upto T_{S_2}.

b. Ceiling on Incentives:

Referring again to Fig. 3.4, if there was no ceiling on incentives earned by the worker or the efficiency shown by the worker, then, even if allowed time was fixed much higher than desired, there will be no difference between time taken and time booked in documents. This will inflate the individual worker's incentive earning but there will be no loss of production. If a a_1 is the ceiling for stage A then area below a a_1 upto the actual time taken curve is the cumulative loss of time upto a production of n pieces because even though time taken reduces, booked time remains equivalent to ceiling a a_1. Similarly for stage B. Area below b b_1 is the cumulative time loss.

Logic of the ceiling has been advanced by behavioural scientists who wanted the worker to be protected from his own greed. Workers' health and that of the equipment and organization were the concern of such theorists. This logic is successful where allowed and standard times are fixed without fault and earning a higher percentage of incentive bonus requires a very high effort on the part of the worker. Where the allowed times are slack and bonus unto the ceiling can be earned without undue effort, the ceiling fails to serve any purpose.

Overtime:

Overtime beyond 48 hours a week and 8 hours a day is payable at double the rate. If n pieces are to be produced in a day and normal workers efficiency yields only kn, then balance of n(1-k) may have to be

(i) produced in overtime

(ii) produced through improvement in workers efficiency

(iii) produced by reducing allowed time by reducing and eliminating many useless components of the same as seen earlier.

Overtime can prove lucrative in the short run but there are many ills of working overtime. Inefficient and long working hours tend to sap the energy out of the workers and without their realization make them progressively tired, and inefficient. Moreover loss of overtime when not required is a source of serious discontentment. Overtime payments not only increase the wage bill, they also tend to increase other overhead costs like maintenance, lighting, supervision etc. Overtime can act as a brake towards improvement of productivity.

3.4 Conclusions:

1. Causes of poor labour productivity are not always traceable to poor labour efficiency.

2. Allowed time can be shown to have many distinct components. Some of which are traceable directly to the faults of Industrial Engineering department, management policy, maintenance and other allied departments. Some components are a result of situation existing at that point of time and only a few can be attributed directly to labour inefficiency and aggressiveness.

3. Capacity utilization improvements are not possible unless all such components are properly understood and appropriate action initiated at the proper level and department.

4. Responsibility of Industrial Engineering department is specifically significant. Management policy of introducing the allowed times at too early a staff, the ceiling on incentive earnings and working of overtime can also have marked, permanent and crippling effects on productivity.

3.4.2. Capacity Utilization Improvement in a Machinery Manufacturing Plant - A case study:

1. Introduction and Problem Statement:

Most of the times underutilization of capacity is either not evident or is overlooked particularly when the enterprise is making profits despite the underutilization. However, it is not difficult to see that such a situation cannot last very long. Moreover, the factors affecting utilization of capacity are sometimes difficult to identify and at other times are difficult to tackle with, even when identified.

In this paper an attempt has been made, through a case study, to emphasize the need for better utilization, to estimate the extent of underutilization and the main factors responsible for the same and finally to suggest the necessary course of action for improvement.

1.1 Demand for Product:

The industry concerned with manufacturing this type of machinery is well established and can successfully manufacture, install and commission plants of the capacity required. The industry is also in a position to export. According to the sectoral report on science and technology plan for Heavy Engineering, seven units are engaged in the manufacture of this type of machinery (70).

According to annual survey of Industries 1968 Vol. IX, 26 firms are engaged in the production of this machinery and its parts (28).

DGTD in 1977 collected information for 19 such firms. It is thus seen that there is a fairly wide base of Industrial units and this item can be considered to be enjoying a competitive market. Production figures for the entire Industry are indicated in Table 3.4.

Table 3.4 Production and Capacity Utilization of Industry X.

Year	Capacity target in Rs.worth	Production in Rs. worth	Capacity Utilization
1971-72	-	17.9 crores	-
1972-73	-	19.2 crores	-
1973-74	-	20.0 crores	-
1974-75	28.15 crores	27.4 crores	97 percent
1975-76	-	31.0 crores	-
1976-77	36.00 crores	39.83 crores	110 percent

These figures are not modified for the rise in price but even then, the increasing trend in production of this item of machinery is evident. Guidelines for Industries (1976-77) (19) has indicated this: 'There is substantial scope for expansion and diversification of existing units'.

The firm itself had sufficient orders. Various manufacturing load centres revealed orders pending for a period of 6 months to 2 years. The firm was also accepting orders other than the main items of machinery and plant.

1.2 Existing Capacity Utilization for the Industry:
It can be seen from Table 3.4 that the Industry as a whole considers its performance satisfactory. However, the measure of capacity utilization is not satisfactory due to the following reasons.

1. Capacity indicated was only a target.
2. Money value is not a satisfactory measure of capacity.

3. Production figures include value of purchased components and hence don't in fact show the value added by the firms.

1.3 Need for Increased Production:

Firm was working in two shifts. Order book was full and there was a need to increase production to meet the promised delivery dates. In the absence of this, there was a danger of extending delivery dates further and there was a chance of loosing some orders. In the absence of this there was a serious apprehension for not expanding working capacity as the delivery dates promised were bound to get stretched and a number of orders could get lost particularly as the competition in this line was growing.

1.4 Need for Better Profitability:

Detailed records were checked. It was found that the company buys its castings and forgings but welding and machining facilities are available. Weldments, castings and forgings are machined and these finished components as such or as assemblies are sent to the site where components ordered on other subcontractors and manufacturers of special equipment are also received. Erection and commissioning of the equipment is also the responsibility of the firm.

A discussion with the authorities revealed the approximate value wise and profit wise distribution as indicated in Table 3.5.

Table 3.5 Components of Assembled Plants.

Item	Percentage of sale value	Percentage of profits on sale value of the component
Purchased components	40 percent	15 percent
Manufactured components	40 percent	-
Erection	20 percent	15 percent

It is thus clear that manufacturing division is not making any profits.

It was further clear that profits on purchased components and erection can partly be justified as coordination effort spent by the firm but also can be looked down upon partly as Middleman's profit on activities which are inflationery in character and hardly productive in nature. As a result, Engineering Projects Ltd. and National Heavy Engineering Corporation (two public sector concerns) have started quoting for such plants in addition to the existing competition and after obtaining the orders, are reordering the components and erection on established manufacturers, the expectation being that Middleman's profit ean be reduced. Whether they will be successful or not, the problem for the firm under consideration is quite clear and can be stated as follows:

1.5 Problem:

With many suppliers eager to swallow the profits attributed to middlemen, there was more consciousness to have a close look at the manufacturing activities as it was felt that earning profits on your own activities was going to be vital in future. This is a good sign for the economy as indirectly it means there is more cost consciousness and more need to reduce costs to improve profitability.

2.0 Definitions and Nomenclature:

(1) Monthly available capacity in Man-m/c hours	=	Total man-m/c hours available on the load centre - (hours lost through absenteeism and through genuine idleness, on account of breakdown of machines, etc).
		included (9)
(2) Total man-m/c hours available / month	=	Total number of staff employed on a load centre x 8 (number of hours per shift) x number of working days per month.
(3) Availability percentage	=	(1)/(2) x 100
(4) Total production in standard hours at a particular load centre	=	Σ Total production of one component(as certified by inspection) through that load centre x number of standard hours allowed for that job on that load centre.
(5) Average efficiency of workers	=	(4) / (1) x 100
(6) Capacity utilization	=	Average worker efficiency x monthly available capacity
	=	Average worker n x availability percentage/100
	=	(5) x (3)

3. Alternative Solutions With Reference to the Six Stage Model as Indicated at Fig. 3.1 :-

Solution Strategy	Expected consequence
1. Employ additional workers in third shift.	Improvement of planned capacity vis-a-vis theoretically rated capacity i.e. bridging of the gap between C and B.
2. Permit over time to workers	Improvement of budgeted capacity vis-a-vis the planned capacity i.e. bridging of the gap between C and D.
3. Off load some items to trade	Improvement of budgeted capacity vis-a-vis the planned capacity, i.e. bridging of gap between C and D.
4. Improve labour efficiency	Improvement of theoretical rated capacity to bring it nearer the installed capacity i.e. bridging of the gap between A and B.
5. Improve percentage availability of time.	i.e. bridging of the gap between budgeted capacity and actual capacity.

Management's preference was observed to be in the following order:

5,4,2,3,1.

3.1 Evaluation of Alternatives:

Additional employment was the last priority in view of the following:

1. There was expectation that labour efficiency will

improve in the near future.

2. That present order book will be sustained for a few years, was not considered a certainty particularly in view of growing competition from Engineering. Project Ltd., and National Heavy Engineering Corporation Ltd.,

3. Third shift working was not in vogue in the region.

4. Third shift working was considered costly, inefficient and a headache.

5. Extra labour force was likely to add to labour trouble.

Off loading or subcontracting was next to last priority because

1. There was dearth of reliable subcontractors.

2. There was expectation of improving labour efficiency in the near future.

Availability percentage was found to be reasonable and did not provide much scope for improvement. On the face of it labour efficiency was considered fairly low and it was decided to, further, investigate the same.

4. Analysis:

The shop was divided into a number of cost centres. Each cost centre had a number of load centres. Table 3.6, 3.7 and 3.8 indicate the relevant parameters of analysis.

Table 3.6 Cost Centre No.1 - Load Details

(Details for December 1977)

Monthly available capacity in	Load Centres			
	Lathe	Horizontal boring	Vertical boring	Slotting
Man-m/c hours	15574	10996	3866	4035
Average efficiency of working in percent	57.9	60.3	52.0	48.5
Load in actual hours per month	21251	11409	5024	4876
Surplus/(Deficit)	(5677)	(413)	(1155)	(841)
Percentage of surplus/ deficit to available capacity	-36.5 percent	-3.7 percent	-30 percent	-20.8 percent

Table 3.7 Cost Centre No. 2 - Load details

(Details for December 1977)

Monthly available capacity in	Load Centres			
	Lathe	Vertical boring	Horizontal boring	Shaper
Man m/c hours	7809	7846	3482	5479
Average efficiency of working in percent	62.0	51.0	67.5	54.8
Load in actual man hours/month	7127	10557	6291	70
Surplus/(Deficit)	681	(2611)	(2809)	5400
Percentage of surplus/ deficit to available capacity	+ 8 percent	-33.0 percent	-80.0 percent	+98.1 percent

Table 3.8 Cost Centre No. 3 - Load Details

(Details for December 1977)

Monthly available capacity in	Lathe	Vertical Boring	Horizontal Boring	Planner	Shaper	Slotter	Hori. Milling
Man-m/c hours	51537	1698	3445	7125	1703	1869	20758
Average efficiency of working in percentage	54.0	32.5	41.0	41.5	47.0	55.0	53.6
Load in actual Man hours/month	41091	2064	3158	7455	2691	3180	35935
Surplus/(Deficit)	10445	(366)	287	(330)	(938)	(1311)	(15177
Percentage of surplus/ deficit to available capacity	-	-21.6	-	-4.6	-55.0	-70.0	-73.0

4.2 (a) Payments to workers during December 1977 under various heads in various shops were examined and are given in Table 3.9.

Table 3.9 Direct Wages, Overtime time and Incentive payment in Various Shops.

	Shops			Total
	HMS	LMS	Fitting	
Direct wages in Rs.	24408	20030	6097	79502
Overtime Rs.	22768	8610	4601	84040
Incentive hours Rs.	2370	1200	713	1390

HMS - Heavy Machineshop

LMS - Light Machine shop.

(b) (i) Under Incentive Scheme:

If standard hours of all jobs done during the month. = K

Actual hours taken = K'

Then efficiency of labour = K/K'

There was a point system and extra incentive payments were made to staff if efficiency was beyond 50 percent.

(ii) Impact of improvement in labour efficiency:

Suppose available m/c hours = A and Labour efficiency = 1/K'

Production = A/K'

If efficiency increases by 10 percent then

$$K'_{new} = K'/1.1$$

$$\text{New Production} = \frac{A \times 1.1}{K'} = \text{10 percent more than previous production.}$$

(c) It can be seen that incentive earning was very low compared to overtime payment and hence there was hardly any motivation to improve efficiency as:

More efficiency means more production and less need of overtime. Since this is leading to less payment to the same worker who is improving efficiency, continuation of overtime means continuation of less efficiency of working. Overtime payment as per factory act regulations is twice that of normal pay and OT payments are therefore more lucrative than payments of incentive earned through better working efficiency.

(d) In case of OT working, total number of hours for which machines works are more than normal working hours and to that extent utilization of equipment is more even though the capability utilization is low. There appear to be two alternatives:

(i) More hours worked at less efficiency with extra hours paid at overtime rate and less efficiency penalised by less incentive payment.

(ii) Less hours worked at more efficiency with more efficiency rewarded by more incentive payment and no need to pay overtime.

Answer is clearly that number (ii) alternative is better. When efficiency is uniformly low and OT is paid to a few, overall result is low production. In course of time, dysfunctional view must prevail even at load centres where load situation is comfortable, effort will be made to bring about a situation where overtime can be demanded and obviously sanctioned if the authorities are pursuing a policy of overtime working to meet extra load.

(e) On further questioning the management, it came about that over time was necessary because orders were piling up and efficiency of workers was the same for last two years i.e. low and in their view if efficiency could be improved, over time could be curtailed. Situation prevailing can be depicted as at Fig. 3.5.

Existence of more pending orders leads to

(i) Desire for more labour efficiency by management.

(ii) Desire for more overtime by labour and superiors and tendancy of management to sanction the same.

However, in view of ineffective management action labour efficiency remains the same and this reinforces demand and justification for over time and this in turn reinforces continued low labour efficiency.

More the orders more the desire of management to have better labour efficiency and better efficiency results if action by management is effective.

Better efficiency of workers leads to less demand and less actual booking of overtime which in turn prompts still better efficiency on the part of worker to compensate for the loss of earning due to less over time. (Fig 3.6)

It is obvious that management action can either make the circle a vicious one or an extremely profitable one.

(f) To further analyse the reasons of low labour efficiency the following features needed examination:

(i) Quality of Standard Times Fixed:

In almost all the load centres, while average efficiency was low, efficiency of individual workers was more than 100 also. This proved the attainability of the standard times.

It was also found that the standard times were borrowed

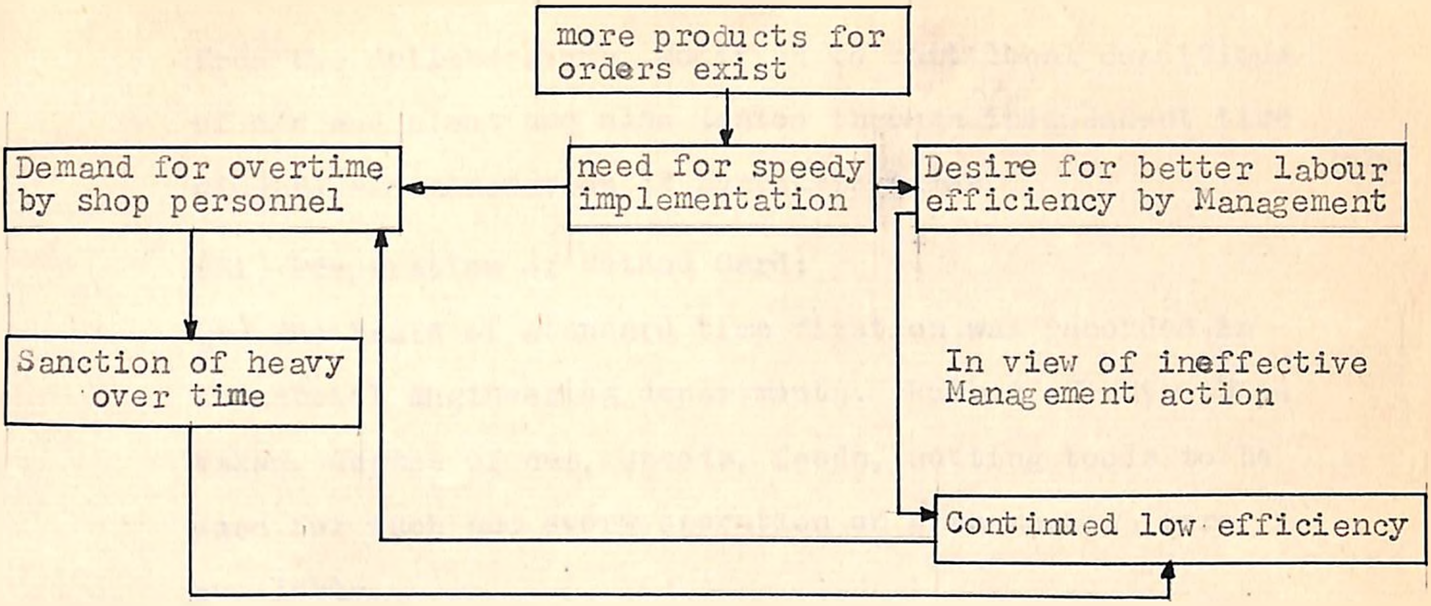


Fig. 3.5

Ineffective Management action & overtime and labour efficiency

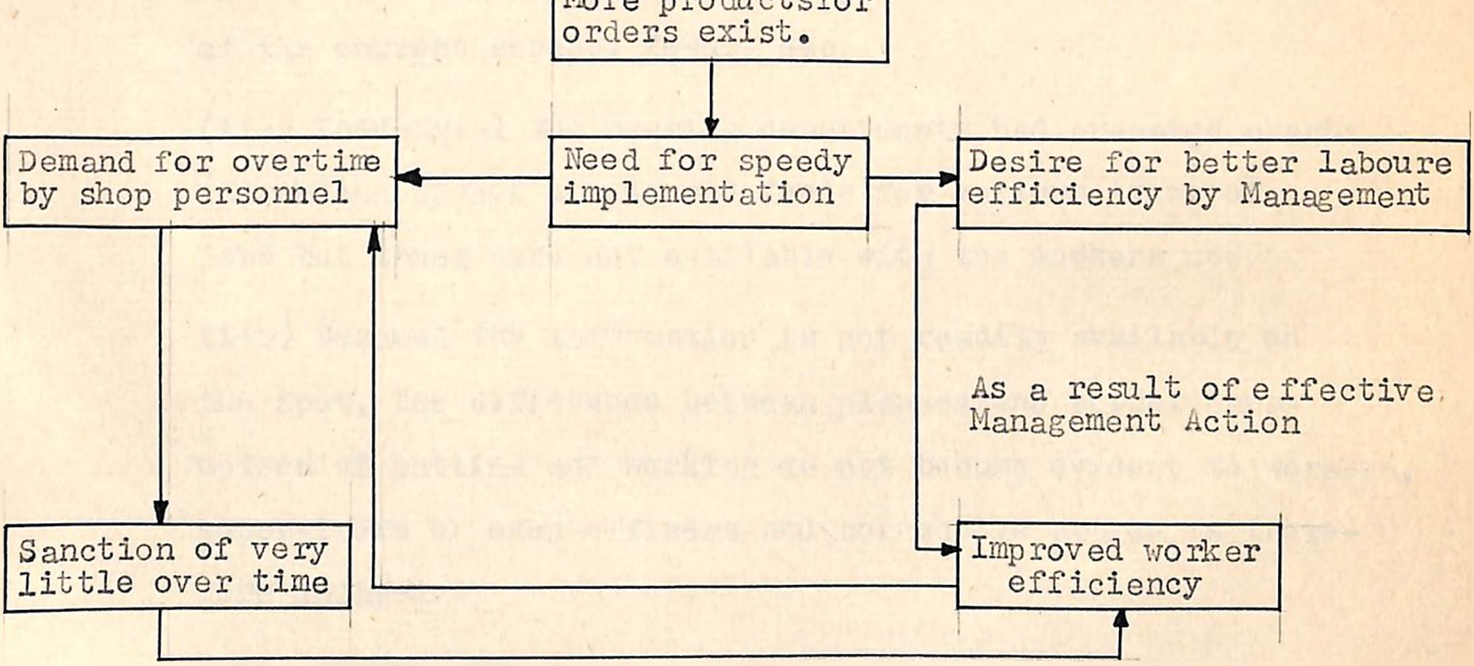


Fig. 3.6

Effective Management action and overtime & Labour efficiency from the collaborators, modified to suit local conditions of m/c and plant and also tested through independent time studies and generation of synthetic times.

(ii) Preparation of Method Card:

(i) The basis of standard time fixation was recorded in Industrial Engineering departments. Number of cuts to be taken, depths of cut, speeds, feeds, cutting tools to be used for each and every operation on each machine were available.

(ii) However, it was seen that the actual practice differed widely from the planned one. It was not evident that this was deliberately done. Most of the workers were not aware of the correct speeds, feeds, etc.

(iia) Industrial Engineering departments had prepared charts indicating proper speeds and feeds for various types of jobs but these were not available with the workers now.

(iib) Because the information is not readily available on the spot, the difference between planned and actual parameters of cutting and working do not become evident to workers, supervisors or even officers and corrective action is therefore delayed.

(iii) Setting Time:

(a) Setting procedures were found to be very crude. No standard components and devices were available with workers. T-Bolts, packing pieces, nuts etc. were also not available in adequate quantities. Setting took lot more time because of this.

(b) Setting times, on the other hand have been kept as indicated by collaborators and according to memories of those who had been to the collaborators' works, the setting fixtures for various operations were in use there. It was therefore a clear anamoly in as much as under the given conditions, a worker was Bound to take more time for setting.

(c) The setting time was more significant because of jobbing character of the shop and difficulty of standardising the setting procedure, setting fixtures, etc.

(iv) Cutting Tools and Accessories:

(a) Cutting tool designs are not carried out for all operations. Standard tools and accessories were used and some of these were found to be inadequate for the job. Thin and long boring bars were used to cut small bores at very reduced depth of out and speed.

(g) Availability of Crane and Other Facilities:

Many times the operators were waiting for the crane. But this was not reflected under that heading because while the operator waited for the crane, he did not care to punch his card off and punch in the idle time card. Similar position happened for many other facilities like waiting for machine (under maintenance), orders (jobs not available) etc. Supervisors being directly responsible for this component, discouraged workers to book these components of idle time.

It was thus apparent that low worker efficiency could be due to

(i) Excessive setting time on machine due to lack of proper fixtures and standard accessories.

(ii) Due to employment of poor cutting speeds; feeds and depth of cut due to lack of knowledge on the part of the worker and due to nonavailability of ready made information to worker from the Industrial Engineering Department.

(iii) Due to idleness as on account of crane not available. (Reporting was cross-checked and a number of discrepancies were noticed between real and booked idle time).

(iv) Due to worker malingering and wasting time.

(v) Due to overtime rate being more attractive than incentive rate.

(vi) Due to some workers being untrained and really slow.

Though a thorough work sampling was not ordered, enough evidence was available to prove the existence of the above factors.

5. Corrective Action, Recommendation and Acceptance After Discussion:

(i) Workers Education: It was decided that for each operation on each job on each machine a blue print will be prepared giving the outline of the concerned portion of the job, giving tolerances required and giving the details of number of cuts, speeds, feed, cutting tools required, setting time, etc. etc. Worker was duty bound to use these parameters and a surprise check could enable comparison of actual with blue print. Each worker was to be given a booklet containing information for all the jobs with which he was concerned.

(ii) Better Loading, Unloading and Setting Facilities: The workers were to be provided with standard clamps, bolts, spacers, supports and where necessary fixtures. Standard times for setting were to be time studied and fixtures improved.

(iii) New Boring Bars, Cutting Tools: Better cutting tools and accessories were to be designed for critical operations.

(iv) New Incentive Scheme: (a) Even though new fixtures, setting arrangements were to be provided, standard time was not proposed to be revised. Workers were to be encouraged to improve their efficiency and earn more money as incentive payment.

(b) After a certain efficiency, the rate of payment per point was to be given a jump, e.g. rate of incentive payment open to suddenly jump to a higher value at 75 percent or 80 percent value thus prompting workers to achieve a higher rate which was now easy in view of the previous methods. A second jump was to be given at 90 percent and so on.

(v) Overtime was to be progressively brought down:

5.1 2nd Stage of Improvement:

The following techniques were recommended to be applied.

(i) Group Technology: The cost centres were designed a long time ago and the relevance of grouping certain machines in one particular cost centre was at best based on Product Layout Principle i.e. one component should be completed within one cost centre as far as possible. This principle has long since been recognised as leading to better control of Production. However, since the jobs keep on changing and the number to be produced is not large it is necessary to allow considerable and costly set up times between successive jobs. The only advantage of control for final product is not enough. It is necessary to study the jobs according to processes and details of working and group jobs on a set of machines so as to enable the same set up to be used for various jobs with either no change or minimum change.

(ii) Identifying the Marginal Operator: Even with the action taken as specified in the first part of the project, some workers will be found to be slow in picking up or deliberately trying to appear slow for many reasons which include laziness, union pressure, lack of confidence, wrong habits and other personnel reasons etc. This will be the right time to study these persons carefully and study the underlying causes for this behaviour. There should normally be very few such staff.

(iii) Operational Research Techniques: Better scheduling and sequencing of jobs through well laid out programmes and principles will form the next step. When defects can be noticed without trouble, the same must be recognised first and sophisticated analysis done later. However, optimization for the entire system is only possible through system analysis and that requires increased use of OR techniques. Linear programming and in this case 'PERT' analysis from raw material to the erection, and many other techniques can be applied usefully.

CONCLUSION:

(1) This was a factory with well laid out system of working based on time standards, cost standards and efficiency consciousness.

(1.2) It was only because of this base that a study could be made quickly and shortcomings pinpointed.

(2) Scope of improvement is naturally tremendous. The direction of effort for the best results has to be determined with careful analysis of facts. Choice of technique should be determined carefully.

(3) In Indian conditions, technological constraints, lack of attention to working details can form a very important cause of underutilization of capacity and low productivity.

(4) Expansion through more shift working will be and should be inhibited as long as the efficiency of working is poor and in case this is ignored, the expansion will drift the enterprise towards sickness.

(5) Overtime working, so usually resorted to in India is suicidal for the plant particularly in times of slight recession with its adverse impact on labour.

3.5 Loss of Capacity due to Working Less Number of Shifts:
It has been shown in Chapter 1 and earlier part of this chapter that increase in production of pieces in a given period leads to reduction in the cost/piece and profits increase till the marginal cost of production equals the prevailing price in the case of a competitive market and that the marginal revenue in the case of monopolistic competition and other types of market conditions.

Yes, a number of Industries work below the optimum level and reasons have been partly listed in the earlier part of this chapter. An informal enquiry from a number of top executives reveals the following as the major reasons:

(1) Demand is uncertain and present day expansion can become a serious liability tomorrow when the demand recedes.

(2) Labour group pressure will increase if more people are employed.

(3) With the pressure of demand and that of requirement of more production, more production can be obtained by increasing the capability of the present equipment through improvement of methods and also by increasing working efficiency of workers through incentives, training and better control. In a way, increasing production through increasing efficiency of working (first two components of capacity loss discussed earlier) is in direct competition to increasing production though working more time.

(4) Problems of power shortage and some times raw material shortage.

(5) Working in night shifts is unnatural and against social welfare.

Taking the points in reverse order, more employment at less comfort is preferable to comfortable and natural working for some and unemployment for others. There hardly seems to be any doubt as to which alternative will yield maximum social welfare. Moreover naturalness is a matter of habit. Today power shortage is forcing a lot of work in night shift as a matter of extreme necessity as more power with less voltage fluctuation is available in the night.

In some areas power shortage is not acute but even here, the working is restricted to less than three shifts. Fig. 3.7 and 3.8 exhibit a negative working and negative accelerator effect is noticed. Fig. 3.7 - less availability of power leads to less production of capital goods which in turn leads to slower rate of construction of power station, this further aggravating the power availability situation. In Fig. 3.8, it can be seen that availability of less working capital with a firm A can lead to less purchases by A thus affecting production plans of other firms including it and so on, thus making its effect felt over a wide range of the industry. An effort to improve utilization in some crucial sectors can increase production at reduced cost of production, some of which can be passed on to consumers who can accelerate their utilization rates with this advantage and some can be used to improve the surplus of the firm for further improvement of production levels and working more shifts.

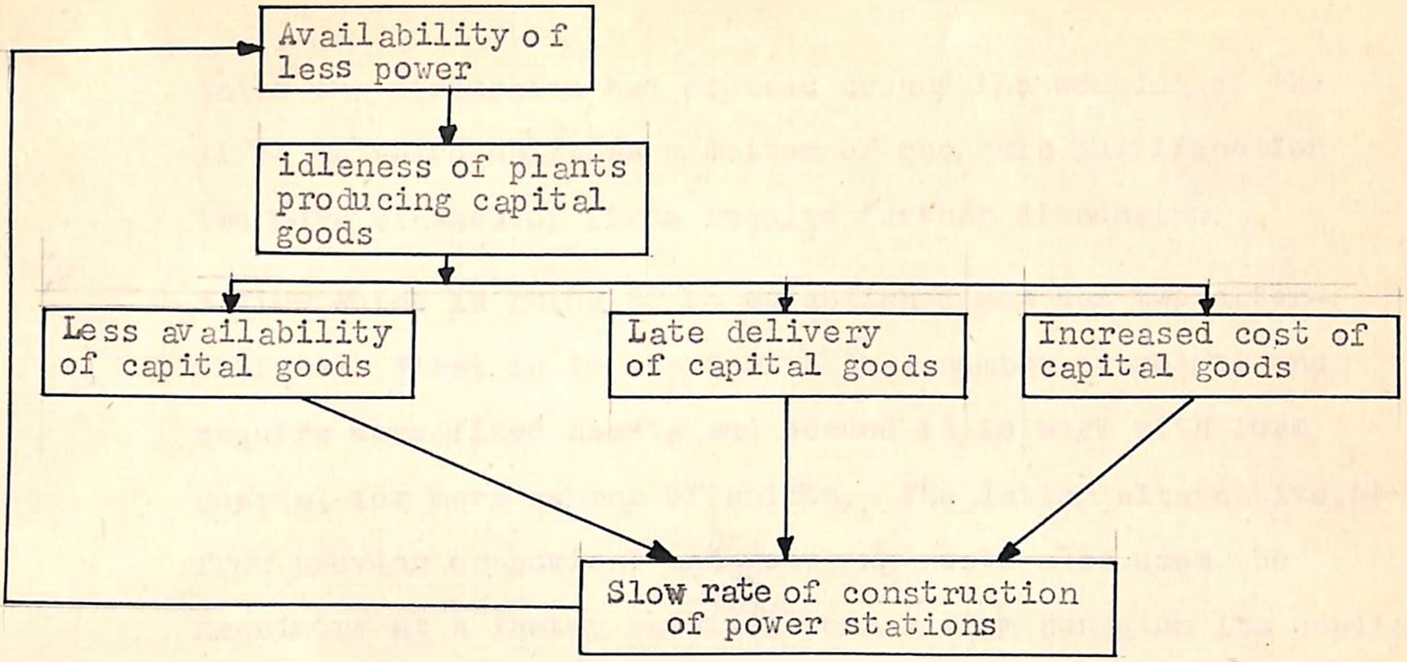


Fig. 3.7

Ill effects of power shortage

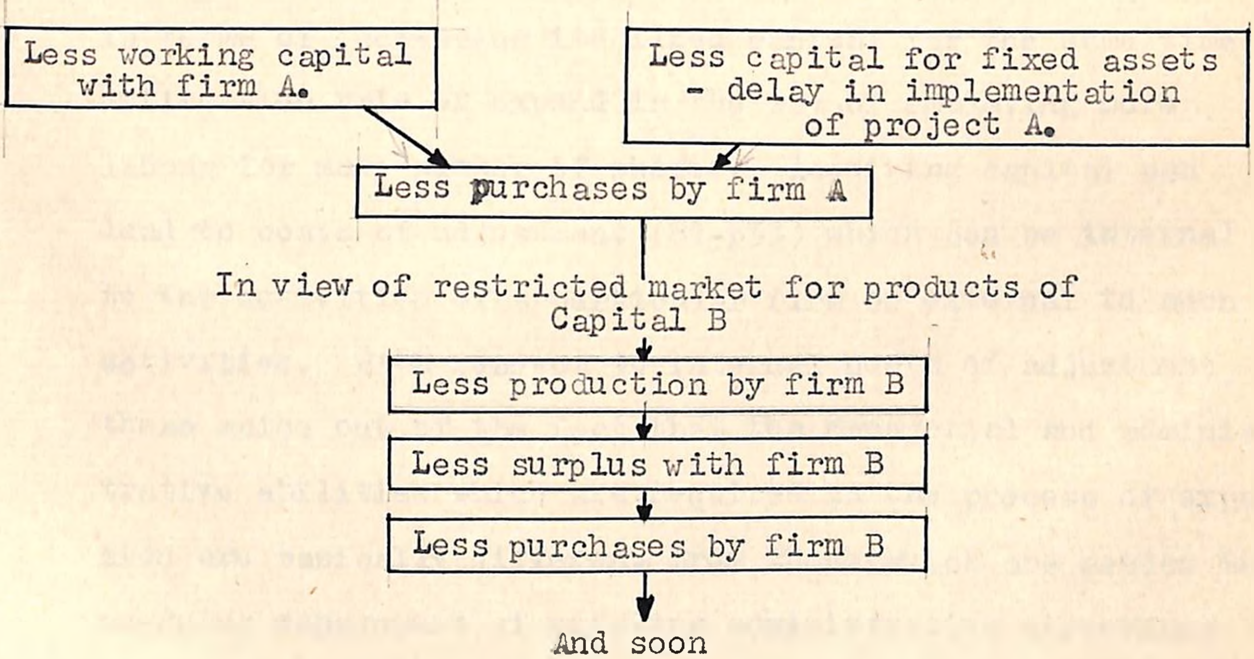


Fig. 3.8

Ill Effects of project delays or sickness of firms.

While the discussion has centred around the working of the firms in third shift as a matter of economic justification two more classes of firms require further discussion.

A firm which is going to be established new has two alternatives: First is to start with less number of shifts and acquire more fixed assets and second is to work with less capital for more number of shifts. The latter alternative, apart from proving economical and reducing costs also uses the machinery at a faster rate and such a firm can plan its capital replacements in a manner so as to reduce the lag between the actual and the best practice technology available (Salter, 83 - pp25).

Secondly a firm contemplating expansion can also think firstly in terms of increasing its fixed capital for the same time utilization rate or expand in the way of employing more labour for more number of shifts. Acquiring capital can lead to costs of adjustment (82-p33) which can be internal to the activities of a particular firm or external to such activities. With respect to internal costs of adjustment these arise out of the fact that the managerial and administrative abilities which are required in the process of expansion are basically different from those which are needed in on-going management of existing administrative structures and current level of productive activities (75). These abilities cannot be readily acquired and hence expansion by acquiring new capital can prove fairly costly. Delivery lags can also affect the cost of acquisition of capital.

In contrast, the cost of adjustment of extending the time of working can be very little as the quality of management and administration required is roughly the same. Training of newly employed workers is required in both cases.

Under these circumstances, non working in third shift sometimes even in second shift is based on very wrong notions, premises and considerations and a lot more effort is required to educate entrepreneurs in this regard. In the final analysis, as the competitiveness grows, consideration of costs should force more time utilization of equipment. While this stage reaches, the Government, can, as a matter of policy, include certain restrictive clauses within the licensing policy and can offer incentives for working the second and third shifts.

In fact, in accordance with the government announcement made in October 1966, industrial undertakings can increase the production of articles for which they were licensed or registered upto a level of 25 percent of the capacity, so licensed provided no additional plant and machinery is installed except minor balancing equipment processed indenegenously.

(2) No additional expenditure of foreign exchange is involved.

(3) Extra production does not occassion any additional demand for scarce raw material (97 - p15).

In the absence of original certification of installed capacity, many firms installed more fixed assets to start with and increased the production by 25 percent later on under the guise of improvement without really working for more number of shifts.

In 1972, government has allowed specified industries to make full use of their capacities on the basis of maximum utilization of plant and machinery. In a press note issued on January 28, 1975, the Government decided to endorse on the licenses, allowing for maximum utilization of plant and machinery in case the industrial undertakings were still working on one or two shifts.

While licensing hurdle has been removed there are a large number of firms who are still not making use of this offer. Some statutory provisions to force firms to utilize their capacities to the maximum has been under consideration of the government. However, it is felt that statutory provisions will be ineffective and sometimes dysfunctional and natural development of capacity utilization as a factor in maximization of profits is more desirable.

3.6 Underutilization of Capacity due to Constraint on Sales and Inputs:

3.6.1 Should all Capacities be fully utilized ?

The question emamates from the fact that utilization of some capacities may be dysfunctional to the economy and market provides the best indication of the usefulness of the products produced by such firms by creating and sustaining the demand for these products or otherwise.

It is not the duty of the Government or Society as a whole to initiate action with a view to rectify the underutilization of these capacities caused due to the poor demand of such products. Nevertheless case seems to be made most of the time for remedial action on the part of the Government. A careful study of the causes of lack of demand is necessary before the corrective actions can be discussed.

3.6.2 Lack of Demands can be Caused By:

(1) Product Differentiation:

Table 3.10 indicates the licensed capacity and the manufacture of various type of vehicles produced in the country. It can be seen that the production of vehicle has been near the licensed capacity in case of Ashok Leyland and TELCO but not in case Hindustan Motors and Standard. Review of past histories of the firms also indicates that any shortfall in production of Ashok Leyland and TELCO has been due to factors other than lack of demand while the vehicles of Hindustan Motors have not been accepted from the beginning. Similarly in case of cars, while Fiat sales have been better, that of Hindustan Motors, and Standards have not been so good. In these and many other instances certain products have been preferred over others and this lack of demand for certain unacceptable products is really not due to lack of demand but due to Product differentiation on the part of consumers.

All the same, Chairman of Hindustan Motors stated some time ago that excise on car manufacture and levy on petrol should

Table 3.10 Utilization of Capacity in Heavy Vehicles

Unit	Installed cap.		Output in 70	71	72	73	74	75	76
Telco	2700		20306	25061	25075	21779	22559	22587	26008
Ashok	8000	Comet	-	5231	3888	5215	6700	7440	10586*
Leyland	1000	Beaver	-	241	356	424	564	486	407*
		Petrol	1976	1851	1714	692	177	100	-
Premier Automobiles	6000								
		Diesel	3025	2221	1805	3562	3784	2151	-
Hindustan Motors	15000		-	2559	2670	3161	2500	1645	950
Standard Motors	3000		-	774	1437	963	-	1395	1010

TELCO : Shortfall of production during 73 due to absenteesm/Power shortage/shortage of items four ancilliaries. Price increases in 69-70, 70-71, 71-72 and 73-74.

Premier Auto: No slackening of demand for Diesel Truck - Shortfalls in production due to less supply of diesel engines from Simpson.

Standard Motors: Being Petrol Engine - demand full.

Hindustan Motors: No demand from beginning - highest in 1973 (lowest for Telco) Product not accepted.

Ashok Leyland: No problem of demand.

be reduced to stimulate demand for cars. Improving the design and quality of such products seem to be low in the priority of many industrialists.

It is possible that capacity utilization of TELCO and Ashok Leyland is also not satisfactory but in that case causes are not sales constraint but many other reasons, some discussed earlier. Scooters, TV sets, Sewing Machines, refrigerators, electric household appliances in consumer goods categories and many industrial capital goods also are included in the list affected in its capacity utilization as a result of product differentiation.

(2) Inferior Technology Resulting in Obsolescene:
Foundries have been crying over the last so many years about the underutilization of its capacities as a result of lack of demand. Railways' revision of its plan was considered as responsible for this situation (17). It is however, to be noted that there are many foundries in India which are overloaded and thriving. The difference appears to be due to the type of technology used. When Railways wants cast iron sleepers, every entrepreneur knows that the requirement of equipment and plant is meagre. A melting unit i.e. cupola, a sand mixing unit and some moulding boxes and one could start a foundry. Requirements have now changed. Products have tended to become more sophisticated, have stricter tolerance levels and as a result, the mushroom growth of foundries with inferior technology has tended to suffer. Perhaps it is for the better that these units

die out. In such cases utilization of the capacities may prove more costly in the long run. All the same, Industry continuously represents to the Government and wants the Government to place orders so as to reduce its underutilization. Similar has been the fate of some fabrication units. Lack of demand here has been for products using inferior technology.

(3) Production Variety:

Table 3.11 indicates production of tyres, tubes, of cycles and automobiles and other products of major tyre manufacturing firms. It can be readily seen firms producing bigger variety of products continue to have better utilization rate in terms of total value as they are able to switch over from the products in less demand to products in better demand. Multiproduct production may require better standards of production planning and control, inventory control and overall management but given all these the utilization rate can be kept high. In fact the objective of continuous product development is itself a strong measure in the direction of improving utilization.

(4) Better Utilization Rates by Consumer:

In recent years 'Railways decided to improve the utilization rates of their locomotives. Some specific operation research teams were deployed to suggest ways and means for the same (81). As a result of many such factors and faced with paucity of funds, orders for rolling stock were curtailed. Some other track expansion programmes were also curtailed.

Table 3.11(a) Net sales for different firms manufacturing ~~good~~ rubber Goods

Sr.No.	Name of Manufacturers	Number of products mfgd.	Sales in value in						
			1968	1969	1970	1971	1972	1973	1974
1.	Ceat Tyres	4	2105	2317	1752	3176	3797	3251	4706
2.	Good year	6	2728	2884	2557	2825	3982	3614	5406
3.	Inchek	3	848	1292	997	1102	712	870	1808
4.	Premier	2	1012	907	724	1547	1866	1868	900
5.	Universal	2	-	-	-	25	112	170	199
6.	Dunlop	14	7097	8170	8833	9833	9622	10243	14690

Table 3.11(b) Percent variation in sales in downtrend

S. No.	Name of Manufacturer	No. of products	%age decline in 1970 over 1969	%age decline in 1973 over 1972.
1.	Ceat Tyres	4	24	14
2.	Good Year	6	11	9
3.	Inchek	3	23	20*
4.	Premier	2	25.5	-
5.	Universal	2	-	-
6.	Dunlop	14	-8.0	2.0*

* 1972 over 1971

Logically this is a step in the right direction and is bound to make railway operations more viable and economical. Similarly, as a result of experience, pressure, necessity and more awareness and also as a result of work study and operational research cells, there has been an improvement in the utilization of resources. This however, caused a chain reaction as seen in Fig. 3.9.

It would appear that as a result of sudden curtailment of demand due to improvement in utilization rate, CLW, DLW and a lot of other subcontractors, machinery and plant builders face an idleness of capacity. For sometime, they may in fact do so. In the long run, however, if railways become more economical in their operations, they will have better surplus and will be in a position to embark upon really needed plans of expansion. In the short run there can be some underutilization which could be avoided by foresight and marketing efforts and market research and by export promotion efforts, and by finding new customers. As a matter of fact, money saved from railways is bound to be allocated to other sectors of the economy.

(5) High Cost of Manufacturer:

Most of the public sector undertakings with their huge overheads have been uncompetitive and unless protected by Government in terms of price/or sales, find it hard to sell under open competition. Government, in fact, advised Electricity Boards, Railways etc, to make direct purchases from the public enterprises and also to extend price pre-

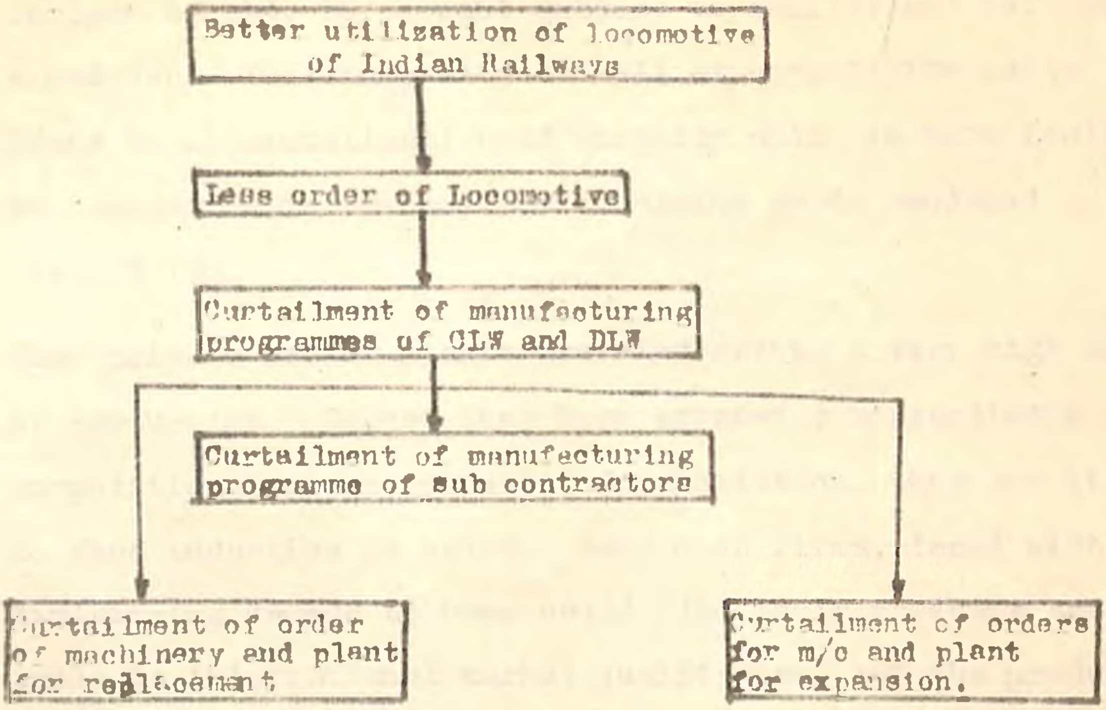


Fig. 3.9.1

Short Term Effects of Better Capacity Utilization by Consumer

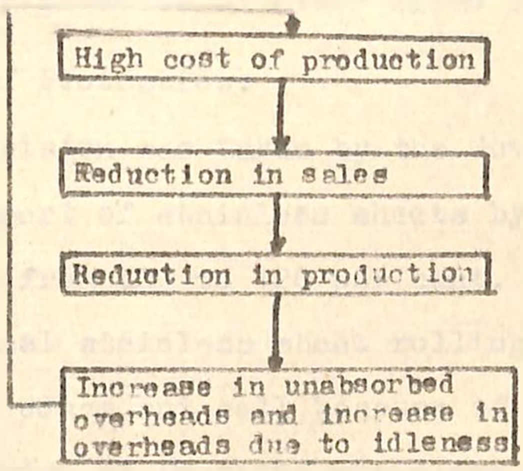


Fig. 3.10

Negative Effects of High Cost of Production.

ference of upto 10 percent subject to quality and delivery schedules. This inability to sell at competitive rates leads to underutilization of capacity which in turn leads to escalation in the cost of remaining goods produced (Fig. 3.10).

Many private sector plants are also having a very high cost of production. Unless they have created a monopolistic competition through product differentiation, they are likely to face reduction in sales. Many such firms, faced with diminishing demand at home could find their products acceptable in international market qualitywise, but the products could not be marketed due to high cost of production and consequently very low margin of profit. Here lack of demand is restricted to products with high cost of production relative to similar products of other firms in India and abroad.

(6) Removal of Protection:

Recently, a decision was taken by the Government of India in allowing import of stainless sheets by reducing the excise duty on import from 320 to 120 per cent. This immediately crushed the local stainless sheet rolling Industry, who were able to produce and sell because of the artificially created high price of imported stainless steel sheets. There are many such industries who thrive as a result of protection in the form of high import duty, ban on imports, ban on issue of further licenses, subsidy, availability of raw material at concessional rates and in many other forms. Removal of such protection immediately brings down the level of sales. Government of India's recent decision of no preference to Public Sector firms in terms of price brought about a panic in the public sector undertakings as even with protection they are finding it difficult to compete.

(7) Unbalanced Sectoral Growth:

In a planned economy, some sectors lag behind and those whose progress is in accordance with time schedule, suffer idleness on account of less demand for their products. Many public sector and private sector firms have found to their dismay that the initially estimated sources of consumption didn't materalize. Many public limited companies who claimed at the time of their start that they will face no difficulty in sales, kept on attributing losses or lack of profits to poor sales later on.

Wishful thinking and poor market research are behind this state of affairs. Forecasting techniques are not applied adequately and no effort is made to collect adequate data on which to base potential areas of marketing and sales promotion effort.

(8) Lack of Export Promotion:

While exports are increasing the percentages of exports to total production is not showing any appreciable growth. Refer table 3.12. This means that the shocks of the economy in terms of periodic recessions have to absorbed by the manufacturing sector which otherwise could export. Government conciousness, better utilization of resources can make the

Table 3.12 Indian Exports as % of World Exports.

Year	Export as percent of world export	Remarks
1948-49	2.2	Mostly due to the cost-structure of Indian being more than that of the competitors.
1954-55	1.4	
1960-61	1.0	
1965-66	0.9	
1971-72	0.6	
1972-73	0.6	
1974-75	0.5	
1975-76	0.5	

Source - Table 14.1 Basic Statistics relating to the Indian Economy - Vol. I October 1976.

Issued by Centre for Monitoring Indian Economy Bombay.

Indian manufacturers competitive in international market.

(9) Poor Forecasting of Demand:

See table 3.13 for the forecast of steel castings. Excessive forecasts coupled with high cost of production and no possibilities of diversification lead to very poor utilization.

3.6.3 Lack of Inputs:

Inputs like Power, raw materials, working capital, labour force etc. are known in advance many times. Exact analysis of requirement and availability is required to be made.

3.6.4 Budgeting:

When constraints on sales or of inputs are known in advance, a lot of advantage can accrue if budgeting is done on the basis of known data and the probabilities accompanying the same. Budgeting may require fixing production levels at more or less than the planned capacity.

More production can be achieved by overtime working, subcontracting of many parts manufactured in the shops and sometimes by employing substitute labour. Less production will involve separation of staff, lay off, idleness or cancellation of orders for parts placed outside the works and start their internal manufacture.

Production patterns can be changed temporarily to suit availability of power. Accepting lower sales levels, and adjusting the budget can be a good technique for the short run only. In the long run new production design and sales promotion have to be resorted to.

Table 3.13 Forecast of Steel Castings

Forecast by	Year of reporting	Estimate of demand in 1970-71
National Industrial Development Corporation.	1963	4.75 lakh tonnes (1)
Representatives of Industry	June 1966	2 lakh tonnes
Planning commission	Dec.1966	2.25 lakh tonnes
Sources close to Industry	Dec. 1966	1.25 lakh tonnes
Actual demand	1970-71	0.60 lakh tonnes(2)

(1) Based on this licenses issued to the extent of 5.4 lakh tonnes.

(2) Close down of many units and acute industrialization in others

Source: Dagli - 17 pp 48-49.

3.7 Underutilization of Capacity by Unplanned Interruption of Input:

Finally this loss is attributed to unplanned interruption of inputs like absenteeism, power shutdown, machine breakdowns, nonavailability of raw materials for a particular operation, nonavailability of cutting tools etc.

3.7.1 Absenteeism: Absenteeism due to leave due to workers, is either taken care of by providing staff as leave reserve or production for that period is not expected (100). It is the unannounced, unplanned absenteeism that affects production, sometimes seriously e.g. as under:

(1) Persons on leave or absent at the same time being more than the leave reserve provided.

(2) Person on leave being such that no alternative arrangements can be easily made for the short time duration of his absence. Due to specialization or lack of training, mobility between jobs is reduced.

(3) Persons absent without notice so that alternative arrangement for that day cannot be made.

(4) Person absent is on a key position like crane driver, and whose absence affects the work of a complete day.

While effect of absenteeism on capacity utilization will be discussed later in Chapter 4, it appears to be a little over rated.

3.7.2 Power Shutdowns: While its effect on production can be severe, effect is also offset by the overlapping of power shut downs and workers' time for personal needs and fatigue. Unless this time is booked as idletime, enough margin exists for workers to make up for the lost time. Only a little more prolonged shutdown affects production seriously. While process industry is affected badly, the effect on engineering products industry can be offset by proper scheduling of work and by continuing as much work on a systematic basis as possible as does not require power like unloading and loading of machines, tools setting, reading instructions and planning the work etc.

3.7.3 Machinery Break Down: Preventive maintenance time as well as fixed percentage for breakdown should be taken into consideration while calculating budgeted capacity. Variances for this allowed percentage need to be discussed (65).

3.7.4 Nonavailability of Job to be Done:

Two types are identified. Firstly purchased raw materials and components may not be available and secondly material may be held up at some previous work stations due to sequencing and scheduling problems.

Time losses due to such reasons are being given the maximum importance as these directly reduce the capacity utilization vis-a-vis budgeted capacity.

For summary of all the reasons for underutilization of capacity, see Table 3.14.

~~42~~

Table 3.14

2.4 ANALYSIS AT THE PLANT OR UNIT LEVEL

This analysis is done in two directions: 1. Examination of the reasons for underutilisation of capital.
2. Impact of underutilisation on profits and meeting other objectives of the firm.

Causes: (1) It is necessary to list the factors causing or contributing to the differences in various capacity concepts. A schematic model is presented below.

Theoretical Capacity

As determined is a fuction of

1. Load centre identification
2. Product Mix requiring production ~~No. of~~
3. No. of Batches of production,
4. Varying costs attached to different load centres.

Theoretical Maximum - Theoretical Rated

is a function of (1,1a,2,3,4,5)

1. Down rating of machine tools and other equipment →
   f(Age, condition, Partial working like one slide of a planer defective, etc.)

1a. Uprating of machine tools and other equipment →
   f(Replacements, better cutting tools, etc.)

2. Poor work methods →
   f(Sequence of working, process layout, wrong calculations of feed speed etc., poor illumination, poor handling methods etc.)
3. Poor tooling →
   f(poor method, poor design, poor manufacture, poor stocking and issue)
4. Rate fixing →
   f(Lack of knowledge of techniques, Lack of full load, Individual and Group Pressures, Extent of Participative Management, Worker Training)
5. Workers Efficiency i.e. less than 100% →
   f(incentive scheme, ceiling, perceived, relationship of effort with reward, job satisfaction, worker's needs, training, communication system, accuracy of working, Group pressure)

Theoretical Rated - Planned

f(1,2,3,4,5,6,7)

1. Holidays →
   f(Region, Religon)
2. Shifts →
   f(Demand Forecasts now and later, Shift Differential, Shift advantage, Transport system in 2nd and 3rd shift, Perception of drop of n in 2nd or 3rd shift, Perception of Security, Social attitude)
3. Absentee allowance →
   To provide idleness or provide extra staff
   f(religion of employees, social of employees, Need of employees, Medical attention and systems, Standard of living, etc.)
4. Breakdown allowance
5. Wage Rate
6. Capital Intensity - Capital/Labour.
7. Technology i.e., Batch, Process, Mass Production.

Planned-Budged

f(1,2,3,4,5,6)

1. Seasonal fluctuation of demand
2. Inventory costs
3. Firing costs
4. Idle time costs
5. Working capital availability
6. Teething Troubles in new development.
7. Power availability (Predicted)

Budgeted-Actual

f(1,2,3,4,5)

1. Power Failures (unpredicted)
2. M/c Breakdown beyond standard %
3. Absenteeism beyond % including strikes and lockouts

3a. " Qualitative

4. Temporary shortage of work →
   f(Non availability of raw materials, Non availability of castings, forgings, of RM, Castings or forgings, Bottleneck at previous load centre)
5. Time lost in unproductive work →
   f(Rejections, deterioration of standard of previous operations, indirect work, pressure of management)

CHAPTER 4

CAPACITY UTILIZATION ESTIMATION AND ANALYSIS AT MACROLEVEL

Application of Output - Capital Ratio Model and Multiple Regression Analysis:

4.0 The objective of this chapter is to assess the extent of capacity utilization in units (as a group) situated in different states and for different years for a particular industry by comparing output to fixed capital employed. Multiple regression method has been used to estimate the correlation between the performance of these units and different other parameters which have a bearing on capacity utilization. Since the primary concern in underdeveloped countries is with faster growth, better utilization of accumulated assets is of vital importance. Output/capital directly measures the utilization of resources blocked in fixed assets and to that extent, the analysis is considered to be useful in providing directions for future action.

First, capacity utilization series is developed for different states/industries for different years. Then a set of influencing variables have been identified. Multiple correlation and regression analysis is employed to identify the influencing variables having significant correlation with capacity utilization. Time series, X-sectional and Pooled data has been used. A number of equations with different variables have been tried. Results for each equation have been interpreted and finally overall conclusions have been listed.

4.0.1 Data: Industry considered was concerned with manufacturing equipment for generation, transmission and distribution of power including transformers. During the period of consideration i.e. (1960-1969) the identifying group number given to this industry was 370-1.1 and this was a part of the group of industries manufacturing Electrical Machinery.

Data has been collected from the Annual Survey of Industries published by the Central Statistical Organization of India. Before 1960, these documents were called 'Census of Manufacturing Industries' and the groupings of industries in these publications was different and hence uncomparable with those given in Annual Survey of Industries. Published data is available only upto 1969.

Out of the years 1960-1969, no survey was done in the year 1967 and in a particular year separate data was included for those states only which had at least three firms operating in it. A total of 9 such states had available data for years more than four out of 9 under study and these have been included. Thus, in all, 69 observations pertaining to 9 different states for 9 different years are available.

Data was collected under the following heads:

(1) State for which data collected.

(2) Year

(3) Book value of machinery, plant and equipment and tools at the end of the year under considerations. This is the depreciated value.

(4) Book value of total fixed assets including land and buildings at the end of the year under consideration.

(5) Inventory of raw materials at the end of the year (Book value).

(6) Inventory of semi-finished goods at the end of the year (Book value).

(7) Inventory of finished goods at the end of the year (Book value).

(8) Total working capital at the end of the year (Book value).

(9) Number of the firms whose data included in the state and year under consideration.

(10) Number of workers employed - A worker is as defined under the factories act, 1948.

(11) Number of persons employed - This is calculated by dividing a total of man shifts by the number of shifts worked.

(12) Number of man hours worked = $\sum_{1}^{n}$ number of workers in a shift x number of hours in the shift, where n is the number of shifts worked in the year.

(13) Amount of wages and salaries paid to all the employees during the year.

(14) Electricity purchased during the year in KWH.

(15) Gross value of production in current prices.

(16) Material consumed for production in current prices.

(17) Value added by manufacture = Gross value of output - Gross value of input.

(18) Machinery and plant index for the year.

(19) Output price index for the year.

(20) Industrial raw material price index for the year.

(21) Consumer price index.

(22) Value of depreciation provided during the year.

Items number 18 - 21 values of the indices have been taken from the Reserve Bank of India Bulletins.

Proforma for collecting data and a sample of the form filled can be seen at Appendix 4.1.

4.0.2 Shortcomings of the Data:

(1) The data is very much old and outdated and analysis of the data for a period ten years behind schedules can hardly serve to provide guidelines for prediction for the present times.

(2) Data is not continuous for a set of undertakings in a state. If the average number of workers falls below 50 in a particular firm in a particular year, the firm is not included in the survey. Sometimes the firms fail to supply the data by a partioular date and the same is not included. This discontinuity hinders systematic analysis, as, in a particular year whan data of a firm, whose data was included last year, is not included, the same can be mistaken for withdrawal ~~or~~ of capital. If the firm left out is a big firm, the analysis can become quite skewed.

(3) Moreover, when the number of firms falls below 3 by the above criterion, the state data is not separately recorded but is included in 'others' column, thus giving a discontinuity to statewise analysis.

Good analysis of weaknesses of data

(4) The absence of data about gross block of capital has resulted in an analysis which could have been improved.

(5) Depreciation details are not given separately for plant and equipment and these details could have proved more useful in a still more rigorous analysis.

(6) Only electricity purchased is given while a total of electricity purchased and generated is more meaningful in establishing any effect of power shortage on capacity utilization.

(7) It was understood through discussion with central statistical office staff that if a firm's main product changes, the firms data is included in another group and this fact introduces sudden changes '+' and '-' in the capital employed and other parameters.

(8) Plant and machinery awaiting installation is not separately given and this fact does not give a true picture of the fixed assets in use.

(9) Even when number of firms in two successive years being reported remains the same, it is not sure that the firms represented are the same. It is just possible that a firm has not been reported upon and a new firm has been added. This affects the true calculation of growth of capital and output. Where a situation like this has been noticed, a comment to that effect should have been included.

(10) Format of the information, includes on one side details about expenditure on firewood, charcoal, coke, coal, kerosene oil etc. and these are negligible quantities in relation

to the total expenditure. For example (see Table 4.1) where part of data from page 3 of Annual Survey of Industries 1968 Vol. IX is repeated.

Table 4.1 Expenditure on Fuel, Electricity etc. of Boiler and Steam Generating Plant Industry.

Items	Expenditure in Rs.
Fuels, oil etc.etc.	34,04,188
Coke	4,870
Charcoal	2,117
Coal Gas	Nil
Natural Gas	Nil
Firewood	Nil
Napta	Nil
Kerosene Oil	2,115
Liquified petroleum	3,014
Water Purchase	427

(11) Expenditure on Research and Development, Quality Control, and workers' training etc. which are now becoming important are not being recorded separately.

(12) Format includes recording upto last rupee. Rounding off to nearest thousand is a much better effort saving device and cannot hinder any conceptual or analytical work for which the data maybe used.

4.0.3 Value of the Data:

Barring these defects, the data gives a detailed account of the performance of the undertakings and can be of immense value in deriving worthwhile conclusions about many sided facets of business. Since the data considers the unit as a whole and not its main product alone, the data is much more valuable in analysing the utilization of resources as compared to the monthly statistics of production (51-pp69-79).

4.1 Construction of Capacity Utilization Series:

Stepwise procedure to estimate capacity utilization is given below: (Computer Programme at Appendix 4.2)
FLOW DIAGRAM – Fig 4.0.

Step 1: Additions to fixed capital (I_t)

$$I_t = K_t + D_t - K_{t-1} \qquad (1)$$

differs from normal eco.anal

where K_t = fixed capital at the end of year under consideration.

K_{t-1} = fixed capital at the end of last year.

D_t = depreciation charged during the year.

Step 2: Price correction to additions to fixed capital.

$$I_{ct} = \frac{I_t}{\text{M and P index}} \qquad (2)$$

M and P index means Machinery and Plant index.

Price correction is not rigorously correct. Firstly fixed capital additions consist of plant and machinery as well as buildings and land. There is no uniform price index of land and buildings available. Hence using machinery and plant

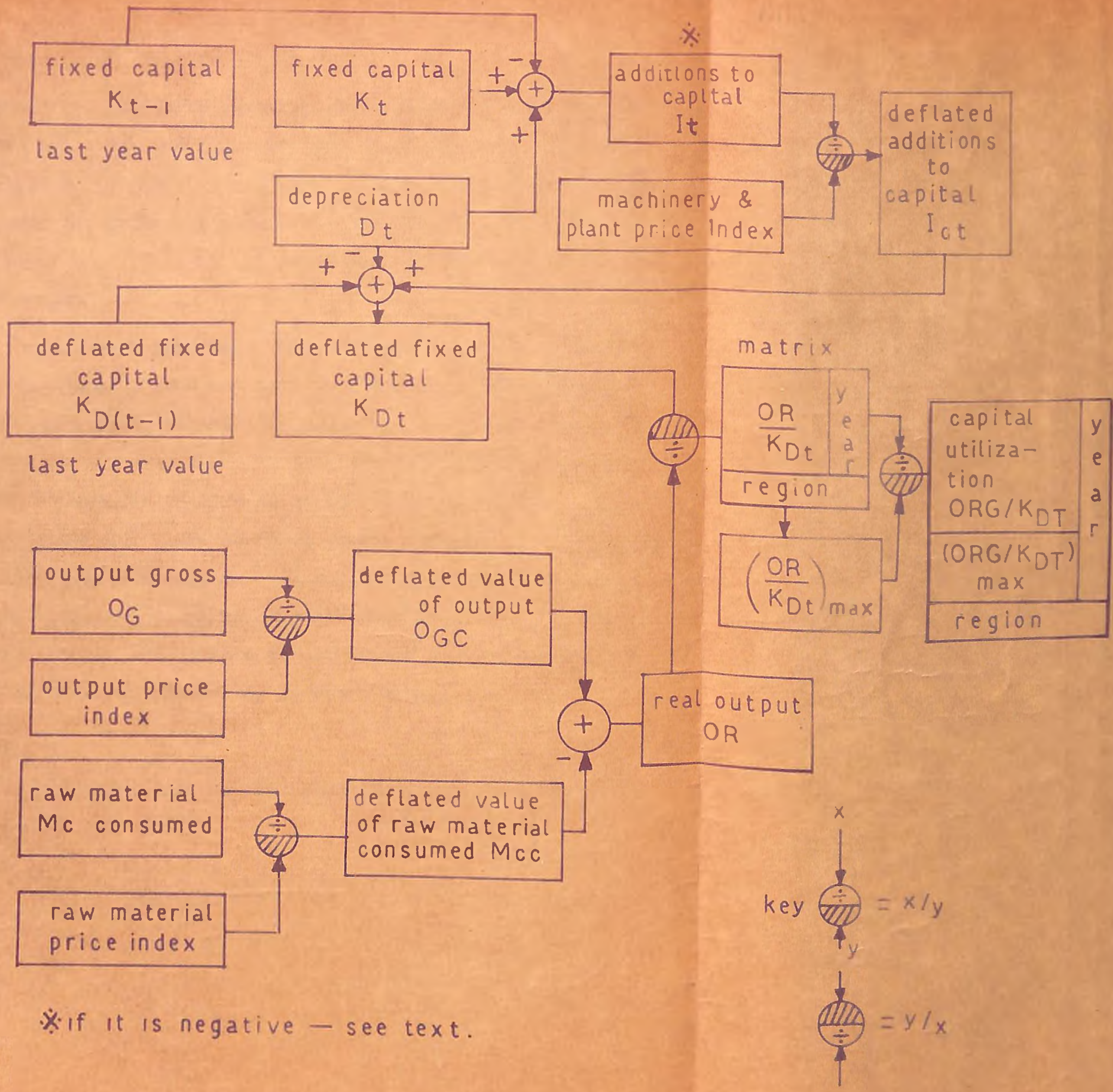


FIG. 4.0 FLOW CHART — ESTIMATION OF CAPACITY UNLIZATION.

index is the nearest approximation.

Secondly, since depreciation is not indicated separately for machinery and plant and for buildings, it is not possible to assess additions to these heads separately and again the price correction to total fixed assets without distinction of plant and machinery and buildings becomes necessary.

It would have been much more accurate to know the addition to machinery, land and building separately and knowing the locations, to correct for price increases. Since the data is not available in that order, the price correction as recommended appears to be the most reasonable. Ratio of machinery and plant to fixed assets (total) is within very close limits and hence replacing buildings and land index with machinery and plant index particularly in the same industry will induce very little error. Table 4.2 indicates ratio of M and P/fixed assets for Industry 370-1.1.

Step 3:

New deflated fixed capital employed at the end of the year

$$K_{Dt} = K_{D(t-1)} + I_{ct} - D_t \qquad (3)$$

Table 4.2 Ratio : M and P/Fixed Assets (Total).

State / Year	ADHRA	TNAD	GUJR	MYSR	PUNJ	UP	KERA	WB	MAHA
1960	.70	.45	-	.57	.45	-	.49	.52	.29
1961	-	.50	-	.52	.46	.22	.55	.52	.43
1962	.60	.57	-	.51	.39	-	.58	.70	.40
1963	-	.56	-	.52	.47	-	.61	.73	.55
1964	.58	.55	.40	.53	.48	.42	.62	.83	.53
1966	.24	.52	.21	.06	.57	.47	.69	.66	.38
1968	.51	.48	.46	.65	.55	.55	.67	.60	.57
1969	-	.41	-	.63	.57	.38	.64	.59	.63

This is a recursive equation and when K_D for 1960 is to be calculated K_D 1959 is not available as the data available is from 1960 onwards.

Assumption:

Here an assumption is made i.e. the total book value of the fixed capital at the end of 1960 is considered to have been added in 1960 itself and since the price index in 1960 for machinery and plant stood at 113.

$$K_{D1960} = \frac{\text{Book value at the end of 1960} \times 100}{113} \qquad (4)$$

Some error is definitely introduced due to this assumption as the capital must have been added slowly from a past year till 1960 but since the history of these additions is not known, there is no alternative but to ignore the same. Error introduced due to this approximation is fortunately not much. Firstly, as seen from Table 4.3, the fixed capital at the end of 1960 was too small compared to one at end of 1969.

Table 4.3 Fixed Capital in Industry 370-1.1 at the end of 1960 and 1969.

Year	States							Figures in (000) Rs.
	ANDHRA	TNADU	MYSR	PUB	UP	KERLA	WB	MAHA
1960	213	6456	2664	838	2458	622	9592	12686
1969	303237	27197	82120	1979	6058	14834	29329	150381

Secondly with base year 1952-53, when M and P index is considered 100, M and P price index in 1960 stood at 113 and in 1969 at 160. In 8 years before 1960 it rose by 13 points only or at an average of 1.63 points per year whereas in the next 9 years it rose by 47 points or on an average of 5.2 points per year. Price correction is obviously much more significant in years after 1960.

Depreciation:

No change has been made to the depreciation permitted which has been taken out in (3) without price correction. Depreciation procedure of different firms is not really known. The correct procedure appears to be as under:

Suppose an asset was procured for Rs. y in 1952-53 (M and P index 100) and k per cent of it was provided against depreciation in 1969 ((M and P) index 160).

Actually to bring this k percent replacement, depreciation required to be provided in 1969,

$$= ky \times \frac{160}{100}$$

and at 52-53 prices $= ky \ \frac{160}{100} \times \frac{100}{160} = ky$

for an asset procured in 1960 of price y,

Depreciation required at 52-53 prices $= ky \times \frac{160}{113} \times \frac{100}{160}$

$$= ky \times \frac{100}{113}$$

Total depreciation at 52 - 53 prices $= \Sigma \dfrac{ky}{\text{Price index of the year of purchase of y.}}$

As ky for different years is unknown, this is difficult to compute. Since the weightage of the depreciation provided on assets procured earlier is more, and since price correction required for assets procured is less, price correction ignoring does not introduce much error. Moreover the error is almost uniformly applied as whatever may be the rule of providing depreciation, it is almost entirely applied uniformly. This procedure has the effect of giving advantage to the newly created capital. This is favourable as the M and P indices are considered conservative.

Gross Capital or Depreciated Capital:

This is another serious controversy on which economists have not been able to agree. Most of the western economists however favour gross capital for the following reasons: (53 - pp 64-65).

(i) Depreciation does not mean that the capital has become less productive to that extent. Through constant maintenance the capital can be kept as good as new.

(ii) Depreciation is really an accounting procedure and the enterprises really follow no rationale which will link loss of productivity or cost of replacement of loss of productivity to depreciation charged. It is of no consequence as far as capacity utilization studies are concerned.

On the other hand there are strong arguments in favour of using depreciated capital. Reasons are as follows:

(i) Undepreciated capital implies that the productivity of the capital remains the same till it is finally retired when it suddenly falls to zero.

(ii) Assumption of good maintenance in Indian Conditions is difficult to accept. There are cases when new machines after working for a year start giving trouble and are responsible for lower production. Preventive maintenance policies are an exception rather than the rule.

(iii) Since our concern is with the return on capital on which return has yet to be made, acceptance of depreciated capital is a good proportion.

(iv) Finally the western economists have not depended so much on economic theory or technical explanation as on the fact that models fit the undepreciated capital better. (53-pp65).

Step 4: Price correction to Gross output O_{GC}

$$O_{GC} = \frac{O_G}{\text{Output price index}} \qquad (5)$$

where,

O_{GC} = output gross after price correction

O_G = output gross before price correction.

Since in this case output is Machinery and Plant only, the price index of m/c and plant only has been used.

Step 5: Price correction to raw material input

$$M_{CC} = \frac{M_C}{\text{Price index for industrial raw material}} \qquad (6)$$

where,

M_{CC} = material consumed after price correction

M_C = material consumed before price correction.

Step 6: Output real = $O_R = O_{GC} - M_{CC}$ (7)

Since a firm has the option to subcontract any amount of work, more purchase of raw material and semi-finished and finished components for the same output will mean less real output from the plant. Therefore correct measure of real output is given by equation (7).

Value added has not been considered for a different reason. Question under consideration is the construction of capacity utilization series. Output real (O_R) measures the correct amount of output. Cost of services and other inputs to make this output possible is important from the point of view of profits and improved productivity in the short run and may affect capacity utilization in the long run but can not be considered with a view to determine production levels.

Step 7: Now $$\frac{\text{output}}{\text{capital}} = \frac{O_R}{K_{Dt}} \qquad (8)$$

This will be a series for each state for each year.

Step 8: Select the maximum value of O_R/K_{Dt} out of the series developed at step 7.

Let this be known as (O_R/K_{Dt}) max.

Step 9: Calculate capacity utilization for each year for each state

$$CU = \frac{(O_R/K_{Dt})_{\text{year, state}}}{(O_R/K_{Dt})_{\max}} \times 100 \qquad (9)$$

This way, a series will be constructed for each year and each state.

Values of $\frac{\text{Output}}{\text{capital}}$ ratios:

Table 4.4 gives these ratios for each year and each state.

Table 4.4 Output/capital ratio for different states in different years for industry 370-1.1

Year	ANDHRA	TNADU	MYSR	GUJ	PUB	UP	KERLA	WBEN	MAHA
1960	1.4	1.87	2.19	-	0.94	-	2.84	2.47	1.66
1961	-	1.26	3.23	-	0.71	1.19	2.96	2.15	1.44
1962	1.31	1.04	-	-	1.25	1.01	2.38	1.76	1.45
1963	-	1.30	2.68	-	1.40	-	2.70	1.95	1.42
1964	2.56	2.03	2.39	-	1.97	-	3.00	2.28	1.76
1965	2.19	2.50	2.35	1.46	2.01	2.79	3.76	2.76	2.02
1966	0.04	1.85	0.44	1.11	3.30	4.75	0.41	2.45	1.01
1968	0.24	1.42	0.49	1.53	3.44	3.99	0.99	2.52	1.05
1969	-	2.56	0.64	2.08	3.98	6.69	1.03	3.14	1.30

Capacity utilization is calculated from the values given in Table 4.4. Values of capacity utilization are given in Table 4.5.

Table 4.5 Capacity utilization figures for Industry 370-1.1 as percent.

YEAR	ANDHRA	TNADU	MYSR	GUJ	PUB	UP	KERLA	WBENG	MAHA
1960	21;07	27.98	32.75	-	14.18	-	42.45	37.01	24.93
1961	-	18.96	48.25	-	10.66	17.82	44.31	32.33	21.55
1962	19.68	15.61	-	-	18.77	15.09	35.67	26.43	21.19
1963	-	19.48	40.11	-	21.00	-	40.37	29.17	21.32
1964	38.25	30.32	35.72	-	29.50	-	44.87	34.18	26.48
1965	32.85	37.39	35.13	21.94	30.12	41.79	56.19	37.13	30.19
1966	0.72	27.70	6.68	16.72	49.42	71.03	6.14	36.71	15.18
1968	3.73	21.26	7.30	22.93	51.50	59.61	14.88	37.88	15.72
1969	-	38.28	9.68	31.09	59.54	1.00	15.40	47.00	19.44

The above table has also been represented in graph form in figure 4.1. From the graph wide variation in capacity utilization can be noticed between different states as well as between years. The variations have been analyzed in the next section.

In terms of the figure 3.1 in Chapter 3,

$$\text{Capacity utilization} = \frac{\text{Actual Production}}{\text{Total capacity of resources}}$$

$$= \frac{0\ a_o\ b_o\ c_o}{0\ a_3\ f_1\ f_o}$$

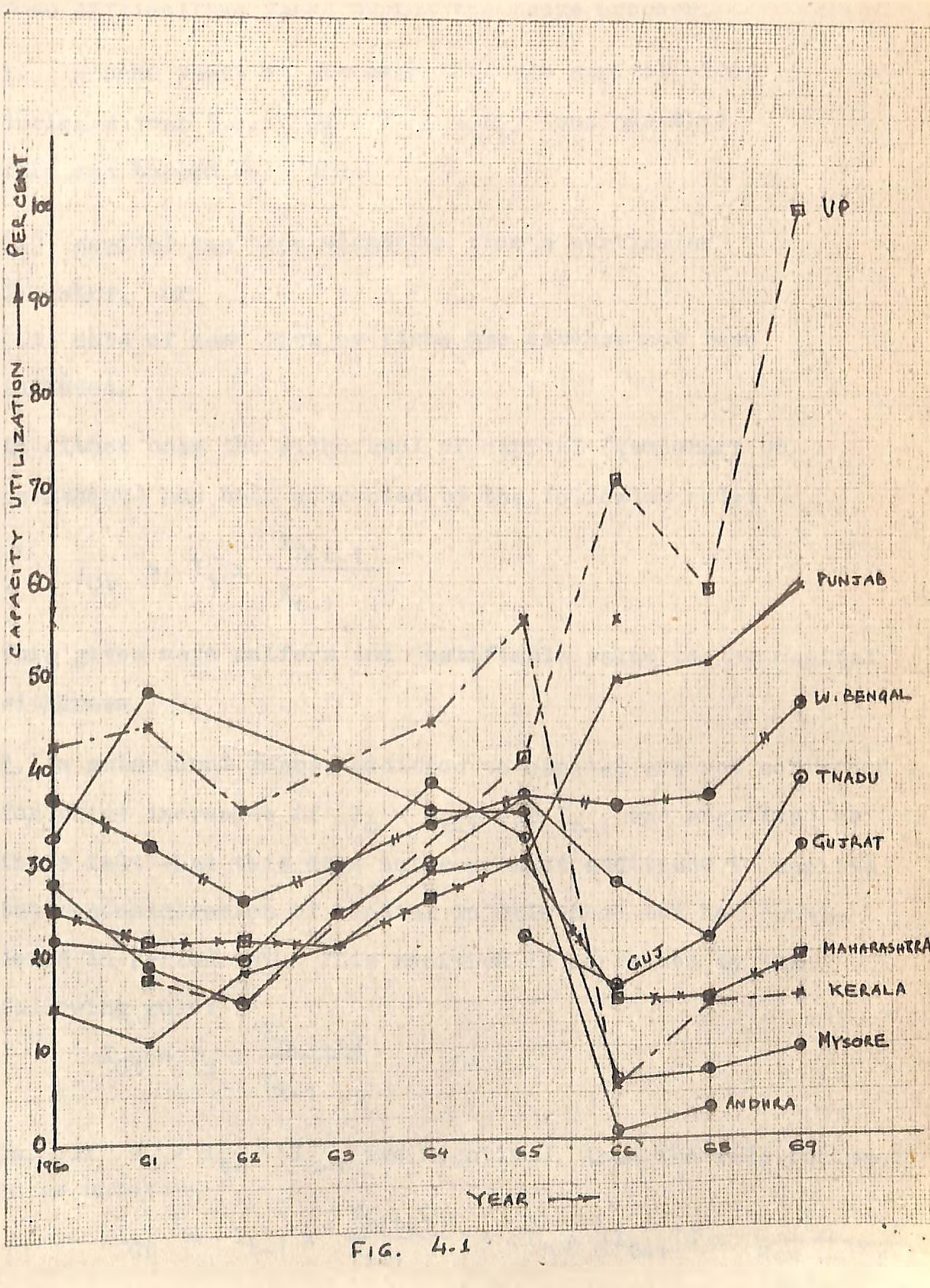

CAPACITY UTILIZATION → PER CENT
0
10
20
30
40
50
60
70
80
90
100
1960
61
62
63
64
65
66
68
69
YEAR →
UP
PUNJAB
W. BENGAL
TNADU
GUJRAT
GUJ
MAHARASHTRA
KERALA
MYSORE
ANDHRA

FIG. 4.1

Some difficulties faced during the above process.

1. In some years it was seen that the capital added during a year i.e. $(K_t - K_{t-1} + D_t)$ was negative. This can happen only when

(i) capital has been withdrawn from a particular Industry, or

(ii) data of some firm or firms has somehow not been included.

In either case the withdrawal of capital (temporary or permanent) has been corrected by the following rule:

$$I_{Ct} = I_t \times \frac{K_{D(t-1)}}{K_{t-1}}$$

This gives more uniform and justifiable value to the capital withdrawn.

2. In subsequent years, addition to capital are not corrected for price increases if $I_t < I_{t-1}$ (If I_{t-1} was negative) as it is felt that this does not represent additions to capital but reconsideration of capital in existence but not considered in period t-1. This addition is corrected by the following rule:

$$I_{Ct} = I_t \times \frac{K_{D(t-1)}}{K_{t-1}}$$

2a. If $I_t > I_{t-1}$ (I_{t-1} was negative), then the rule followed is as under:

$$I_{Ct} = I_{t-1} \times \frac{K_{D(t-1)}}{K_{t-1}} + (I_t - |I_{t-1}|) \times \frac{1}{\text{Raw material Price Index.}}$$

4.1.1 Effects of Price Correction and Varying Definition of Output and Capital.

While the effects of price increases are important and for a rigorous analysis, corrections for price changes must be made, one is not sure that at a fairly aggregated level, and for the purpose of x-sectional analysis, where capacity utilization of one state is being determined only relative to the other states, non-consideration of price correction will introduce a serious distortion. Moreover, the controversy also exists regarding the following:

(i) Employing total output, output-materials consumed, output-input (value added) for real output.

(ii) Employing Machinery and Plant, fixed capital or productive capital i.e. including working capital for capital.

To test the actual differences, output/capital ratios for 1969 were calculated for the above industry taking the book values as such i.e. without price corrections and by considering the following:

1.	Output/PC	Total output per unit of productive capital (fixed capital + working capital).
2.	Output/FC	Total output per unit of fixed capital.
3.	Output/M & P	Total output ~~xx~~ per unit of machinery and plant and tools.
4.	$\frac{\text{Output-M}}{\text{PC}}$	(Total output - materials consumed) per unit of productive capital.
5.	$\frac{\text{Output-M}}{\text{FC}}$	(Total output-materials consumed) per unit of fixed caiptal.

6. $\frac{\text{Output-M}}{\text{M \& P}}$ (Total output-materials consumed) per unit of machinery and plant.

7. VA/PC Value added per unit of productive capital.

8. VA/FC Value added per unit of fixed capital.

9. VA/M& P Value added per unit of machinery and plant.

10. By taking a geometric mean of all the nine mentioned above. Table 4.5a indicates the respective capacity utilization percentages obtained by the above mentioned considerations. In almost all the cases, the capacity utilization as estimated through the geometric mean is higher than calculated in section 4.1.0.

These differences are not insignificant but when the variations range from 9 per cent to 100 percent and data being analysed is so crude, the imperfections of any method used cannot prove very glaring and the analysis is bound to prove quite fruitful. It emphasizes once again that even though the capacity utilization levels are only relative, improvements even here, not worrying about the absolute levels, can be very rewarding for the economy. Yet, the effect of not correcting for prices is to show the capacity utilization levels in better light.

Table 4.5b has been constructed using the figures from table 4.5a but only considering Fixed Capital as the basis of comparison. Output has been considered in three ways as before i.e.

(i) output gross

(ii) output gross - materials consumed

(iii) value added.

Table 4.5(a) Capital Utilization for 1969 using different basis and without price correction

State	Capacity Utilization basis										
	Output/PC	Output/FC	Output/MP	Output-M/PC	OutputM/FC	OutputM/MP	VA/PC	VA/FC	VA/MP	Geometric Mean	Output-M/FC deflated
Andhra	13.2	5.9	6.3	14.0	6.95	7.5	5.4	2.5	2.63	6.16	-
T Nadu	59.6	31.6	35.3	74.0	43.5	49.5	56.5	30.8	35.00	44.2	38.2
Mysore	15.1	13.0	10.8	12.0	11.4	9.6	6.8	6.5	5.14	7.36	9.68
Gujrat	48.0	32.5	38.0	68.0	51.0	75.0	36.0	25.8	30.0	42.10	31.09
Punjab	84.0	72.5	70.3	95.5	92.4	91.0	87.5	78.5	75.0	82.6	60.00
U.P.	100.0	100.0	100.0	92.6	100.0	100.0	100.0	100.0	100.0	99.0	100.0
Kerala	25.6	21.8	17.3	27.0	25.0	20.4	21.0	17.8	14.4	20.8	15.4
W. Bengal	72.0	49.5	46.5	100.0	78.0	71.0	75.0	55.0	50.0	59.4	47.0
Maharashtra	43.5	21.4	20.0	63.5	35.0	33.6	57.0	29.4	27.8	34.3	20.0

Table 4.5(b) Capacity Utilization for 1969 using different basis and without price correction.

State	Capacity Utilization Basis					
	Output / FC	Output_M / FC	VA / FC	Arithmetical Average	Output-M / FC(deflated)	Difference
Andhra	5.9	6.95	2.5	5.1	-	-
T Nadu	31.6	43.50	30.8	35.3	38.2	3.1
Mysore	13.0	11.40	6.50	10.3	9.68	- 0.62
Gujrat	32.5	51.00	25.80	36.6	31.1	- 5.5
Punjab	72.5	92.4	78.5	81.0	60.00	-21.0
U.P.	100.0	100.0	100.0	100.0	100.0	0
Kerala	21.8	25.0	17.8	21.5	15.4	- 6.1
W. Bengal	49.5	78.0	55.0	61.0	47.0	-14.0
Maharashtra	21.4	35.0	29.4	39.0	20.0	- 19.0

Arithmetical average has been taken of the three values calculated above and compared to values for 1969 from table 4.5.

It is clearly seen that this method has also the effect of showing capacity utilization to be more than the actual values. These are again due to prices of finished goods having risen more than the fixed assets and thus showing capacity utilization to be more than actuals.

4.2 Influencing Variables:

A discussion of variables which are likely to affect the level of capacity utilization will now be taken up. At this stage their connection with capacity utilization is explained in terms of economic theory and behavioural aspects of operation of Industrial units. 15 such variables have been identified.

4.2.1 Capital Intensity:

$$\text{Capital intensity is defined as } \frac{\text{Total fixed capital employed(deflated}}{\text{Total no. of workers employed.}}$$

(i) For the same number of workers, total capital employed can be increased through procurement of expensive machinery and plant incorporating latest innovative features, designs, and developments. Such equipment in the hands of workers is expected to improve the rate of output. If the ratio of capital intensity is improved this way, the capacity utilization will improve only when rate of output increased is more than the rate of increase in capital intensity.

(ii) The capital intensity can also be increased by asking one worker to operate more than one machine as is done in more or less automatic plants. If the production per machine does not suffer and adequate man-machine balance can be struck then, through the capital intensity changes, effect on capacity utilization is nil as according to our definition, capacity utilization means utilization of capital assets. It is however, improbable that output per machine under the circumstances will not change. If that happens and output is reduced then increase in capital intensity is responsible for lower capacity utilization.

(iii) If, for the same capital, number of shifts are increased and more workers employed, i.e. time utilization of equipment is increased, then the total capacity utilization in terms of output/capital will definitely show a rise, though the capital intensity will fall.

Since the number of shifts of working are not known, a capital intensity factor can imply any of three facts enumerated above. Under these circumstances, except for (i) capital intensity is likely to be negatively correlated to capacity utilization.

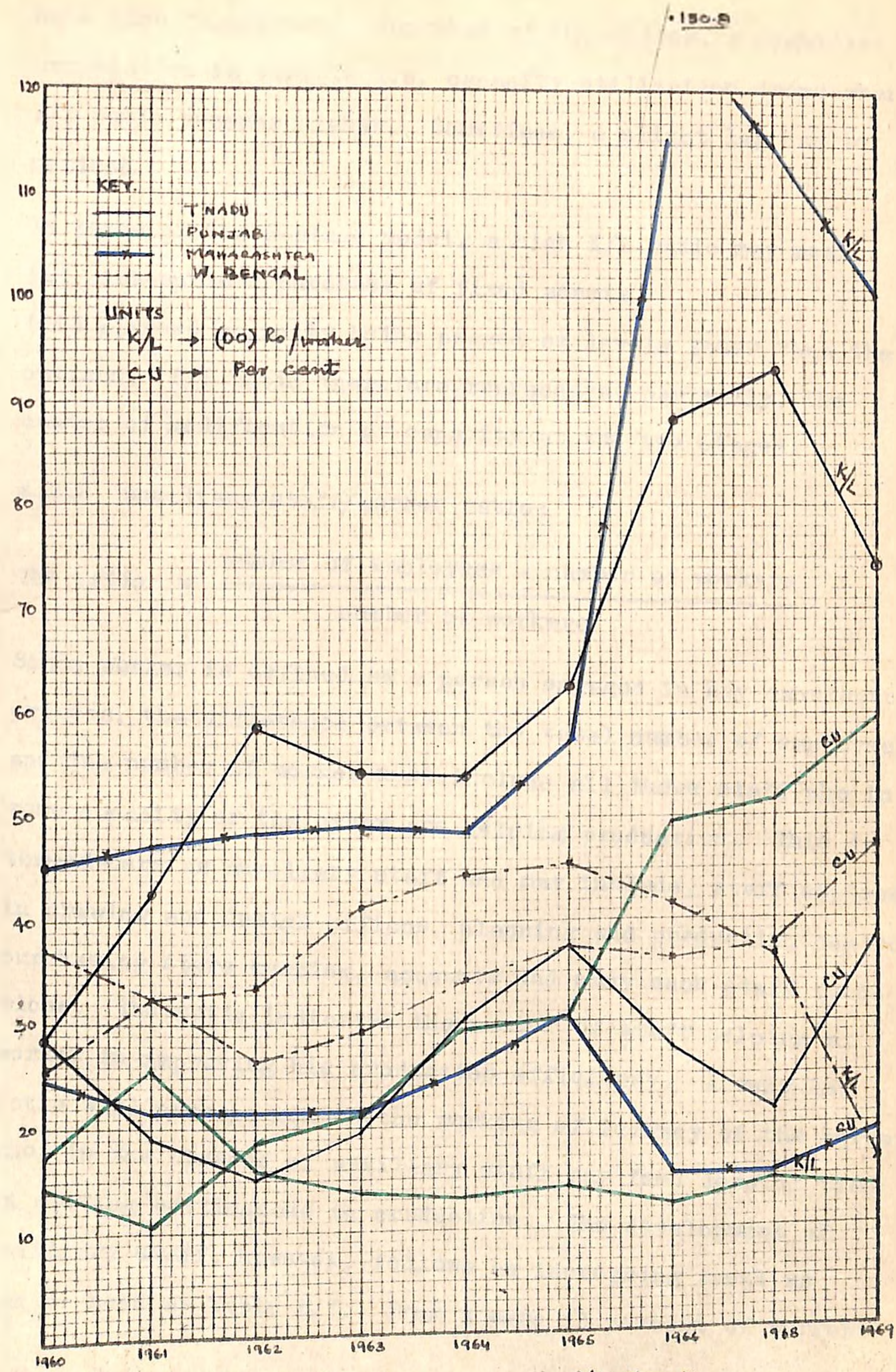
Change in the capital/worker ratio may be necessitated by a change in Technology necessary for the new range of products or by a change in the factor price ratio (4 - p28).

Changes for the various years of K/L ratio for various states are recorded in Table 4.6. K/L ratio for some states (West Bengal, T. Nadu, Maharashtra and Punjab) has been shown against different years in graphical form in fig. 4.2. For comparison, capacity utilization curves for the same states

Table 4.6 K/L Ratio Rs. (000)

Capital Intensity for Various States for Different Years for Industry No. 370-1.1

	Andh.	Tam. Nadu	Mys.	Guj.	Pun.	U.P.	Ker.	West Beng.	Maharas.
1960	1.71	2.85	1.90	-	1.71	-	1.43	2.55	4.50
1961	-	2.26	1.56	-	2.55	3.96	1.79	3.26	4.71
1962	3.19	5.85	-	-	1.60	4.74	1.90	3.37	4.82
1963	-	5.40	1.63	-	1.36	-	1.90	4.13	4.90
1964	3.77	5.38	2.45	-	1.30	-	1.76	4.45	4.85
1965	6.86	6.26	3.29	6.36	1.40	2.92	1.58	4.53	5.72
1966	112.65	8.83	17.66	9.49	1.21	2.39	17.95	4.18	13.08
1968	84.64	9.32	14.45	9.79	1.46	3.24	11.00	3.65	11.50
1969	-	7.40	12.63	7.74	1.35	2.59	10.51	1.64	10.17



150.8
120
110
100
90
80
70
60
50
40
30
20
10
KEY.
T NADU
PUNJAB
MAHARASHTRA
W. BENGAL
UNITS
K/L → (00) Rs/worker
CU → Per cent
K/L
CU
1960
1961
1962
1963
1964
1965
1966
1968
1969
YEARS →

Fig 4.2

have also been drawn. For most of the states, a negative correlation is visible i.e. capacity utilization drops when K/L ratio becomes higher. Sometimes, a slight lag can be noticed.

In terms of the 6-stage model, a high K/L ratio may mean
(i) sub-optimum purchase of fixed assets
(ii) planned capacity being pegged at levels lower than the optimum. K/L ratio therefore represents, partially, the causes of modification of capacity at the two stages.

4.2.2 Auxiliary staff/worker ratio:

$$\text{The ratio} = \frac{\text{number of employees - number of workers}}{\text{number of workers}}$$

Since worker is defined as a person engaged in any manufacturing process, the difference between the total number of employees and the number of worker must include all those staff who in some capacity or the other are helping production. This is termed here as auxiliary staff and may include, staff employed in drawing and design offices, planning and production control, purchasing store keeping, accounts and many such staff functions. The ratio indicates the number of staff helping a worker in improving his production efficiency. A very low ratio will perhaps reduce the working efficiency of the worker who, in the absence of auxiliary staff may feel loss of time in solving bottlenecks to production. The development of auxiliary staff, however, follows an increasing trend as can be seen at table 4.7. From a mere 13 percent of workers

Table: 4.7

Industry 370 - 1.1 Auxiliary staff/workers

	Andh.	Tam. Nadu	Mys.	Guj.	Pun.	U.P.	Ker.	West Bengal	Maharas.
1960	.16	.13	.26	-	.14	-	.22	.21	.11
1961	-	.18	.23	-	.03	.07	.22	.22	.12
1962	.10	.26	-	-	.02	.05	.21	.26	.14
1963	-	.31	.21	-	.03	-	.24	.34	.06
1964	.30	.39	.26	-	.05	-	.25	.37	.10
1965	.32	.39	.36	.44	.56	.11	.27	.38	.32
1966	.50	.48	.46	.48	.13	.11	.35	.34	.44
1968	.87	.53	.34	.52	.12	.13	-	.40	.36
1969	-	.52	.33	.53	.10	.13	.37	-	.32

strength in 1960 auxiliary staff has gone up to the level of 50 percent by 1969 in some states. However, it is not surprising. More and more staff functions are becoming highly specialised and therefore the number of departments and their strengths are continuously increasing. The ideal ratio is a function of the complexity of the production range. In a multiple regression analysis of all the years and all the states, the simple correlation coefficients of auxiliary staff to workers ratio to the following variables was high.

1. Capital per work.
2. Capital per unit,
3. Semifinished and raw material inventory per worker.
4. Electricity in KWH per worker.

The simple correlation coefficient with capacity utilization was -ve and only - 0.204. -ve correlation coefficient indicates that in the case of many states even though the ratio was high, capacity utilization was low. While that may not have affected the level of capacity utilization, it is clear that provision of auxiliary staff beyond a certain level may have no influence on the level of capacity utilization. In worst circumstances, conflicting roles of different departments can affect capacity utilization adversely.

Interpreted in terms of the six stage model, auxiliary staff is helpful if at all in collecting data and realistic framing of budgeted capacity and later on in ensuring that the actual production is as near the budgeted capacity as possible. In case budgted capacity is very much lower than the capacity expected of resources invested, capacity utilization will be automatically low despite the presence of a large number of auxiliary staff.

It is however expected that if capacity utilization was to be measured in relation to the budgeted capacity, the role of auxiliary staff will appear more significant. One more word about the presence of auxiliary staff particularly in public sector undertakings: These levels are first decided in relation to the workers required for the highest level of production for which the plant is installed and finally planned. These auxiliary staff are also quickly recruited while the actual recruitment of workers is regulated, based on actual production. Even if recruited, the surplus staff is given auxiliary staff work. Many times therefore the auxiliary staff shows a far bigger strength. This strength is the result of a faulty manpower assessment and naturally cannot be expected to be effective in improving capacity utilization. In a particular public sector undertaking $\frac{\text{auxiliary}}{\text{worker}}$ ratio as per DPR = 0.25.

Actual ratio in 1975 = 1.5*

*This includes 570 workers out of 1400 shown as auxiliary staff being surplus to working requirements.

4.2.3 Capital per Unit:

Assuming that there is no restriction on increasing inputs other than fixed capital as the fixed capital is increased, increasing capital per unit can be seen as increasing the scale of production and if the increasing scale of returns are assumed, then more the capital/unit, more is supposed to be the capacity utilization in terms of output to fixed capital employed. Capital/unit is given for different states over years in table 4.8. Comparing the table to table 4.5 (capacity utilization) high capital/unit generally leads to lower utilization of capacity.

As a matter of fact this variable does not represent the increasing scale of production for many reasons. Firstly averaging over the units distorts the scale of production of individual production units. One big firm and 10 small firms existing in one state and whose data is aggregated and then averaged cannot reveal the true nature of the scale. Moreover, many other factors are more important in determining output and their interjection dwarfs any role that increasing capital/unit may have to play.

If capital per unit increases and so does capital/worker, it clearly indicates that while capital per unithas gone up, the number of workers has not gone up to the same extent. Neither substitution of capital for labour, nor economies of scale can be inferred.

In the presence of the factor capital/worker, this factor does not appear to be influencing capacity utilization in any particular manner.

4.2.4 Rate of Change of Capital:

This has been estimated as $\dfrac{\text{deflated capital added in the current year}}{\text{deflated capital stock at the end of last year.}}$

Table : 4.8 Capital/Unit.

	Andh.	Tam. Nadu	Mys.	Guj.	Pun.	U.P.	Ker.	West Bengl	Maharas.
1960	94.24 (2)	513 (11)	770 (3)	–	244 (3)	–	179 (3)	644 (13)	927 (12)
1961	– (12)	504 (12)	641 (3)	=	94.3 (4)	697 (3)	211 (3)	721 (13)	942 (13)
1962	211.92 (3)	1039 (10)	–	–	229 (4)	854 (3)	236 (3)	1007 (13)	982 (14)
1963		1044 (11)	876 (3)	– –	176 (5)	–	228 (3)	928 (17)	1696 (14)
1964	236.18 (5)	1082 (10)	901 (6)	–	155 (9)	–	214 (3)	1206 (16)	1304 (23)
1965	679.78 (3)	1271 (11)	980 (7)	1726 (7)	114 (7)	802 (3)	195 (3)	830 (23)	1492 (23)
1966	446.10 (4)	1387 (16)	6334 (9)	2998 (6)	78 (11)	609 (4)	2293 (4)	783 (31)	2624 (25)
1968	37055 (5)	1310 (15)	7454 (7)	2056 (10)	117 (11)	437 (8)	1223 (6)	718 (25)	2104 (43)
1969	–	990 (13)	6675 (7)	1715 (10)	93 (10)	427 (8)	1118 (7)	558 (29)	450 (40)

The faster rate of investment is likely to lead to lesser utilization of capital stock after addition of the capital due to many reasons, the important of these being the limitations of the existing 'Management' capability. As a matter of fact all staff functions including planning, control, maintenance inspection, tool room and industrial engineering may be found inadequate, and may require additional strengthening vis-a-vis the capital being added. Even if this is done, behaviour of new assets is likely to be somewhat unpredictable and stabilization takes a little time. This period, sometimes called gestation period (82-p43) can differ with different managements but on the whole capacity utilization does get affected due to the rate of the change of capital.

Addition to fixed capital can affect the capacity utilization in another way. More output as a result of increased capital cannot be readily absorbed by the existing market. In any case, even if the new investment was planned as a result of the change in demand, time lag between the decision to invest and the actual installation of fixed assets in such that the real output may not match the existing demand and it will take some time for demand to match output.

Phasing of additional investments in a manner that it does not tax the managerial and administrative capabilities is itself a function of these capabilities and hence the factors in a way, represents the managerial capability. Economic factors can help or hinder the process of stabilization of new capital. Capacity utilization is naturally likely to be inversely related to the rate of change of capital.

Table 4.9 gives the values of rate of change of capital for various states for various years. Figure 4.3 represents these figures graphically along with capacity utilization for some states.

If rate of change in year t-1 = x_1 and in year t = x_2 and $x_2 > x_1$. Then it is assumed that x_1 has been absorbed. If however, $x_2 < x_1$ then rate of change for year t is taken as $= (x_1 + x_2)/2$. This has been done to take care of the fact that huge addition to capital in one particular year may have its effect in subsequent years.

A number of investment theories have been advanced and sufficient number of models have been built linking the level of investment in a particular year to past sales, present sales, past profits, present profits, levels of capital stock etc. (53 - pp50). The concern in this study is not as to why this rate of investment comes about but on its possible effects on utilization of the capacities which get created as a result of this investment.

4.2.5 Employees/Unit:

This is calaulated by dividing the total number of employees in a state by the number of units in the state.

When average number of employees in a unit increases, specialization becomes feasible and leads to many advantages for the firm.

Table: 4.9

Rate of change of capital

	Andh.	Tam. Nadu	Mys.	Guj.	Pun.	U.P.	Ker.	West. Bengl.	Maharas.
1960	-	-	-	-	-	-	-	-	-
1961	-	0.19	0	-	0	-	0.32	0.24	0.18
1962	0.60	0.96	-	1.71	0.32	0.27	0.62	-	0.24
1963	-	0.60	0.26	-	0.89	-	0.17	0.38	0.91
1964	0.40	0.34	1.29	-	0.85	-	0.13	0.40	0.42
1965	0.86	0.45	0.43	-	0.43	0.08	0.09	0.30	0.48
1966	89.8	0.85	1.89	0.60	0.35	0.20	16.9	0.48	1.16
1968	44.94	0.10	3.96	0.12	0.32	0.30	8.6	0.25	0.71
1969	-	-	2.60	0.08	0.16	0.15	4.48	0.15	0.40

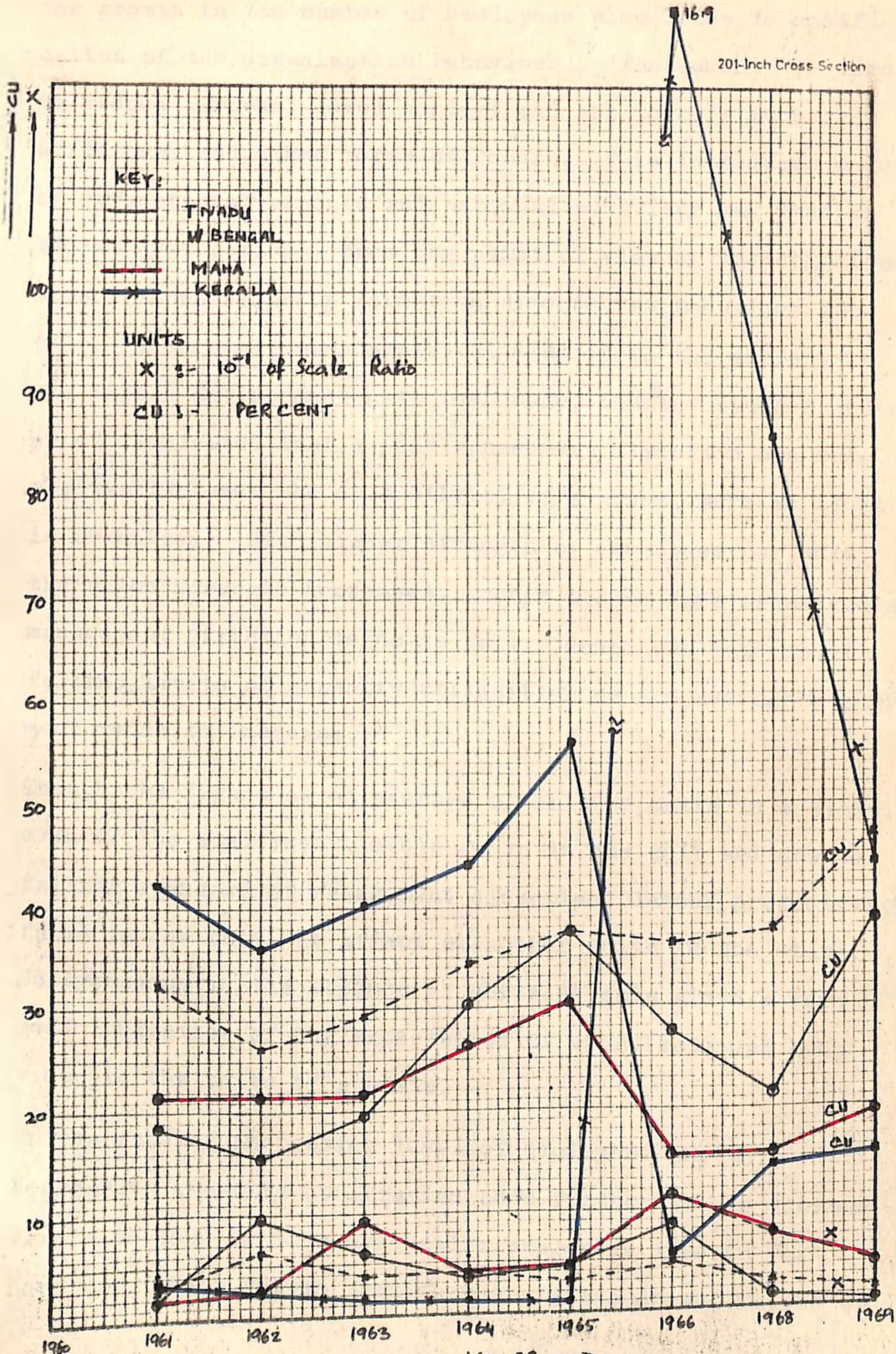

201-Inch Cross Section
CU
X
KEY:
TNADU
W BENGAL
MAHA
KERALA
UNITS
X :- 10^{-1} of Scale Ratio
CU :- PERCENT
100
90
80
70
60
50
40
30
20
10
1960
1961
1962
1963
1964
1965
1966
1968
1969
YEARS →
16.9
22
CU
CU
CU
CU
X
X

Fig 4.3

The growth in the number of employees also leads to modification of the organization behaviour. 'Management' is forced to reduce personal level contact and has to rely more on efficiency and other forms of report. This introduces a lot of dyfunctional aspects and personal behaviour may tend to become dysfunctional from the point of view of the organization. Moreover, group formation affects the behaviour further. Though not many empirical studies on the subject in the Indian Environment have been made, Schacter studies (60 - pp 47) indicated that a poor management direction can substantially lower the productivity of a group, more so if it is organized. With higher strength of employees per unit, the union strength increases, groups become more organized and management direction tends to fall. Hence one can expect falling levels of capacity utilization as the average employment tends to increase.

Though the figure is an average of all the units in a state, even if the employment levels go up in one unit and due to falling standard of management direction, labour productivity falls in one unit, it affect all other units in the state. So averaging in the absence of unitwise data gives a very good indication of the expectation of organizational behaviour in the units of a state.

In the face of increasing level of employees per unit, decreasing capacity utilization adds further to the vicious circle as idle or less productive employees lose in take home pay, which drives them further to groups and unions to safeguard their interest and the ensuing confrontation lowers capacity utilization further.

Figures for employees/unit for the nine states for 9 years may be seen at table 4.10. Comparative position of capacity utilization vis-a-vis the employees/unit for the year 1968 is given at fig. 4.4. It is clear from the figure that as the number of employees/firm increases, capacity utilization generally tends to fall.

It is not surprising that the public sector undertakings with huge large number of employees per unit in the engineering sector at least are not showing a good level of capacity utilization.

A good management direction and control can however alter the picture. Schacter study revealed that a well organized employee force under a competent management direction can lead to the highest productive standards.

4.2.6 Working Capital to Fixed Capital Ratio:

This was calculated by deflating the working capital to 1952-53 prices, using Industrial Raw Materials price index and by using Fixed capital (deflated) as calculated earlier. Lack of working capital has been indicated as one of the major reasons for poor output by the Industry representatives off and on. Credit squeeze by the Government of India resulted in a number of factories running to low levels of capacity utilization and a number of smaller units had to finally close down.

Table: 4.10 Employees/Unit.

	Andh.	Tam. Nadu	Mys.	Guj.	Pun.	U.P.	Ker.	West Bengl.	Maharas.
1960	64	204	574	-	164	-	152	306	230
1961	-	140	506	-	38	188	144	272	225
1962	73	224	-	-	147	190	150	376	232
1963	-	253	649	-	133	-	149	301	368
1964	82	280	463	-	125	-	152	373	296
1965	131	283	405	391	127	304	158	253	344
1966	594	233	524	470	73	282	173	251	289
1968	822	215	694	319	90	153	49	275	249
1969		204	706	339	76	186	146	240	279

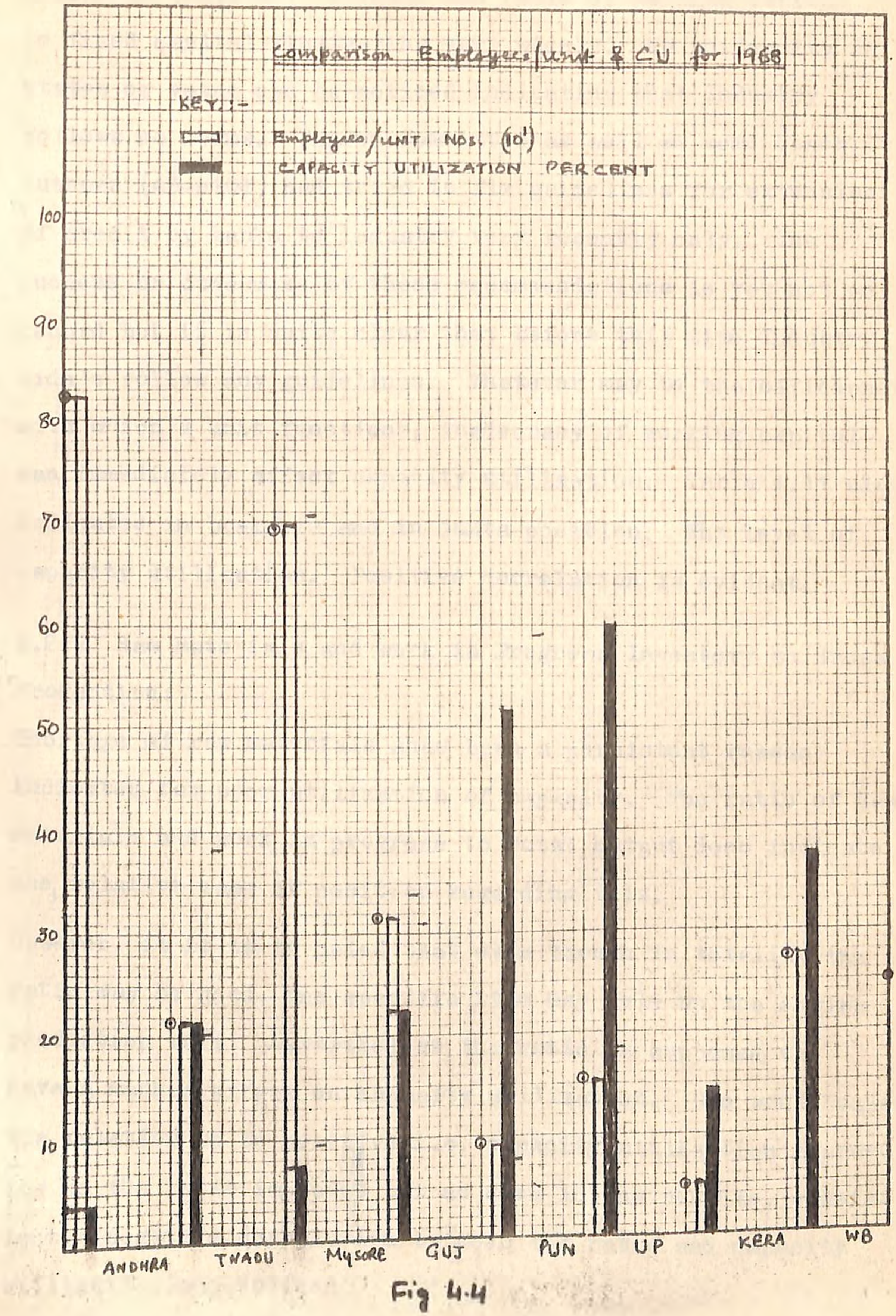

Comparison Employees/unit & CU for 1968
KEY :-
Employees/UNIT NOS (10')
CAPACITY UTILIZATION PERCENT
100
90
80
70
60
50
40
30
20
10
ANDHRA
TNADU
MYSORE
GUJ
PUN
UP
KERA
WB

Fig 4.4

A look at table 4.11 reveals the ratio of working capital to fixed capital fluctuating very widely. No uniformity in states or years can be noticed indicating that Industry follows no norms. Tandon Committee as well as some other authors (43-p104) had tried to fix guidelines for extension of credit by banks to industry very recently only. The success or otherwise of these recommendations is yet not on record but it is quite clear that before this time Industry didn't follow any guidelines. Whatever may be the efficiency with which a unit functions, inadequacy of working capital can immediately affect capacity utilization. Table 4.11 also indicates in brackets and in juxta position, the level of capacity utilization. Positive correlation is evident.

4.2.7 Raw Materials and work in Progress Inventory to Gross Production:

Shortage of raw materials has been a persistent reason indicated for poor utilization of capacity. The ratio of Raw materials and work in progress to total output does indicate the relative ease of position regarding this.

However, it is to be noted that even though in totality the ratio may be good, one specific item may hold up the entire production belt. Nevertheless, the ratio is supposed to have a marked effect on capacity utilization. One would expect the relation to be positive i.e. capacity utilization improving as the ratio improves but as seen in the results, consistently negative correlation between the ratio and capacity utilization was noticed.

Table: 4.11 Working capital/ Fixed Capital

	Andh.	Tam Nadu	Mys.	Guj.	Pun.	U.P.	Ker.	West Bengl.	Maharas.
1960	0.0 (21.07)	0.55 (27.98)	3.03 (32.75)	-	0.93 (14.18)	-	1.42 (42.45)	0.64 (37.0)	0.70 (24.9)
1961	-	0.18 (18.96)	4.19 (48.25)	-	0.49 (10.66)	0.52 (17.8)	0.78 (44.3)	1.04 (32.2)	0.55 (21.5)
1962	0.95 (19.68)	0.02 (15.61)	-	-	0.80 (18.77)	0.13 (15.0)	1.28 (35.6)	1.16 (26.4)	0.71 (21.7)
1963	-	0.69 (19.48)	5.02 (40.11)	-	0.96 (21.00)	-	1.42 (40.3)	1.08 29.1)	0.87 (21.3)
1964	0.76 (38.25)	0.80 (30.32)	2.80 (35.72)	-	0.69 (29.50)	-	1.15 (44.8)	0.57 (34.1)	1.18 (26.4)
1965	0.50 (32.85)	0.99 (37.39)	2.29 (35.13)	0.23 (21.94)	0.77 (30.12)	1.40 (41.7)	1.05 (56.0)	0.82 (37.7)	1.09 (30.2)
1966	0.15 (.72)	0.04 (27.70)	0.25 (6.68)	0.38 (16.72)	1.00 (49.42)	1.14 (71.0)	0.48 (6.14)	0.73 (36.7)	0.44 (15.2)
1968	0.15 (3.73)	0.32 (21.26)	0.93 (7.30)	0.56 (22.93)	1.01 (51.50)	1.14 (59.6)	0.97 (14.88)	0.65 (37.6)	0.23 (15.7)
1969	- (38.28)	0.59 (9.68)	1.15 (31.09)	0.92 (59.5)	0.81 (100)	1.16 (15.4)	0.52 (47.0)	0.82 (47.0)	0.58 (19.5)

On close scrutiny it is argued as follows:

Inventory control is a major area affecting cost of production. All competent managements are trying to reduce the levels of raw material and work in progress inventories to optimum levels. The increased interest in Inventory is evident from the spate of inventory models in material management literature. Very high ratio of raw material and semifinished inventories, despite known adverse effects on cost can only point to Managements' lack of interest or lack of capability. Either way, with this type of management, probability of capacity utilization being low is high. Particullarly for WIP, managements' lack of scheduling can be responsible for increased WIP. A few shortcomings are noticeable as follows:

(i) Inventory levels are given at the end of the year under consideration. These levels can fluctuate widely during the year.

(ii) Aggregation of all types of raw materials and work in progress fails to highlight the specific shortages and excesses.

(iii) In case of future sales expectation, the increase in inventory is a deliberate management decision and the -ve correlation may be incidental (82-161).

(iv) Price correction through a consumer raw materials index may be a very crude approximation and in the absence of details of components, though necessary, may be introducing distortion. However since one type of Industry is under consideration, the mix of raw material may not be very dissimilar.

Various percentages of this ratio held in various state over various years is given in table 4.12. Comparing with WC/FC ratios given in table 4.11, no relationship can be established between WC/FC and inventory ratios.

4.2.8 Finished Goods Inventory to Gross Production Ratio: This ratio is intended to indicate the level of demand for the products. When demand falls and the finished goods inventory starts increasing there has to be a cutback in production. Reduction in production levels is accompanied with changes in manpower requirements, labour idling, cut back in purchases and reduction in other expenditure. Reduced levels of productions tend to increase cost per unit product. Hence cutbacks in productions are generally avoided and minor variations in sales are absorbed by varying the finished goods inventories within certain levels. Increasing levels of this inventory therefore are an indicator of decreasing demand. Though reducing levels of the finished goods inventory may be a result of poor output from production units.

Only inventories for the year under consideration are taken and not that of the previous year. It is seen in most of the industries that the actual production plans are varied depending on the sales from month to month and reaction

Table: 4.12

Semi-finished and Raw material inventory to Gross Production percentage.

	Andh.	Tam. Nadu	Mys.	Guj.	Pun.	U.P.	Ker.	West. Bengl.	Maharas.
1960	0	30.0	45.3	-	32.4	-	27.3	32.8	30.4
1961	-	32.2	38.7	-	61.5	39.3	28.9	39.6	26.8
1962	52.5	35.3	-	-	23.0	50.5	34.0	42.9	29.9
1963	-	40.0	40.0	-	29.1	-	30.1	33.9	40.0
1964	32.2	37.2	46.1	-	33.0	-	31.7	33.7	36.2
1965	29.3	43.9	46.5	31.3	29.8	29.2	23.4	35.7	36.6
1966	329.8	28.9	92.2	39.1	20.3	30.4	96.7	40.5	39.1
1968	163.2	58.4	86.3	38.4	19.7	32.8	60.3	38.0	42.6
1969	-	45.9	94.6	35.1	17.4	27.0	79.9	35.8	38.2

rates are very fast. Inventory building is dependent upon the working capital available as well as the expectation of future sales.

Ratios as calculated are shown in Table 4.13. Inventory has varied from 0 to 24 percent. This factor is considered very important by the Industry but in the analysis has not emerged as a powerful variable. If the maximum level of finished goods inventory is not high enough, working capital available is not adequate and reaction rate to sales level is high, the actual built up inventory may remain very low.

4.2.9 Emoluments per Employee:

Table 4.14 indicates the ratio for the different regions from 1960-1969. Extent of emoluments vary in 1969 from Rs. 960/- per employee per year in Punjab to Rs. 3650/- per employee per year in Kerala. These are actual money emoluments as corrected for price index and for this purpose total employees living index has been considered. These thus represent real wages. While there is an increasing trend of this ratio, there is no increasing trend of capacity utilization. 'Regional' variations may be due to differential group pressures on the management. Organized workers with collective bargaining may be able to arrange for their members progressively better pay scales without connecting the enhancements to increases in productivity. Hence higher values of this ratio are not correlated to output positively. Negative correlation is indicated when

Table: 4.13
Finished Goods Inventory/Gross Production.

	Andh.	Tam. Nadu	Mys.	Guj.	Pun.	U.P.	Ker.	West Bengal	Maharas.
1960	0	0.02	0.10	–	0.08	–	0.11	0.02	0.03
1961	–	0.02	0.12	–	0.24	0	0.01	0.02	0.04
1962	0	0.04	–	–	0.11	0.10	0.04	0.03	0.06
1963	–	0.09	0.02	–	0.05	–	0.05	0.07	0.04
1964	0	0.08	0.06	–	0.07	–	0.03	0.05	0.05
1965	0	0.07	0.09	0.05	0.06	0	0.04	0.06	0.05
1966	–	0.08	0.09	0.04	0.03	0.01	0.02	0.06	0.10
1968	–	0.08	0.19	0.11	0.03	0.06	0.04	0.04	0.10
1969	–	0.03	0.14	0.05	0.03	0.03	0.01	0.05	0.08

Table 4.14 Deflated Emoluments/Employee

	Andh	Tam. Nadu	Mys.	Guj.	Pun.	U.P.	Ker.	WEST Bengal	Maharas.
1960	0.77	1.07	1.37	-	1.53	-	1.31	1.22	1.99
1961	-	1.29	1.42	-	0.80	0.95	1.50	1.30	1.91
1962	0.85	1.51	-	-	2.19	1.06	1.60	1.57	1.38
1963	-	1.52	1.52	-	0.86	-	1.29	1.79	2.27
1964	0.95	1.79	1.31	-	0.66	-	1.19	1.74	2.11
1965	1.19	1.93	1.45	1.90	0.56	1.21	1.07	1.69	2.35
1966	1.80	1.58	1.74	2.05	0.80	1.22	1.09	1.64	2.20
1968	2.26	1.83	1.73	1.83	0.82	1.45	3.65	2.00	2.27
1969	2.91	2.91	2.03	1.75	0.96	1.69	3.65	2.21	2.61

Table 4.15 Hours per year per worker (000).

	Andh.	Tam. Nadu	Mys.	Guj.	Pun.	U.P.	Ker.	West Bengal	Maharas
1960	2.32 (.02)	2.34	2.34	-	2.23	-	2.37	2.32	2.31
1961	-	2.26	2.18	-	2.40	2.21	2.31	2.25	2.26
1962	2.24 (-.06)	2.31	-	-	2.34	2.29	2.34	2.28	2.27
1963	-	2.31	2.34	-	2.32	-	2.23	2.39	2.26
1964	2.38 (.08)	2.25	2.20	-	1.84	-	2.31	2.36	2.16
1965	2.37 (.07)	2.24	2.32	2.24	2.32	2.46	2.38	2.35	2.22
1966	2.34 (.04)	2.25	2.25	2.25	2.37	2.27	2.36	2.30	2.23
1968	2.37 (.07)	2.36	2.37	2.34	2.36	2.42	2.07	2.21	2.24
1969	-	2.88	2.14	2.43	2.38	2.39	2.21	1.01	2.22

Schacters model is referred to (160 - pp47). According to Schacters experiments, in the absence of managerial direction, highly cohesive groups (strong union) may be least productive. Emoluments gained through strength of labour groups has to be matched with Managerial competence to enable better output for the same level of capacity available. Relationship between capacity utilization and emoluments per employee for T Nadu is shown in an example.

4.2.10. Hours per Year per Worker:

Average = 2250 hours.

Simple correlation coefficient with capacity utilization = 0.019.

Calculation Method:

Man hours worked = Σ Number of men present x hours in shift all shifts in a year.

Values are given in table 4.15 and overtime hours are not considered.

Comments:

1. For this industry at least, the number of hours worked by each worker was not significantly different between regions and between years except for West Bengal in 1969.
2. These hours are calculated from the gate attendance cards of workers. If idleness prevails after the worker was reported for work, the same will not be reflected here.
3. Absenteeism can be compensated by overtime and therefore figures don't truly reflect the loss due to strikes, lock-outs or absenteeism.
4. Simple correlation with capacity utilization is very low. It may indicate that the time standards are so loose

that the workers can compensate for lost production by working a little more efficiently for lesser hours when they so desire particularly after a strike when workers' as a part of overall agreement assure that they will compensate for lost production.

5. Contrary to general feeling absenteesm as such seems to have very little effect on output.

Two kinds of absenteeism can be recalled. Firstly the workers may be on paid leave. Since paid leave will be invariably availed by the worker, the management has to either provide leave reserve against this leave or reduce the availability of man hours to this extent in the reckoning for output. Relatively speaking, with almost the same type of service conditions available, the effect on account of this kind of absenteeism on output cannot be significant.

Unauthorised absenteeism can upset working not only of the load centre from where the worker has absented but also of these load centres which are fedby this load centre. Immobility of existing workers from one load centre to another aggrevates the consequences resulting out of unauthorised absenteeism.

This kind of absenteeism may be offset by the booking of overtime. Exceptionally long spells of strikes and lockouts can affect production badly. However after a lockout or strike the demand for the product is high, absenteeism of workers is low, efficiency of the workers is high particularly when the agreement consequent to strike or lockout is satisfactory and there is relative peace in the working environment. As a result some of the loses of production are offset and in an aggregate analysis the differences may not prove significant.

4.2.11 Electricity per Worker:

Average = 1280 K watts (all years, all regions)

Standard deviation = 0.88

Simple correlation with capacity utilization = - 0.370.

With capital/worker = 0.727.

Values are given table 4.16.

Comments:

1. The figures are in KWH/worker/year.

2. The record is of electricity purchased and not produced within the plant. To this extent, it may not be a true indication of the electricity consumption per worker.

3. Increasing trend from 1960-1969 in quite clearly visible.

4. Bigger values can indicate two things:

(i) Capital deepening: More sophisticated equipment in the hands of workers, doing more work per unit time and thus consuming more power. High simple correlation coefficient with capital per worker.

(ii) Uncontrolled losses of electricity: As the size of the company becomes bigger, the power consumption losses go up.

5. -ve correlation is significant in as much as it proves that higher consumption of electricity is dysfunctional and higher the consumption of electricity, the output per capital increase may not be compensated and in fact go down.

Table: 4.16 Electricity per worker (000 KW Hr.)

	Andh.	Tam. Nadu	Mys.	Guj.	Pun.	U.P.	Ker.	West Bengal	Maharas.
1960	0.40	0.88	0.15	–	0.48	–	0.62	0.64	1.01
1961	–	1.19	0.80	–	0.35	1.01	0.35	0.91	0.99
1962	0.84	1.32	–	–	0.32	1.21	0.39	1.38	0.96
1963	–	1.38	0.81	–	0.35	–	0.30	1.56	1.23
1964	1.07	1.63	0.72	–	0.30	–	0.32	1.56	0.53
1965	1.21	1.81	1.00	1.55	0.44	1.29	0.73	1.67	1.91
1966	3.50	1.75	1.46	2.11	0.62	0.91	2.76	1.52	2.20
1968	5.73	2.05	1.68	1.89	0.94	1.41	1.97	1.37	2.38
1969	3.52	2.03	1.49	0.61	1.11	1.29	0.76	2.26	2.26

Table: 4.17 Wages to value added (percentage).

	Andh.	Tam. Nadu	Mys.	Guj.	Pun.	U.P.	Ker.	West. Bengal	Maharas.
1960	1.27	0.41	0.80	–	4.40	0.59	0.66	0.39	0.58
1961	–	0.55	0.55	–	0.81	0.59	0.50	0.35	0.38
1962	0.38	0.53	–	–	1.67	0.40	0.57	0.49	0.32
1963	–	0.47	0.65	–	0.75	–	0.51	0.54	0.54
1964	0.31	0.55	0.40	–	1.17	–	0.52	0.49	0.48
1965	0.02	0.41	0.48	0.62	0.82	0.79	0.45	0.50	0.59
1966	2.51	0.42	0.93	0.72	0.73	0.51	2.50	0.57	0.59
1968	1.71	0.78	2.19	0.95	0.61	0.42	0.63	1.13	0.76
1969	–	0.75	1.69	0.68	0.69	0.25	1.59	0.93	0.70

6. However, the correlation coefficient is low.

Till 1969, power shortage was not so acute. Even now (1978) when power position is acute, one can observe that optimum utilization of power is not the primary concern of the management. When less power forces idleness of equipments, some of this idleness can get offset against time required to be provided against labour fatigue, preparation for loading work, understanding work instructions, and continuing work requiring no power.

To that extent relationship between consumption of power purchased and output is not very explicit.

4.2.12 Wages as a Percentage of Value Added:

Simple correlation coefficient with capacity utilization = 0.011.

1. In Maharashtra, Gujrat, UP and T Nadu, percentage of wages to value added has been less than 1.

2. However, for running plants, the losses or gains don't seem to affect capacity utilization (low correlation coefficient).

3. When the operation results in a loss:

(i) Cost of production can be reduced by improving utilization.

(ii) Cost of production can be reduced by other controls.

(iii) Utilization can be reduced but this will push up the cost/piece further.

4. Values for different years and different regions are given in table 4.17.

4.2.13 Number of Firms:

Average = 10.04 (All regions, all years)

Simple correlation coefficient with capacity utilization=0.012.

Values are given in table 4.18.

Comments:

1. If number of firms is large, more competition exists. This can force firms to reduce their cost of production through better utilization of resources, or depending upon market conditions restrict output due to lesser number of total orders available in the interim period i.e. the period when new capacity has been created and its full absorption by the demand is yet to take place.

2. Number of firms in an industry can be the result of licensing policy which can itself be an outcome of the current policy on import substitution, export promotion or expectations of future growth.

4.2.14 Value Added per Worker:

Average = Rs. 6390/worker

Simple correlation with capacity utilization = 0.101.

Values are given in Table 4.19.

Comments:

1. Value added per worker is normally misconstructed as a productivity index. However, value added as calculated here is a sort of fund remaining for distribution amongst workers, share holders, Government and creditors. The value of this depends upon many other factors and this does not seem to ~~be~~ influence capacity utilization substantially.

Table: 4.18 No. of firms.

	Andh.	Tam. Nadu	Mys.	Guj.	Pun.	U.P.	Ker.	West Bengal	Maharas.
1960	2	11	3	-	3	-	3	13	12
1961	-	12	3	-	4	3	3	13	13
1962	3	10	-	-	4	3	3	13	14
1963	-	11	3	-	5	-	3	17	14
1964	5	10	6	-	9	-	3	16	23
1965	3	11	7	7	7	3	3	23	23
1966	4	16	9	6	11	4	4	31	25
1968	5	15	7	9	11	8	6	25	43
1969	-	13	7	10	10	8	7	29	40

Table: 4.19 Value added /worker (Rs.000).

	Andh.	Tam. Nadu	Mys.	Guj.	Pun.	U.P.	Ker.	West Bengal	Maharas.
1960	0.85	3.55	2.60	-	0.48	-	2.89	4.49	4.59
1961	-	3.35	3.80	-	1.21	2.06	4.41	5.48	6.74
1962	3.08	4.54	-	-	1.69	3.51	4.25	5.02	6.14
1963	-	5.75	3.83	-	1.60	-	4.28	6.01	6.09
1964	6.38	7.16	6.47	-	0.95	-	4.54	0.77	7.57
1965	89.59	10.91	6.85	7.43	1.79	2.86	5.05	0.07	8.72
1966	.15	11.14	5.44	8.35	2.48	5.28	1.18	7.73	10.70
1968	5.71	8.25	2.44	6.71	3.47	9.01	5.89	5.69	9.31
1969	-	12.73	3.45	8.51	3.30	16.32	6.75	3.59	10.54

2. From the point of view of the entrepreneur, the ultimate decision maker whose decisions affect capacity utilization, (value added - wages) seems to be more relevant.

4.3 Regression Model Used:

1. Standard regression package was used. This package estimates the coefficients using least square method and assuming a linear relationship of the predictor with the explained variable of the form

$$Y = \alpha_0 + \alpha_1 x_1 + \alpha_2 x_2 \ldots\ldots \alpha_n x_n + \epsilon$$

2(i) First simple correlation coefficient of all the variables with the explained variable are calculated and the first variable to enter the equation is decided on the basis of maximum +ve or -ve correlation with dependent variable.

(ii) After the entry of this variable, the effect of this variable on all other variables including the explained variable is removed. In other words and to generalise, the question at (p+1)th step is to decide as to which variable is to enter next ? Ref. to (9).

We calculate partial correlation coefficients:

$r_{yj.12\ldots p}$, $j = p+1, \ldots, n$ and then choose that predictor variable to enter in the regression which has numerically the largest partial correlation coefficient with Y. Or we choose an ℓ such that $p+1 \leq \ell \leq n$ such that

$|r_{y\ell.12\ldots p}| \geq |r_{yj.12\ldots p}|$ for $j = p+1$ to n.

It can be seen that $F_{statistic} = \dfrac{||X_{n+1}^{(p)}||^2 - ||X_{n+1}^{(p+1)}||^2}{||X_{n+1}^{(p+1)}||^2 / k-p-2}$

where k = number of observation.

p = number of variables entered.

Critical region is $F \geq F_{p,k-p-1,\ 1-\alpha}$.

Where α is the error accepted of the first type i.e. the possibility of rejecting the hypothesis even though it is correct.

If H_0 is accepted, the new variable does not decrease the unexplained sum of squares significantly and so should not be entered. The programme is so written that at each stage, the new variable is selected with the process mentioned above. This reduces the problem of multi-collinearity as after the effect of the variable introduced is reduced, the variable having collinearity with the introduced variable will almost become zero and be pushed in the end of the list of variables for entry into the regression equation.

Tests of Hypothesis:

(a) Significance of the coefficient of estimate

$H_0 : b_1 = 0$

$t = b_1/s_b$

If $t \geq t\,(1-\alpha/2)\ (n-p-1)$ $t(1-\alpha/2)(n-p-1)$

or

$t \leq -t(1-\alpha/2)(n-p-1)$

where n = number of observations

p = number of variables entered.

Then H_o is rejected and b_1 considered significant.

Tables used (73-p528).

(b) Goodness of Fit:

Critical region of size α

$F \geq F_{p,k-p-1,1-\alpha}$

where F = MSF / MSE and

$$MSR = \frac{\text{sum of squares due to regression}}{p} = \frac{SSR}{p}$$

$$MSE = \frac{\text{sum of squares due to error}}{k-p-1} = \frac{SSE}{k-p-1}$$

$$SSR = \sum_{i=1}^{k} (\hat{Y}_i - \bar{Y})^2 \quad SSE = \sum_{i=1}^{k} (Y_i - \hat{Y}_i)^2$$

when H_o is rejected we may that Fit is good.

Tables used (73 - pp529).

Step by Step Regression:

Advantage of this regression is that the regression can be stopped as and when standard error of estimate starts going up.

4.3.1 Abbreviations and Units of variables used in regression equations.

Explained Variable	Abbreviation	Units
1. Capacity Utilization	CU	Percent
Explaining Variables:		
1. Fixed capital per worker	FC/W	Rs.(,000)
2. Fixed capital per unit	FC/U	Rs.(,000)
3. Auxiliary staff per worker	(E-W)/W	Ratio
4. Employees per unit	E/U	Number
5. Working capital per fixed capital	WC/FC	Ratio
6. Finished Goods inventory per gross production unit	FI/GP	Ratio
7. Machinery and Plant per fixed capital unit	MP/FC	Ratio
8. Man Hours per worker	MH/W	Hours(,000)
9. Emoluments per employee	Em/E	Rs.(,000)
10. Electricity per worker	El/W	KWH(,000)
11. Wages per unit of value added	Em/VA	Ratio
12. Semi Finished and raw materials inventory per gross production unit.	SI/GP	Percent
13. Value added per worker	VA/W	Rs.(,000)
14. Number of firms	U	Number
15. Rate of change of capital	X	Ratio

Where FC = Fixed capital Rs.(,000)

WC = Working capital Rs.(,000)

E = Number of employees

E = No. of employees

W = Number of workers

Em = Emoluments Rs. (,000)

El = Electricity KWH (,000)

FI = Finished goods inventory Rs. (,000)

SI = Semifinished goods inventory including raw materials inventory Rs. (,000)

U = Number of firms

GP = Gross production Rs.(,000)

MH = Man Hours worked Hours(,000)

VA = Value added Rs. (,000).

4.3.2 Equation Forms Used:

Equation Number		Equation Form
1.	1.1	$CU = \alpha_o + \alpha_3 \frac{WC}{WC} + \alpha_5 U + \alpha_6 \frac{SI}{GP} + \alpha_7 \frac{E}{U} + \alpha_8 \frac{EI}{GP}$
2.	1.2	$CU = \alpha_o + \alpha_1 \frac{FC}{W} + \alpha_3 \frac{WC}{FC} + \alpha_4 \frac{Em}{E} + \alpha_6 \frac{SI}{GP} + \alpha_7 \frac{E}{U}$
3.	1.3	$CU = \alpha_o + \alpha_1 \frac{FC}{W} + \alpha_2 \frac{E-W}{W} + \alpha_3 \frac{WC}{FC} + \alpha_4 \frac{Em}{E} + \alpha_5 U + \alpha_6 \frac{SI}{GP} + \alpha_7 \frac{E}{U} + \alpha_8 \frac{FI}{GP} + \alpha_{10} \frac{VA}{W}$
4.	1.4	$CU = \alpha_o + \alpha_3 \frac{WC}{FC} + \alpha_4 \frac{Em}{E} + \alpha_6 \frac{SI}{GP} + \alpha_7 \frac{E}{U} + \alpha_9 X$
5.	1.5	$CU = \alpha_o + \alpha_1 \frac{FC}{W} + \alpha_2 \frac{E-W}{W} + \alpha_3 \frac{E}{U} + \alpha_4 \frac{WC}{FC} + \alpha_5 \frac{SI}{W} + \alpha_6 \frac{FI}{GP} + \alpha_7 \frac{MP}{FC} + \alpha_8 \frac{MH}{W} + \alpha_9 \frac{Em}{E} + \alpha_{10} \frac{El}{W} + \alpha_{11} \frac{Em}{VA} + \alpha_{12} \frac{SI}{GP} + \alpha_{13} \frac{VA}{W} + \alpha_{14} U$
6.	2.1	$CU_1' = \alpha_o + \alpha_2 \frac{W}{E} + \alpha_4 \frac{Em'}{E} + \alpha_7 \frac{E}{U}$
7.	2.2.1	$CU_1' = \alpha_o + \alpha_1 \frac{FC'}{W} + \alpha_4 \frac{Em'}{E} + \alpha_6 \frac{SI'}{GP} + \alpha_7 \frac{E}{U}$
8.	2.2.2	$CU' = \alpha_o + \alpha_1 \frac{FC'}{W} + \alpha_4 \frac{Em'}{E} + \alpha_6 \frac{SI'}{GP} + \alpha_7 \frac{E}{U}$
9.	2.3.1	$CU_1' = \alpha_o + \alpha_1 \frac{FC'}{U} + \alpha_2 \frac{SI'}{GP} + \alpha_3 \frac{E}{U} + \alpha_4 \frac{VA'}{U}$
10.	2.3.2	$CU' = \alpha_o + \alpha_1 \frac{FC'}{U} + \alpha_2 \frac{SI'}{GP} + \alpha_3 \frac{E}{U} + \alpha_4 \frac{VA'}{U}$
11.	3.1	$\frac{W}{E} = \alpha_o + \alpha_1 \frac{FC}{W} + \alpha_2 \frac{FI}{GP}$
12.	3.2	$\frac{VA}{W} = \alpha_o + \alpha_1 \frac{SI}{GP} + \alpha_2 \frac{Em}{E} + \alpha_3 \frac{FC}{W}$

4.4 Interpretation of Results:

4.4.1. Equation 1.1:

Time Series Analysis: The regression estimates were found for each state with observations for each year from 1960-1969. The estimates, multiple correlation coefficient R are given in table 4.4.1. Fit is good for all states. Correlation of WC/FC, U and FI/GP is generally positive and that of E/u and SI/GP is generally negative. X-sectional analysis estimates were found for each year with the data of all states as observations.

Since the observations were limited to a maximum of nine only, only a few variables were selected at random. While table 4.4.2a gives the estimates of the coefficients of all the variables, table 4.4.2b only gives the estimates of the coefficients which are found significant. As the variables are introduced one by one, the process was stopped as soon as the standard estimate of error was found to increase.

Interpreting the results at table 4.4.2a, it can be seen that for the years 1961,1962,1963 and 1966, WC/FC ratio has been positively and significantly correlated to capacity utilization, meaning thereby that lack of working capital resulted in poor capacity utilization in these years.

For years 1968, 1969, semifinished and raw materials, inventory as a ratio of gross production has been found to be -vely and significantly correlated to capacity utilization meaning thereby that firms having more stocks of raw

Table: 4.4.1 Time Series Estimates for Equation 1.1

State		$\frac{WC}{FC}$	U	$\frac{SI}{GP}$	$\frac{E}{U}$	$\frac{FI}{GP}$	R	F Calculated	F Table
	α_0	α_3	α_5	α_6	α_7	α_8			
TNADU	-47.4	17.24**	3.45***	-	0.18**	-322.9**	0.956	10.65*	9.60
		(4.77)	(0.76)		(0.05)	(80.27)			(2.5 %)
Mysore	29.1	11.05**	-	0.12	-0.077**	59.24***	0.995	85.94*	-
		(2.86)		(0.20)	(0.023)	(25.55)			
Punjab	56.6	-	2.33***	-0.79**	-0.1677***	-	0.979	40.29*	
			(0.94)	(0.21)	(0.064)				
U.P.	422.1	-81.62***	-	-9.04**	-	573.57***	0.978	14.74***	9.16
		(34.2)		(2.06)		(166.8)			(10 %)
Kerala	64.4	-11.94	-	-0.72*	0.099***	-	0.985	54.8*	
		(6.22)		(.08)	(.037)				
West Bengal	23.8	-	0.57**	-	-	-	0.693	6.47**	5.59
			(0.22)						(5 %)
Mahast.	19.1	13.86*	-	-	-	-	0.871	19.03*	12.2
		(3.17)							(1 %)

Table 4.4.2a X-Sectional estimation for equation No. 1.1

Year	Intercept α_0	WC/FC α_3	U α_5	SI/GP α_6	E/U α_7	FI/GP α_8	Multiple correla-tion coeff-icient R	F Calcula-te	F Table value
1960	19.73	20.76	2.45	-0.455	-0.069	-	0.65	0.367	*
		(21.2)	(2.54)	(0.866)	(0.107)				
1961	52.5	21.1	-	-0.378	-.1254	-102.9	0.915	2.606	*
		(11.36)		(0.678)	(0.104)	(109.7)			
1962	14.9	11.93(p)	-0.33	-0.0896	0.0208	-	.851	1.3240	*
		(5.58)	(0.92)	(0.26)	(0.0473)				
1963	7.35	5.2	31.97	-0.82	-	-	0.80	1.20	*
		(3.85)	(250.1)	(0.86)					
1964	6.8	-	-0.821**	-0.84	0.03(p)	107.9	0.957	6.48	9.24
			(.229)	(.49)	(.018)	(358)			
1965	53.9	12.72	0.1305	-0.67	-0.035	-	.74	1.21	*
		(6.90)	(0.4634)	(0.64)	(0.038)				
1966	13.7	38.3	0.212	-0.08	0.01	-138.0	0.86	1.8	*
		(31.7)	(1.12)	(0.12)	(0.06)	(454.4)			
1968	53.0	16.41	-0.143	-0.61**	0.058	-242.9**	0.923	3.45	5.31
		(20.1)	(0.561)	(0.78)	(.0414)	(104.97)			(10%)
1969	- 22.5	121.2(p)	0.3426	0.014	-0.157(p)	-	0.954	5.06	9.24
		(47.811)	(.96)	(.47)	(.0750)				

Note: * Significant at 1 percent level; ** Significant at 5 percent level
*** Significant at 10 percent level; p Significant at 20 percent level.

Table 4.4.2b X-sectional estimation for equation No. 1.1

Year	Intercept α_o	WC/FC α_3	U α_5	SI/GP α_6	E/U α_7	FI/GP α_8	Multiple Correlation coefficient R	F Calculate	F Table value
1961	40.03	7.50***	-	-0.5414	-	-	0.844	4.95***	4.32
		(2.76)		(0.33)					(10%)
1962	12.92	12.36**	-	-	-	-	0.831	11.1705*	10.0
		(3.69)							(2.5%)
1963	8.22	4.05(p)	-	-	-	-	0.690	3.70	4.54
		(2.09)							(10%)
1966	-0.83	51.59*	-	-	-	-	0.834	16.06*	12.2
		(12.86)							(1%)
1968	45.07	-	-	-0.317**	-	-	0.704	6.9**	5.59
				(0.12)					(5%)
1969	82.4	-	-	-0.822**	-	-	0.77	7.3**	5.59
				(0.304)					(5%)

Note: * Significant at 1 percent level

** Significant at 5 percent level

*** Significant at 10 percent level.

material and semifinished inventory resulted in poor capacity utilization. Referring to earlier description of the variable, it is clear that the negative correlation is on expected lines. To repeat, higher ratio indicates poor managerial competence, leads to reduced working capital for other requirements and interferes with production scheduling.

It is also seen that the fit of the equation is good in all cases except in 1963 and the significance level is 1 to 10 percent. Multiple regression coefficient is also considerably high.

Number of firms, employees/firm and finished inventory levels have been found to be rather having poor influence on capacity utilization except as follows. In 1964, number of firms is significant at 5 percent level and correlation is negative. It is seen from table 4.18 that in 1964, number of firms suddenly increased from 3 to 6 in Mysore, 5 to 9 in Punjab, and 14 to 23 in Maharashtra. There was hardly any time for the firms to react to this competition and against the reasoning given in the section before, the correlation coefficient is negative.

In the same year employees/unit is significant at 20 percent level only and is positively correlated to capacity utilization. Finished inventory to gross production ratio is also found to be negatively and significantly correlated to capacity utilization in 1968. This is as per reasoning given earlier.

In 1969, employees/unit is negatively correlated to capacity utilization and is significant only at 20 percent level. This is as per reasoning given earlier.

4.4.2. Equation 1.2:

X-Sectional Analysis: In table 4.4.3a, the estimates of coefficients of x-sectional analysis for years 1960-1969 are given. In this form of equation the significant factors WC/FC and SI/GP have been retained. Employees/ unit has also been retained. Finished inventory to gross production and number of firms have been replaced with emoluments/employee and fixed capital per worker.

Only in 1961, all the factors except emoluments/employee are all significant. FC/W is significant at 1 percent level and the fit of the equation is good at 1 percent level. FC/W is negatively correlated and so is SI/GP. WC/FC is negatively correlated as well and that is unexpected. Employees/unit is positively correlated to capacity utilization and this is, perhaps, because of the employees/unit being at manageable levels in the year 1961. In later years, the increase in the number has been found to be negatively correlated to capacity utilization. In later years employees/unit exceeded the optimum level that can be managed well. WC/FC ratio is also positively correlated in all other years.

In table 4.4.3b, regression has been terminated whenever the entry of a few variable is found insignificant by 't' test or the 'standard error estimate' starts going up. It is

Table 4.4.3a X-Sectional estimation for equation No. 1.2

Year	Intercept α_0	(FC/W)[1] α_1	(WC/FC)[5] α_3	(Em/E)[3] α_4	(SI/GP)[2] α_6	(E/U)[4] α_7	Multiple correlation coefficient R	F Calculate	F Table value
1960	30.3	1.71	2.91	- 12.05	0.24	-	0.509	0.17	*
		(8.55)	(9.87)	(24.03)	(0.66)				
1961	73.7	-11.62*	-8.01***	-	-0.542**	0.093**	0.997	120.8*	99.2
		(1.1)	(2.58)		(0.08)	)0.02)			(1%)
1962	10.7	1.02	14.76	-	-0.08	0.0012	0.848	1.28	-
		(3.48)	(10.31)		(0.27)	(0.0346)			
1963	98.4	2.12	15.74	-5.3	-2.29	-	0.777	0.764	-
		(4.09)	(11.48)	(10.38)	(1.62)				
1965	51.3	-1.18	14.6174	13.31	-0.748	-0.072	0.828	1.31	-
		(2.84)	(9.8652)	(11.39)	(0.710)	(0.049)			
1966	51.3	1.81	39.5***	-27.85	-0.75	0.062	0.936	4.27	-
		(1.03)	(17.2)	(20.88)	(0.39)	(0.058)			
1968	56.7	0.64	22.03	-12.31	-0.32	-0.036	0.936	4.27	-
		(0.58)	(13.67)	(7.62)	(0.47)	(0.0386)			

Table 4.4.3b X-Sectional estimation for equation No. 1.2

Year	Intercept α_0	FC/W α_1	WC/FC α_3	Em/E α_4	SI/GP α_6	E/U α_7	Multiple Correlation coefficient R	F Calculated	F Table value
1962	12.92	-	12.36**	-	-	-	0.831	11.17*	10.0
			(3.67)						(25%)
1966	-0.83	-	51.58**	-	-	-	0.834	16.06*	12.2
			(12.86)						(1%)
1968	45.07	-	-	-	-0.32**	-	0.704	6.91**	5.59
					(0.12)				(5%)

seen that WC/FC upto 1966 and SI/GP in 1968 remain the most significant factors and results are no different than given in tables 4.4.2b.

Time Series Analysis: Same equation was regressed against various states over the years and estimates are tabulated at tables 4.4.4a and 4.4.4b. In table 4.4.4b variables were introduced till they were significant or standard error of estimate kept on reducing.

Capital/worker is significant in UP and West Bengal and both are negatively correlated. In other states even though not significant at 10 percent level, negative correlation exists in most of the states. Working capital to fixed capital ratio is negatively corrrelated at significant level in West Bengal but is +vely correlated in Maharashtra.

SI/GP is significantly and negatively correlated in most of the states while employees/unit are significantly and negatively correlated to capacity utilization in Punjab and West Bengal.

4.4.3 Equation 1.3:

X-sectional Analysis: Effort has been made to see the effect of other variables by various combinations and estimates obtained are indicated in table 4.4.5a. For each year different variables have been selected to force their entry if possible and see their effect on capacity utilization. For each year these variables whose estimates are given in table 4.4.5a have been included.

Table: 4.4.4a Time Series Estimation for Equation 1.2.

State	Intercept α_0	FC/W α_1	WC/FC α_3	Em/E α_4	SI/GP α_6	E/U α_7	Multiple correlation coefficient R	Standard error	F Calculated	F Table value
TNADU	27.6	2.65	26.64	6.58	-0.64	-0.07	0.911	5.46	2.93	9.29
		(2.13)	(13.23)	(5.78)	(0.34)	(0.07)				(10 %)
MYSORE	33.8	-0.53	6.74	8.15	-0.04	-0.05	0.990	4.19	21.18**	19.3
		(1.3)	(5.85)	(27.6)	(0.84)	(0.03)				(5 %)
PUNJAB	110.5	17.6	-20.2	-15.1***	-1.88**	-0.16***	0.987	4.595	23.26**	14.2
		(15.6)	(16.38)	(6.64)	(0.48)	(0.07)				(2.5%)
UP	99.9	-34.6*	-37.7*	79.2*	-	-	0.999	0.529	∞*	99.2
		(0.66)	(1.19)	(1.13)						(1%)
KERALA	42.10	3.32	-8.6	5.97	-1.51***	0.28	0.990	3.85	30.58**	28.2
		(2.65)	(7.23)	(5.59)	(0.64)	(0.16)				(1%)
W.BENGAL	69.5	-2.6**	-13.6**	4.5	-0.15	-0.05**	0.969	2.37	9.3**	9.01
		(0.94)	(4.2)	(3.2)	(0.32)	(0.017)				(5%)
MAHARASHTRA	16.2	-0.31	13.43	6.2	-0.18	-0.02	0.943	3.15	3.24	9.29
		(0.72)	(7.33)	(5.9)	(0.47)	(0.04)				(10%)

Table 4.4.4b Time Series estimation of equation 1.2

State	Intercept α_0	Capital worker α_1	WC/FC α_3	Em/E α_4	SI/GP α_6	E/U α_7	Multiple correlation coefficient R	F Cal-culated	F Table value
W.Bengal	62.5	-2.4** (.82)	-14.13** (3.6)	5.2 (2.54)	-	-0.05** (0.015)	0.966	14.34*	9.60 (2.5%)
Punjab	102.9	-	-	-8.31*** (3.68)	-1.2* (0.13)	-0.2414* (0.048)	0.977 -	36.56* *	12.1 (1%)
Kerala	64.4	-	-11.9 (6.22)	-	-0.7* (0.08)	0.099** (0.037)	0.985	54.88*	-
Mysore	66.3	-	-	-	-0.64* (0.061)	-	0.973	66.3*	-
Maharashtra	12.12	-	13.86* (3.17)	- -	- -	- -	0.871	19.03*	-
TNADU	9.25	-	-	9.95*** (4.5)	-	-	0.641	4.89***	3.59 (10%)

Table 4.4.5a X-Sectional estimation for equation 1.3

Year	Intercept α_0	FC/W α_1	$\frac{E-W}{W}$ α_2	WC/FC α_3	Em/E α_4	U α_5	SI/GP α_6	E/U α_7	FI/GP α_8	VA/W α_{10}	Multiple correla- tion co- fficient R	F Calcu- lated	F Tabl valu
1960	17.3	-	-	-2.4	-	-2.4	-	-	38.65	10.19	0.866	1.50	-
				(6.2)		(1.95)			(145.11)	(5.35)			
1961	73.7	-11.62*	-	-8.01***	-	-	-0.54**	.09**	-	-	0.997	120.8*	99.2
		(1.10)		(2.58)			(.08)	(.02)					(1 %)
1962	1.8	-	-	12.72***	-	-.75	-	-	28.4	3.65	0.928	3.13	9.24
				(4.27)		(.62)			(57.6)	(2.32)			(10%)
1963	27.0	-	-	3.21	-	-0.4	-	-	-4.9	-	0.725	0.7423	-
				(4.20)		(.94)			(28.4)				
1964	44.4	-0.13	-	0.52	-	-0.52	-	-	-103.4	-	0.864	1.4731	-
		(1.77)		(3.04)		(0.41)			(88.7)				
1965	41.4	-7.68	-	-.84	20.3	-.26	-	-	-52.9	0.23	0.716	0.3508	-
		(8.61)		(12.08)	(30.1)	(0.9)			(221.8)	(0.41)			
1966	20.5	1.11	-	43.3	-	-0.02	-0.47	.008	-98.6	-	0.901	1.45	
		(1.35)		(34.1)		(1.22)	(0.48)	(.06)	(483.3)				
1968	60.02	-.01	-	17.97	-10.4	-	-.24	.0065	-171.16	-	0.96	4.01	9.33
		(.81)		(13.72)	(7.56)		(.46)	(.05)	(155.5)				
1969	-27.8	0.23	-	175.1	-	0.48	-	-0.13	-108.0	-	0.96	4.54	9.33
		(3.15)		(56.3)		(.82)		(.13)	(557.04)				

For 1969, SI/GP has been removed to see which other factors are powerful in the absence of this predominant factor.

In table 4.4.5b, only those variables have been allowed to enter the equation, where coefficients are significantly different from zero as seen by 't' test, or upto a stage where standard error of estimate starts increasing.

It can be seen that for 1960, number of forms and value added per worker are significant. Correlation is negative for number of firms which is contrary to expectation but VA per worker correlation is positive.

For 1964, number of firms is again significant at 5 percent level and correlation is negative, the possible reason for which is given earlier (Para 4.5.1). Finished inventory also appears significant at 20 percent level and this is negatively correlated as expected.

For 1965 FC/W appears negatively correlated and significant only at 20 percent level.

For 1969, in the absence of SI/GP, WC/FC and E/u are both significant at 5 percent and10 percent level respectively and are -vely correlated, with capacity utilization as expected. FC/W entered first but in the presence of WC/FC and E/u its effect does not appear to be so great.

From table 4.4.5b, it can be seen that correlation of FC/W with capacity utilization is -ve in most of the years while that of WC/FC with capacity utilization is +ve in most of the years and that of SI/GP with capacity utilization is -ve

Table 4.4.5b X-sectional estimation for equation 1.3

			F calculated	F table
1960	$CU = 17.56 - 2.28^{***} U + 9.49^{**} VA/W$	$R = .855$	5.4468^{***}	4.32
1964	$CU = 44.7 - .55^{**}U - 99.4^{p} FI/GP$	$R = .861$	5.73^{***}	4.32
	(.24) (61.7)			(10%)
1965	$CU = 46.5 - 245^{p} FC/W$	$R = .544$	2.9476	3.59
	(1.43)			(10 %)
1969	$CU = - 2.02 - .737 FC/W + 102.17^{**} WC/FC - .13^{***} E/U$	$R = .949$	12.33^{*}	9.98
	(2.09) (33.54) (.0546)			(2.5 %)

in most of the years, of FI/GP with capacity utilization is -ve in most of the years. Correlation of Em/E and E/u with capacity utilization is uncertain.

Time Series Analysis: In table 4.4.6a, estimates of the coefficients of various variable effecting capacity utilization in various regions over the years are indicated. For states of Mysore, Punjab, Kerala, West Bengal and Maharashtra, the goodness of fit exists and multiple correlation coefficient is high.

WC/FC as a factor is significant in all states except Andhra and West Bengal and it is positively correlated. Auxiliary staff to workers ratio was found significant in Maharashtra and correlation is positive i;e. the role played by staff is important.

Occasionally other factors like (E/u, Mysore), (VA/W, TNADU) and (FI/GP, Mysore) have been found to be significant. Non-uniformity is explanable by the existence of different industry norms in each region and industrial growth rate in each state being different.

The trend of the various variables are as follows:
Correlation of FC/W with capacity utilization is showing no trend being, -ve for Mysore and +ve for West Bengal and that of (E-W)/W with capacity utilization is generally positive but is negative in West Bengal and Kerala. This shows that the correlation is negative at higher values of auxiliary staff worker ratio. Correlation of WC/FC, U,

Table 4.4.6a Time Series Estimation for Equation 1.3

State	Intercept α_0	FC/W α_1	$\frac{E-W}{W}$ α_2	WC/FC α_3	Em/E α_4	U α_5	SI/GP α_6	E/U α_7	FI/GP α_8	VA/W α_{10}	Multiple correlation coefficient R	F Calculated	F Table value
Andhra	11.5	-	-	-7.68 (15.5)	-	7.7 (5.1)	-	-.05 (.02)	-	-	0.930	4.26	9.16 (10 %)
TNadu	32.4	-	34.3 (44.1)	15.66*** (5.3)	-13.5 (9.02)	-.84 (1.3)	- -	-	-226.2 (111.06)	2.55*** (.84)	0.987	8.57	9.33 (10 %)
Mysore	21.03	-.33 (.43)	-	10.14** (2.15)	-	1.32 (1.10)	-	-.05** (.013)	64.88 (26.9)	-	0.997	76.1*	39.3 (2.5 %)
Punjab	53.3	-	4.57 (14.64)	-	-	1.7 (1.75)	-.52 (.64)	-.17 (.17)	-56.5 (110.2)	2.04 (6.2)	0.984	10.77***	9.33 (10 %)
Kerala	-120.1	-	-141.9 (94.25)	-	-	17.7 (14.9)	-1.3 (.7)	1.42 (.86)	-225.6 (189.2)	-4.7 (7.41)	0.990	17.4522***	9.33 (10 %)
West Bengal	61.3	.921 (2.74)	-18.42 (10.69)	-15.77*** (4.02)	-	.06 (.2)	-.04 (.02)	-	-3.37 (80.9)	-	0.984	10.79***	9.33 (10 %)
Maharashtra	28.04	-	27.9** (6.04)	13.75** (1.93)	-	0.21*** (.05)	-.27 (.100)	-	-114.8*** (39.1)	-1.33 (.47)	0.995	34.3**	19.3 (5 %)

with capacity utilization is generally positive and that of SI/GP, E/u, Em/E is generally negative. Correlation of FI/GP is generally showing negative correlation and this is expected as discussed earlier.

Table 4.4.6b has been reconstructed from the same data used for preparing table 4.4.6a regression variables have been entered till the standard error of estimate starts increasing and new variables entering are found to be insignificant.

In each state two or three variables are found to be of higher significance and fit is generally good and multiple regression coefficient fairly high. Number of firms is significant in Punjab, West Bengal and Maharashtra and somewhat in Andhra and is positively correlated to capacity utilization meaning more number of firms has lead to improved capacity utilization.

Employees/unit is significant in Andhra and Mysore and is negatively correlated. It is seen that in both states, E/u has become very high due to installation of huge one unit public sector complexes.

Working capital to fixed capital ratio is significantly and positively correlated to capacity utilization in T.Nadu, Mysore, and Maharashtra. It is showing significant negative correlation in West Bengal.

Semifinished inventory ratio is significantly but negatively correlated in Kerala. Even when insignificant, correlation has always been negative. Finished inventory ratio is

Table 4.4.6b Time series Estimation of Coefficients for equation 1.3

State	Equation Form	Multiple correlation coefficient R	F Calculated	F Table value
TNADU	$CU = 19.45 - 6.07\ Em/E + 14.64^{*}\ WC/FC - 148.8^{**}\ \frac{FI}{GP} + 2.5^{*}\ \frac{VA}{W}$ (3.32) (2.87) (38.28) (0.516)	0.975	19.32*	16.0 (1%)
KERALA	$CU = 59.7 - .6041^{*}\ \frac{SI}{GP}$ (0.07)	0.946	59.7*	12.2 (1 %)
WB	$CU = 47.5 - 11.8^{***}\ \frac{WC}{FC} - 3.14^{**}\ \frac{FC}{W} + 0.436^{**}\ U$ (4.9) (1.02) (0.14)	0.929	10.65*	7.76 (2.5%)
PUNJAB	$CU = -5.9 + 7.508^{**}\ \frac{VA}{W} + 3.29^{**}\ U$ (2.79) (.88)	0.966	42.6*	10.9 (1%)
ANDHRA	$CU = 11.75 - 0.05^{*}\ \frac{E}{U} + 6.18\ U$ (.012) (3.43)	0.921	8.39***	5.46 (10%)
MYSORE MAHARASHTRA-	As in Table 4.4.6a			

significantly but negatively correlated in T Nadu. Except Mysore, correlation is always negative. Value added/worker is significantly and positively correlated in Punjab and Tamil Nadu but is negatively correlated in Kerala and Maharashtra.

Emoluments/employee in case of Tamil Nadu is not significantly correlated and correlation is negative.

4.4.4 Equation 1.4:

In equation 1.4 a very different variable, rate of change of capital X has been introduced. It has a negative correlation with capacity utilization and has significantly entered in all years except 1966 and 1968. Refer tables 4.4.7a and 4.4.7b.

4.4.5. Time Series Analysis - Conclusions:

Best estimates for all years, using the equation forms mentioned before, have been summarized at table 4.4.8. Going through this table, it can be seen that:

(i) Factors significantly correlated to capacity utilization vary in each state although a substantial part of capacity utilization variation can be explained by the factors concerned. Multiple correlation coefficients are high and fitness of good is significant mostly at 1 percent level.

(ii) Fixed capital/worker is negatively correlated. Employees/unit is negatively correlated except in Kerala. Working capital/fixed capital is positively correlated except in West Bengal. Semifinished inventory is negatively correlated in all states. Number of firms is positively correlated except in Punjab.

Table 4.4.7a X-Sectional analysis of estimation for equation 1.4

Year	Intercept α_0	WC/FC α_3	Em/E α_4	SI/GP α_6	E/U α_7	X α_9	Multiple correlation coefficient R	F Calculated	F Table value
1961	4.25	17.27*	-	-	-0.05**	107.32*	0.998	302.25*	99.2
		(1.03)			(.0085)	(5.23)			(1%)
1962	9.5	8.75	10.61	-	-0.01	-10.59	0.954	5.1435	9.24
		(3.60)	(5.90)		(0.018)	(4.86)			(10%)
1963	52.2	2.32	-	-0.45	-	-20.78	0.975	7.4350	9.16
		(1.57)		(0.42)		(8.00)			(10%)
1964	58.5	6.18***	-20.45	-	0.0542***	-29.9**	0.979	11.7640***	9.24
		(1.811)	(3.93)		(.0166)	(4.99)			(10%)
1965	51.1	13.11	6.98	-0.62	-0.052	-7.7	0.840	1.4416	9.31
		(9.9)	(11.42)	(.74)	(.056)	(12.32)			(10%)
1966	46.3	35.0	-15.67	-.92	0.07	2.6	0.930	3.8692	5.31
		(18.41)	(18.89)	(.53)	(.06)	(1.62)			(10%)
1968	64.6	15.93	-13.02	-0.35	-0.028	1.01	0.938	4.3952	5.31
		(12.08)	(7.2)	(.47)	(.04)	(.88)			(10%)
1969	-65.6	155.7*	-	1.82**	-0.325*	-22.34**	0.997	96.9**	89.2
		(12.52)		(0.33)	(.034)	(3.76)			(2.5%)

Table 4.4.7b X-sectional estimation for equation 1.4

Year	Intercept α_0	WC/FC α_3	Em/E α_4	SI/GP α_6	E/U α_7	X α_9	Multiple correlation coefficient R	F Calculated	F Table Value
1961	As in previous table No. 4.4.7a								
1962	8.54	9.21**	9.03	-	-	-9.36**	0.947	8.54***	5.39
		(3.09)	(4.59)			(3.83)			(10 %)
1963	44.2	-	-	-	-	-28.2**	0.904	18.02*	12.2
						(6.64)			(2.5 %)
1964	As in previous table No. 4.4.7a								
1965	45.2	-	-	-	-	19.06*	0.688	6.31**	5.59
						(7.58)			(5 %)
1966	-0.83	51.58*	-	-	-	-	0.834	16.06*	12.1
									(1 %)
1968	45.07	-	-	.0.31**	-	-	0.704	6.09**	5.59
				(.12)					(5 %)
1969	As in previous table No. 4.4.7a								

Table 4.4.8 Summary of best fitting estimates

State	Intercept α_0	FC/W α_1	$\frac{E-W}{W}$ α_2	E/U α_3	WC/FC α_4	FI/GP α_6	SI/GP α_{11}	VA/M α_{12}	U α_{13}	Em/E α_{14}	Multiple correlation coefficient R	F
Andhra	11.75	-	-	-.05*	-	-	-	-	6.18	-	0.921	8.39***
TNadu (i)	-47.4	-	-	-.18**	17.24**	-322.9**	-	-	3.45**	-	0.956	10.65*
(ii)	19.45	-	-	-	14.64	-148.8**	-	2.5*	-	-6.07	0.975	19.32*
Mysore (i)	29.1	-	-	-.077**	11.05**	59.24**	-.12	-	-	-	0.995	85.94*
(ii)	21.03	-.33	-	-.05**	10.14**	64.88	-	-	1.32	-	0.997	76.1*
Punjab (i)	56.6	-	-	-16.77***	-	-	-.79**	-	-2.33***	-	0.979	40.29*
(ii)	102.9	-	-	-.24*	-	-	-1.2	-	-	-8.31***	0.977	36.56*
(iii)	- 5.9	-	-	-	-	-	-	7.508**	3.29**	-	0.966	42.6*
U.P. (i)	422.1	-81.62***	-	-	-	573.5**	-9.04**	-	-	-	0.978	14.74***
W. Bengal	62.5	-2.4**	-	-.05**	-14.13**	-	-	-	-	5.2***	0.966	14.34*
Kerala	64.4	-11.94	-	.099***	-	-	-.072*	-	-	-	0.985	54.8*
Maharashtra	28.04	-	27.9**	-	13.75**	-114.8***	-	-1.33	.21***	-	0.995	34.3**

Emoluments per employee is negatively correlated except in West Bengal.

Finished inventory/gross production is having different correlation in different states, -ve in Tamil Nadu and Maharashtra and +ve in Mysore and UP.

Value added/worker is positively correlated in T NADU and Punjab but is negatively correlated in Maharashtra.

Auxiliary staff/worker ratio is significant and positively correlated only in one state i.e. Maharashtra.

(iii) While the estimates of coefficients vary considerably amongst different states, the near consistency of the direction of correlation indicates that the equations can be used to draw qualitative conclusions generally and quantitative conclusions for different states.

(iv) Manhours/worker, electricity per worker, capital per unit, have not proved significant. This means that the effects of absenteeism and power availability are overrated.

4.4.6 X-Sectional Analysis - Conclusions:

(i) X-sectional analysis has the advantage of assuming economic and market parameters to be the same for all regions and therefore internal management, differentiation of products, rate of change of capital and internal structure of the industry are expected to be more important.

(ii) Referring to table 4.4.9;

1. Fixed capital per worker is negatively correlated except in 1966.

2. Employees/unit is negatively correlated except in 1961

Table 4.4.9 Summary of best fitting estimates.

Year	Intercept	FC/W	$\frac{E-W}{W}$	E/U	WC/FC	FI/GP	SI/GP	VA/W	U	Em/E	X	Multiple correlation coefficient	F Table value
	α_0	α_1	α_2	α_3	α_4	α_6	α_{11}	α_{12}	α_{13}	α_{14}	α_{15}	R	
1960	17.56	-	-	-	-	-	-	9.49**	-2.28***	-	-	0.855	5.45**
1961(i)	73.7	-11.62*	-	.093**	-8.01***	-	-.542**	-	-	-		0.997	120.8*
(ii)	4.25	-	-	-.05**	17.27*						107.32*	0.998	302.25*
1962(i)	12.92	-	-	-	12.36**	-	-	-	-	-	-	0.831	11.17*
(ii)	8.54	-	-	-	9.21**	-	-	-	-	9.03	-9.36**	0.947	8.54***
1963	44.2	-	-	-	-	-	-	-	-	-	-28.2**	0.90	18.02*
1964(i)	58.5	-	-	-.054***	6.18***	-	-	-	-	-20.45**	-29.9**	0.979	11.76***
(ii)	44.7	-	-	-	-	-99.4(p)	-	-	-.55**	-	-	0.861	5.73**
1965	45.2	-	-	-	-	-	-	-	-	-	-19.06**	0.688	6.31**
1966	-0.83	51.58*	-	-	-	-	-	-	-	-	-	0.834	16.06*
1968	45.07	-	-	-	-	-.31**	-	-	-	-	-	0.704	6.9**
1969(i)	-65.6	-	-	-.325*	155.7*	-	1.82**	-	-	-	-22.34**	0.997	96.9*
(ii)	-2.02	-.737	-	-.13***	102.17**	-	-.822**	-	-	-	-	0.949	12.33*

when rate of change of capital has not been considered.

3. Working capital/fixed capital ratio is positively correlated except in 1961 when x has not been considered.

4. Finished goods inventory/gross production is negatively correlated wherever applicable.

5. Semifinished goods inventory/gross production is negatively correlated wherever applicable.

6. Rate of change of capital is negatively correlated except in 1961.

7. Number of firms is negatively correlated in 1960 and 1964; possible reasons have been given earlier.

8. Auxiliary staff/worker ratio, has not entered as a significant variable.

9. Value added/worker was found positively significant only on 1960;

10. Emoluments/employee is negatively correlated when significant.

(iii) With the sample size being small and data base having its shortcomings, the amount of consistency in the influence of variables is really remarkable. Given the problem of bias, multicollinearity and autocorrelation, all of which cannot be removed because of lack of sufficient information, the influence of the variables on capacity utilization can be predicted qualitatively if not quantitatively, as the estimates show a fairly wide divergence.

(iv) Most of the estimates are significant and the fit of the equation is generally good at 1 percent level.

The conclusions reached are indicative of very important structural changes and managerial decisions that need to be brought about. Appropriate technology and more employment for the same capital will reduce capital intensity and improve utilization. An upper limit on employees per unit is also desired i.e. the medium sized plants appear to be the best. While firms with better availability of working capital seem to be at an advantage in improving capacity utilization, blocking the capital in raw materials does not come out as a wise decision. Competitiveness improves rather than hinders the capacity utilization and therefore tendency to limit licenses appears to be harmful. Rate of change of capital by different firms needs to be regulated. ~~Aee~~ this also points to be inadvisibility of starting huge. (E/u more), capital intensive (FC/W more) plants with a very fast introduction of capital. (X more like BHEL in Andhra and some other plant at Mysore.) The conclusions are not dogmatic but are a result of statistical analysis.

A brief summary of the variables and the characteristics of their correlation with capacity utilization is given in table 4.4.12.

4.4.7 Pooling of X-sectional and Time series Data: - Equation 1.5: In this section, regression has been attempted after pooling the data of all the states for all the years. For this three sets of readings have been considered as follows:

(a) A total of 68 observations for 9 years over 9 regions have been used in the first instance.

(b) A total of 66 observations have been used as at (a) less the following - (i) UP-69 (100 percent CU and maximum variance) (ii) UP-66 (71.03 percentCU and next maximum variance).

The non-consideration of these two values improves the regression equation considerably. Maximum values for UP could be accidental. Capital employed in UP is comparatively low and CU changes are very sensitive to changes in capital employed.

(c) A total of 61 observations as at (b) less the following:
(i) Punjab-69 (59.54 CU),(ii) UP 68 (59.61 percent CU),
(iii) Kerala-65 (56.19 CU),(iv) Kerala-66 (6.14 percent CU),
(v) West Bengal-69 (47 percent CU).

These showed the maximum variances with application of the equations at (b) multiple regression coefficient has improved further.

The regression was tried with variables included in equation form 1.5. In table 4.4.10, only these variables have been included, introduction of which in the regression equation led to reduction of standard error.

Conclusions:

1. Referring to table 4.4.10 in all the cases of (a),(b) and (c) the following variables have been found significant:

(i) Employees/unit is significant at 1 percent level and is negatively correlated to capacity utilization.

(ii) Working capital to fixed capital ratio is significant at 1 percent level and is positively correlated to capacity utili-

Table 4.4.10 Pooling of X-Section and Time series data

Eqn.	Intercept α_0	FC/W α_1	$\frac{E-W}{W}$ α_2	E/U α_3	WC/FC α_4	FI/GP α_6	EL/W α_9	SI/GP α_{11}	VA/W α_{12}	U α_{13}	Multiple correlation co-efficient R	F calculated
1:5[1]	41.6	.32	-.	***-.0262	***9.659*	***-80.75	-3.4461	***-.1878	.1024	.2744	0.648	5.4415
		(.32)		(.0146)	(2.572)	(42.15)	(3.13)	(.1223	(.1591)	(.2388)		
1.5[2]	34.90	.2344	8.63(p)	*-.0319	*9.864	***-57.96	-3.305p	***-0.153	-	**.3470	0.743	8.82*
		.2428	(7.51)	(.0118)	(1.923)	(30.77)	(2.278)	(.089)		(.1720)		
1.5[3]	30.87	-	19.56*	-.0318*	9.32*	-65.90*	-2.771p	-.0636**	-	***.2265	0.817	15.27*
			(6.07)	(.0089)	(1.37)	(21.12)	(1.7174)	(.0286)		(.1365)		

1. A total of 68 observations for 9 years over 9 regions.
2. A total of 66 observations as at (1) less 1. UP 69 100 percent CU and maximum variance
   2. UP 66 7103 percent CU and next maximum variance.

   A non consideration of these two values improves the regression equation based on less magnitude of capital and output.
3. No. of 61 observations as at (2) less Punjab 69 (59.54 CU) UP 66 (59.61 percent CU)
   Kerala 65 (56.19 percent CU) Kerala 66 (6.14 percent CU)
   W. Bengal 69 (47 percent CU)

   These showed the maximum variances from the equation at (2) multiple regression coefficient has improved further.

zation.

(iii) Finished inventory to gross production is significant at 10 percent level for (a) and (b) and at 1 percent level for (c) and is negatively correlated to capacity utilization.

(iv) Semifinished inventory to gross production is significant at 10 percent level for (a) and (b) and at 5 percent level for(c) and is negatively correlated to capacity utilization.

(iv) Number of firms is significant at 5 percent level for (b) and 10 percent for (c) and is positively correlated to capacity utilization.

(vi) Auxiliary staff/worker ratio is significant at 1 percent level for (c) only and is positively correlated to capacity utilization.

(vii) Electricity per worker is found significant only at 20 percent level for (b) and (c) and is negatively correlated to capacity utilization meaning thereby that power wastage took place.

(viii) Fixed capital/worker, semifinished inventory per worker, machinery and plant to fixed capital ratio, manhours per worker worked, emoluments per employee, emoluments to value added ratio, value added per worker did not enter significantly in the regression equation.

2. A pooled regression equation can thus be written as:

$$CU = 30.87 + \underset{(6.07)}{19.56}\,\frac{E-W}{W} - \underset{(0.009)}{0.032}\,\frac{E}{U} + \underset{(1.37)}{9.32}\,\frac{WC}{FC} - \underset{(21.12)}{65.90}\,\frac{FI}{GP} - \underset{(1.71)}{2.77}\,\frac{El}{W}$$

$$- \ 0.064 \frac{SI}{GP} + 0.2265 \ U \ (R = 0.817)$$

$$(0.0286) \qquad (0.1136)$$

Standard error of estimate = 7.268.

Consistent results, with a goodness of fit which is significant at 1 percent level, and a reasonably good multiple regression coefficient have been revealed in the pooled regression for all the cases. Sample size is considered quite satisfactory. The results are also in conformity, behaviour wise with individual time series and x-section estimates, the conclusions of which are reported in paras 4.4.5 and 4.4.6.

4.4.8 Comments on Equation Forms 2.1,2.2.1,2.2.2,2.3.1, 2.3.2, 2.4.1, 2.4.2.

All these equations have been estimated from ratios derived from data for 1969 as published, without price correction, with further particular features as given below:

Equation 2.1: Capacity utilization calculated as the geometric mean of various combinations as mentioned in section 4.1.1. of this chapter and explaining variables selected as workers per employees ratio, emoluments per employee, and employees per unit where emoluments are <u>not</u> corrected for price increases.

Equation 2.2.1: Capacity utilization calculated as for equation 2.1 i.e. as the geometric mean, but explaining variables selected as fixed capital/worker, semifinished inventory to gross production, employees/unit and emoluments per employee.

Fixed capital, semifinished inventory, gross production and emoluments undeflated.

Equation 2.2.2: Capacity utilization calculated as for the series of equations for 1st group (equations 1.1 - 1.4 i.e. (Output-M)/FC) though fixed capital and production figures are not corrected for price changes. Explaining variables are the same as in equation 2.2.1.

Equation 2.3.1: Capacity utilization calculated as for equation 2.2.1 and explaining variables selected as semi-finished inventory/gross production ratio, employees/unit, value added per unit, fixed capital per unit. All values undeflated.

Equation 2.3.2: Capacity Utilization calculated as for equation 2.2.2 and explaining variables same as for equation 2.3.1.

Equation 2.4.1: Capacity Utilization as in 2.2.2 but the figure for Andhra was dropped as it was considered unrealistic. Explaining variables as in equation 2.2.2.

Not applying the price correction has not made difference with capacity utilization calculation but the correlations in case of explaining variables viz, SI/GP, Em/E, E/U have become positive as compared to negative correlation (Tables 4.4.8 and 4.4.9) generally obtained. Price correction therefore seems to be a must for obtaining realiable results. The results are given in tables 4.4.11a and 4.4.11b.

In table 4.4.11a all the results are indicated whereas in table 4.4.11b, only those variables have been mentioned which were found significant and which entered the regression equation.

Table 4.4.11a X-sectional estimation for 1969

Eqn.	Intercept	FC/W	W/E	Em/E	SI/GP	E/U	VA/U	FC/U	Multiple correlation co-efficient R	F calculated	F Table values
	α_o	α_1	α_2	α_4	α_6	α_7	α_{11}	α_{12}			
2.1	-156.6	-	243.86	.0055	.	-.0058	-	-	.701	2.26	3.07
			(129.18)	(.0103)	.	(.0157)					(10 %)
2.2.2	94.51	-8.9*	-	-	2.81*	-.0054	-	-	.913	7.5266*	6.23
		(2.16)			(0.75)	(.0086)					(2.5 %)
2.2.1	87.04	-8.02*	-	-	2.54*	-.0042	-	-	.881	5.22**	4.53
		(2.32)			(.75)	(.0092)					(5 %)
2.3.1	70.05	-	-	-	-1.43	-.159***	1.93	0.67	.749	1.9285	-
					(1.3)	(.096)	(1.65)	(.83)			
2.3.2	73.99	-	-	-	-1.33	-.146**	1.78	.59	.726	1.67	-
					(1.45)	(.108)	(1.85)	(.93)			
2.2.2*	106.52	-8.25*	-	-.0024	1.008	.04**	-	-	.963	16.03*	11.4
		(1.47)		(.0041)	(.8125)	(.017)					(1 %)

* Same as 2.2.2 except that data for Andhra not used.

Table 4.4.11(b) X-Sectional Estimation for 1969.

Equation	Intercept α_0	FC/W α_1	W/E α_2	SI/GP α_6	FC/U α_{12}	Multiple correlation coefficient R	F Calculated	F Table value
2.1	-90.1	-	183.7**	-	-	0.681	7.808**	7.21
			(65.7)					(2.5 %)
2.2.1	84.5	-8.3*	-	2.61*	-	0.876	13.21*	8.65
			(.74)					(1 %)
2.2.2	94.0	-9.21*	-	2.90*	-	0.906	18.45*	8.65
		(1.88)		(0.66)				(1 %)
2.3.1	48.1	-	-	-	-.11***	0.537	3.65***	3.36
					(.06)			(10 %)
2.3.2	53.77	-	-	-	-.13***	0.568	4.308***	3.36
					(.064)			(10 %)

Table 4.4.12 General Conclusions on the Correlation of Variable with Capacity Utilization.

Explaining variable Description and Symbol.		Sign of correlation	Exception Year	State	Whether significant
1. Fixed capital per worker	FC/W	-ve	1966	-	Yes
2. Fixed capital per unit	FC/u	-	-	-	No
3. Auxiliarly staff per worker	$\frac{E-W}{W}$	+ve	all	all except Maharashtra	Yes
4. Employees/Unit	E/u	-ve	1961	Kerala	Yes
5. Working capital per fixed capital	$\frac{WC}{FC}$	+ve	1961	W. Bengal	Yes
6. Finished Goods Imentory perGross Production Unit	$\frac{FI}{GP}$	-ve T NADU MAHA + ve Mysore UP	-	-	Yes
7. Machinery and Plant per fixed capital	$\frac{MP}{FC}$	-	-	-	NO
8. Man Hours per worker	MH/W	-	-	-	No
9. Emoluments per employee	$\frac{Em}{E}$	-ve	-	West Bengal	Yes
10. Electricity per worker	$\frac{El}{W}$	-	-		No
11. Emoluments per Unit of value Added	$\frac{Em}{VA}$	-	-	-	No
12. Semifinished and Raw Material Inventory per Gross Production unit	$\frac{SI}{GP}$	-ve	-	-	Yes
13. Value Added per worker	$\frac{VA}{W}$	+ve	1960	+ve T Nadu Punjab	No
14. Number of Firms	U	+ve	1960, 1964	Punjab	Yes
15. Rate of charge of capital	X	-ve	1961		Yes

Entry of variables was discontinued after the estimate of standard error was found to go up.

Comments on equation forms 3.1 and 3.2:

Equation 3.1: $\frac{W}{E} = \alpha_0 + \alpha_1 \frac{\text{capital}}{\text{worker}} + \alpha_2 \frac{\text{finished goods inventory}}{\text{gross production}}$

Year	α_0	α_1	α_2	Multiple regression coefficient	F as calculated	F from tables.
1969	1.78	-0.0042**	-0.0010	0.750	5.16*	3.11
		(0.0013)	(0.0014)			(1 percent)

Equation 3.2: $\frac{VA}{W} = \alpha_0 + \alpha_1 \frac{SI}{GP} + \alpha_2 \frac{Em}{E} + \alpha_3 \frac{FC}{W}$

$= 5511 - 140.3 - 0.22 + 205.23 \quad 0.411 \quad .4754*$

In equation 3.1, it was seen that workers strength of total employees decreases as capital per worker increases and as the semifinished inventory goes up as a proportion to total production. It is logical as in these two eventualities more staff functions become necessary. The fit is good at 1 percent level.

In equation 3.2 value added per worker as a function of semi-finished inventory, fixed capital per worker or emoluments per employee was not found to be significantly fit. Estimates of coefficients were also not significant.

4.5 Inter Industry Comparisons:

4.5.1 For this purpose a group of industries manufacturing 'Machinery other than Electrical machinery' was selected. One other industry manufacturing electrical goods as discussed in section 4.1 - 4.7 was also included. In all 28 industries were included and their identification number as well as description can be seen at table 4.5.1 at columns 2 and 3.

4.5.2 Construction of Capacity Utilization Series:

For calculating capacity utilization for an industry, the steps employed are the same as given in last section. However, a maximum output-capital ratio for an industry is determined and with this considered as 100 percent, capacity utilization for all other years are calculated. Similar procedure is adopted for all other industries in the group. Capacity utilizations so determined are recorded in table 4.5.1. It is seen that for each industry there is a 100 percent capacity utilization for some year or the other. As pointed out earlier, the 100 percent utilization is not an absolute figure but only a relative one and even if compared to this somewhat arbitrary but real maximum, the underutilization can be improved, a lost of improvement is likely to take place.

It is also seen that the maximum does not take place in any particular year. Number of industries having 100 percent utilization yearwise is given in table 4.5.2.

Table 4.5.1 Capacity utilization estimates for industry group manufacturing machinery

S. No.	Identification No.	Industry Description.	Capacity utilization									Max. output to capital ratio
			1960	1961	1962	1963	1964	1965	1966	1968	1969	
1	2	3	4	5	6	7	8	9	10	11	12	13
1.	360.1	Boiler+Steam Generating plants.	-	-	-	28.98	36.8	-	16.95	49.3	100.0	1.64
2.	360.3	Internal combustion Engines.	59.1	51.4	-	43.1	80.0	100.0	51.3	69.2	73.7	3.54
3.	360.4.1	Textile Machinery	66.1	78.6	71.8	78.1	92.3	100.0	85.1	54.6	81.2	1.85
4.	360.4.2	Jute Machinery	44.4	63.3	45.5	64.4	95.6	55.9	61.1	100.0	75.9	4.76
5.	360.4.4	Sugar Machinery	40.0	57.1	53.7	43.4	57.2	67.9	60.6	86.6	100.0	2.24
6.	360.4.5	Tea Machinery	78.0	53.0	52.0	52.0	71.0	88.2	73.9	100.0	73.0	2.34
7.	360.4.6	Mining Machinery	43.2	100.0	6.8	5.0	-	-	17.5	17.5	21.2	1.47
8.	360.4.8	Cement Machinery	-	-	-	-	-	75.5	27.7	63.0	100.0	0.94
9.	360.4.9	Chemical Machinery	97.5	79.7	60.8	68.9	100.0	95.9	21.1	56.5	72.3	2.03
10.	360.4.10	Pharmaceutical Machinery	-	-	-	36.1	41.7	100.0	95.2	40.5	19.5	3.43
11.	360.4.11	Paper Machinery	-	39.1	26.2	67.5	74.6	90.9	100.0	40.5	47.1	1.53
12.	360.4.12	Construction Machinery	52.3	62.5	100.0	78.0	98.0	86.0	72.5	45.0	65.0	2.63
13.	360.4.13	Oil Mill Machinery	66.3	54.3	54.9	56.4	60.1	76.1	81.1	95.3	100.0	2.97
14.	360.4.14	Rice Machinery	100.0	93.6	86.5	69.8	60.7	72.5	64.8	64.4	86.7	2.59
15.	360.5.2	Converging equipment.	49.4	58.3	64.4	49.8	-	50.3	49.6	89.6	100.0	1.83
16.	360.5.11	Power Driven Pumps	62.0	59.8	81.7	98.8	88.6	53.9	73.9	82.8	100.0	3.19
17.	360.5.12	Compressors Air and Gas.	50.9	70.9	78.7	72.3	91.4	88.8	64.8	81.73	100.0	2.94

1	2	3	4	5	6	7	8	9	10	11	12	13
18.	360.5.13	Referegeration Plants.	79.3	100.0	78.1	57.8	76.9	38.5	28.6	28.2	54.0	5.87
19.	360.5.14	Fire Fighting Equp.	48.0	52.0	82.0	87.0	100.0	71.5	11.12	30.8	33.7	6.46
20.	360.6.1	Ball Roller Bearings	81.2	100.0	-	-	40.1	41.7	43.2	41.3	60.5	1.62
21.	360.7.	Machine Tools	92.4	82.5	76.8	84.3	100.0	68.6	62.7	56.2	49.9	0.79
22.	360.8.1	Tractors	80.9	88.8	93.7	25.0	65.4	77.6	97.7	100.0	98.5	2.09
23.	360.8.2	Agricultural Implants.	76.8	77.1	67.9	67.0	76.9	65.5	100.0	87.9	92.1	3.21
24.	360.11.1	Type-writers	52.5	64.9	67.8	78.9	76.7	70.3	82.4	100.0	70.9	3.40
25.	360.11.3	Air-conditioner	100.0	87.8	60.2	48.5	40.9	65.6	41.7	34.7	32.3	3.57
26.	360.11.5	Sewing Machines	30.7	28.2	33.5	30.1	22.9	39.1	42.1	68.7	100.0	4.92
27.	360.12.	Weighting Machines	74.3	78.7	69.6	91.1	100.0	85.9	91.9	82.01	81.2	2.95
28.	370.1.1	Elec. Equipment for Generation etc.	100.0	87.1	18.6	18.2	22.9	29.2	22.9	-	34.9	1.97

Table 4.5.2: No. of Industries having maximum capacity utilization yearwise.

Year	Number of industries showing 100 percent CU
1960	3
1961	3
1962	1
1963	0
1964	4
1965	3
1966	2
1968	4
1969	8
	28

It is thus clear that government policies and general economics situation are not the governing factors in determining capacity utilization in a particular industry. The internal structure and the management quality play a far bigger role.

4.5.3 Explaining Variables:

The same explaining variables as used in the analysis in the last section have been used with the addition of the following:

Maximum output/capital ratio: This ratio is the maximum obtained in an industry in the years under consideration. It is contended that if the highest ratio is higher than other industries, firstly it will invite more capital almost to the point of saturation or even creating excess capacity in the industry and secondly a little less utilization will still give enough output to yield sufficient profits. Thus capacity utilization might be adversely affected while in the case of lower ratios of output to capital, unless capacity utilization is higher, sufficient profits might not materialize. Maximum output to capital ratio for the various industries are indicated in the last column of table 4.5.1.

Lowest ratio is for Machine tools (.72) and highest ratio is for fire fighting equipments (6.46). Cement machinery ratio is also less (.94). Higher ratios can be seen for referigeration plants (5.87), sewing machines (4.92), Jute Machinery (4.76), and Air-conditioners (3.57).

4.5.4 Regression Equations and Estimates:

1. Since the number of observations is fairly high for x-sectional analysis nearly 26-28 for every year except a few, all the variables could be simultaneously included and since the regression model is such that only one variable is selected at a time on the basis of maximum simple correlation with capacity utilization after reduction of the effect of variables already included, the actual significant variables were likely to be selected automatically. The results of the regression analysis are given in table 4.5.3.

Table 4.5.3 X-Sectional Estimates

Year	Intercept	FC/u	E/u	Maxm. O/K	FC/W	$\frac{E-W}{W}$	$\frac{WC}{FC}$	$\frac{FI}{GP}$	
	α_o	α_1	α_2	α_3	α_4	α_5	α_6	α_7	
$\underline{I_a}$									
1969	158.8	.0075*	-	-19.5*	-7.82*	11.63***	-	-	(
		(.0019)		(5.57)	(1.72)	(8.67)			(
1968	99.34	.0074	.0087	-12.95*	-9.57*	-	-0.29	-121.1	
		(.0043)	(.053)	(3.54)	(2.17)		(1.37)	(78.2)	
1969	99.8	-	.053**	-.175*	-2.8*	-	-9.2**	-	3
			(.023)	(.048)	(.83)		(4.37)		(1
1968	89.97	-	-	-.17*	-1.65	-99.3**	5.77*	-	
				(.04)	(1.11)	(45.3)	(1.18)		

Table 4.5.3 X-Sectional Estimates

Year	Inte-rcept	FC/u	E/u	Maxm. O/K	FC/W	$\frac{E-W}{W}$	$\frac{WC}{FC}$	$\frac{FI}{GP}$	$\frac{MH}{W}$	$\frac{Em}{E}$	$\frac{El}{W}$	$\frac{Em}{VA}$	$\frac{SI}{GP}$	$\frac{VA}{W}$	X	R	F CAL	F TABLE
	α_o	α_1	α_2	α_3	α_4	α_5	α_6	α_7	α_8	α_9	α_{10}	α_{11}	α_{12}	α_{13}	α_{14}			
$\underline{I_a}$																		
1969	158.8	.0075*	-	-19.5*	-7.82*	11.63***	-	-	0.24	-	7.67**	-14.9	-0.02	-	29.88***	0.882	6.25*	3.89
		(.0019)		(5.57)	(1.72)	(8.67)			(1.9)		(3.6)	(16.2)	(0.19)		(17.01)			(1 %)
1968	99.34	.0074	.0087	-12.95*	-9.57*	-	-0.29	-121.1	-	-11.87	16.58*	38.3**	-	5.36**	-	0.896	6.16*	3.89
		(.0043)	(.053)	(3.54)	(2.17)		(1.37)	(78.2)		(10.58)	(5.5)	(16.1)		(2.2)				(1 %)
1969	99.8	-	.053**	-.175*	-2.8*	-	-9.2**	-	3.72***	-	-	-46.77*	0.347	-	-	0.834	6.22*	3.70
			(.023)	(.048)	(.83)		(4.37)		(1.89)			(12.36)	(.207)					(1 %)
1968	89.97	-	-	-.17*	-1.65	-99.3**	5.77*	-	-	-13.3	-.22	-.90	.26	3.76**	-	0.906	8.7*	3.89
				(.04)	(1.11)	(45.3)	(1.18)			(9.95)	(4.75)	(3.62)	(.23)	(1.73)				(1 %)

2. Equations in Group Ia are more reliable than group Ib. After the computer programme has converted the basic data into the required ratio, physical check gave certain errors particularly at places where the capital appeared to be withdrawn. Ia group estimation are after the necessary corrections had been made. Moreover rate of capital additions was introduced as a factor in Ia. Ib have been retained for purposes of comparison.

3. Comparing 1969 Ia with 1968 Ia, therefore, it is found that:

(i) Fixed capital per unit is positively correlated in both at 1 percent level in 1969, 20 percent level in 1968.

(ii) Maximum output to capital ratio negatively correlated in both at 1 percent level.

(iii) Fixed capital per worker negatively correlated in both at 1 percent level.

(iv) Electricity per worker positively correlated in both at 5 percent and 1 percent levels respectively.

(v) Wages to value added positively correlated in 1968 (5 percent level) but negatively correlated in 1969.

(vi) Variables included in 1968 but not in 1969 are employees/unit (negative correlation, not significant upto 20 percent level), working capital/FC (negative correlation not significant upto 20 percent level), finished inventory level (-ve correlation not significant upto 20 percent level). Value added per worker (+ve, significant at 5 percent level).

(vii) Variables included in 1969 but not in 1968:

Auxiliary staff/workers ratio (+ve, significant at 10 percent level), Manhours/worker (+ve, not significant upto 20 percent level), Semifinished inventory (-ve, not significant upto 20 percent level), Rate of change of capital (+ve, significant at 10 percent level).

It is seen that the factors common to 1968, 1969 are generally concerned with the internal structural characteristics of the industry like maximum output to capital ratio, fixed capital per worker, average fixed capital per unit, electricity purchased per worker, and per cent of wages to value added.

These ratios change very slowly. The signs attached to these estimated coefficients of these variables tally with the theory explained earlier as well as the results with the analysis in the past section.

Finished inventory level are subject to change, beyond the control of management in a short term consideration. In 1969 because of entry of the variable rate of change of capital, some of the factors otherwise significant in 1968 might have been dwarfed. Sign of the coefficient of rate of change of capital is positive contrary to logic. As the regression progress is seen (appendix 4.5.), it is found that the simple correlation of this factor with CU is -ve and on entry it had a negative sign. In combination with other factors, the sign has changed particularly after the entry of variable maximum output to capital ratio.

Sufficient trends of variables having a bearing on capacity utilization are visible in this regression analysis. However, for predictive value in quantitative terms, this may not be much when many behavioural factors leading to these desired ratios still remain to be studied.

CHAPTER-5

CAPACITY UTILIZATION ESTIMATION AND ANALYSIS AT MICROLEVEL - ANALYSIS AT FIRM LEVEL.

5.0 Direct measurement of actual production in terms of final physical products and the comparison of this with the 'capacity' of the plant is the best and the most reliable method. However, in a plant producing a variety of products, both the measurement of actual production and estimation of actual capacity pose inumerable problems. A realistic assessment of capacity involves an optimizing exercise whereby the best product Mix has to be determined, within the constraints of existing load centres, existing staff and other facilities, and for this capacity to act as a standard of comparison, the variety of production has to be expressed as a single value. Somewhat similar problems are experienced in estimating a single value for the variety of products using common facilities. (This was discussed in chapter 3).

Indirect measurements of capacity utilization are, therefore, used by many firms. In this chapter, firstly, a general schematic model used for indirect measurement of capacity utilization is described. Secondly, application of the model by a number of firms is reviewed with special attention to the strong and weak points of the special application in each firm. Lastly some behavioural implications of the use of such measurements are indicated. It will be seen that though the treatment is different, the model is derived from the general model explained at chapter 3.

5.1 Model:

(i) For one load centre: In figure 5.1, the time balance of a particular load centre is indicated. A load centre is defined as a group of similar machines on which the various jobs can be loaded without any distinction of machines within the group. Time period can be weekly, fortnightly or monthly, depending upon the evaluation and control frequency.

With reference to Fig. 5.1.

Capacity utilization $= \dfrac{t_{prj}}{t_j}$ If t_j is known

Otherwise $= \dfrac{t_{prj}}{t_{pj}}$ for the jth load centre.

(ii) Aggregation: For a collection of load centres i.e. for a section, shop or plant

$$\text{Simplified capacity utilization} = \frac{\sum_j t_{pr(j)}}{\sum_{(j)} t_{(j)}} \quad \text{or}$$

$$\frac{\sum_j t_{pr(j)}}{\sum_j t_{p(j)}} \tag{1}$$

These are however two objections to this aggregation as follows:

1. Non-uniformity of load centres: All load centres differ

Total Time available on the load centre 'j' $= t_j$ (Installed or rated capacity)

Total time for which operator provided $= t_{pj}$

(Planned capacity)

$t_j - t_{pj}$ = Time loss due to Management decision equivalent to area $a_2a_3b_3b_2$ in fig. 3.1

Total time planned in one time period $= t_{Bj}$

(Budgeted capacity

$t_{pj} - t_{Bj}$ = Time loss due to circumstances in short run.
(considered during budgeting exercise)[1]
(equivalent to area $a_1a_2b_2b_1$

(1) Lack of orders
Lack of materials
Lack of power
Workers on long leave etc.

Total time actually worked $= t_{BTj}$

(Actual production

$t_{Bj} - t_{BTj}$ = Time loss due to operational problems (2)
(equivalent to area $a_oa_1b_1b_o$ in fig. 3.1)

(2) Absenteeism, Machinery Breakdown, Power failure, Expected work not available, waiting for instructions, drawings, and tools etc.

Productive time worked $= t_{apj}$

(Actual Productive Production)

$t_{BTj} - t_{apj}$ = Time loss partly necessary and partly due to poor management (3)
(equivalent to part area $oa_ob_oC_a$ of fig.3.1)

(3) Rejections and Rectifications, Maintenance and General Jobs not concerned with production, development jobs etc.

Standard Production time $= t_{PRj}$

(Actual Productive Production normalized to desired efficiency)

$t_{apj} - t_{PRj}$ = Time loss due to labour inefficiency.
(Equivalent to part area $C_ob_3d_1d_o$ in fig. 3.1)

$*t_{PRj}$ = Pieces produced x standard time per piece

Fig. 5.1 - Time losses for every load centre.

in their cost/unit time of production. These costs can be very different in certain cases. Automatic computerized machines and simple lathe machines may indicate a difference of as much as Rs. 200/- hour. Therefore, modified aggregate capacity utilization

$$= \frac{\sum_j t_{pr(j)} \; W_j}{\sum_j t_{i(j)} \; W_j} \quad \text{or} \quad \frac{\sum_j t_{pr(j)} \; W_j}{\sum_j t_{p(j)} \; W_j} \qquad (2)$$

where $t_{pr(j)}$ = standard productive working time on load centre j.

$t_{p(j)}$ = planned capacity of load centre j

W_j = cost/hour of load centre j and this may consist of direct labour + factory overheads. In a way this becomes the weightage factor for load centre j.

2. $\sum_j t_{p(j)}$ or $\sum_j t_{p(j)} \; W_j$ is not the aggregated capacity of the total number of load centres for the simple reason that due to the production of variety of goods and due to the requirements of definite sequences to be followed all load centres cannot be planned for a man-machine balance and some load centres (even though planned for utilization) will be left idle even after reaching the most optimum product Mix decision.

In case of comparison with 'installed capacity', these idlenesses will be more pronounced as the optimum product mix decisions leave certain machines partly utilized and for which no subsequent managerial decisions at the operating levels can be of use. This objection can only be removed by first finding the optimum product mix by using a linear programming model as under:

Decision Variable: Set of X_i (i = 1,2,...n)

Objective Function Minimise $\sum_j (C_j - \sum_i x_i \; t_{ij}) W_j$ (i)

Subject to constraint $\sum_j x_i \; t_{ij} \leq C_j$ for all js (ii)

where C_j = planned capacity of load centre J
(if comparison with installed capacity is required, installed capacity should be considered)

x_i = number of product of i manufactured (i =1,...,n)

t_{ij} = standard time of job i on load centre j.

j = load centre j = 1,...,m.

W_j = cost of load centre j

Equation (i) minimises the cost of idleness of all load centres combined.

Equation (ii) puts realistic constraints on load centre j. It is assumed that sufficient inventory is available on each load centre for working and different jobs don't go though different load centres as if on a balanced belt.

For interlinked load centres an interlinkage constraint should be introduced as under

$$x_{ij} \geq \frac{x_{i(j+1)}}{n} \quad / \; n \qquad \text{for all js}$$

where n is the efficiency of (j+1)th process. Secondly C_j is first assumed as installed capacity and for idleload centres, operators are planned as per requirement. Thirdly since capacity (ideal) is being determined, no concessions for break down, absenteeism etc. have been given to the capacity at load centre j.

With this model, the realistic planned capacity = $\sum_j \sum_i x_i \; t_{ij} \; W_j$ and aggregated capacity utilization

$$= \frac{\sum_j t_{prj} \; W_j}{\sum_j \sum_i x_i \; t_{ij} \; W_j} \qquad (3)$$

However equation (3) introduces a number of complications. Application of linear programming models require a long preparation and so far, the application of the same for determining the product mix in a complex shop has not been noticed in any firm. Though accurate, this measure is not used by any firm. Since change in (3) from (2) is only in terms of the denominator, this does not vitiate the comparison from one period to another if equation (2) is used. Application of (2) is not difficult as most of the firms have a system of announcing upto-data of load centre rates from time to time.

It was however seen that most of the firms prefer to follow capacity utilization rule as given at number (1) and in case some machines are 'very high cost' ones, separate attention is paid to these.

5.2 Application of the Model:

In all 9 firms were examined for details regarding the application of the model for indirect measurement of capacity utilization. The firms' names are not indicated in difference to the wishes of the managements concerned. Out of these 9 firms, no detailed analysis was done for 3 firms for reasons indicated below:

5.2.1 Firms not Considered:

(1) Unreliable Data: In one firm, the industrial engineer himself indicated that the figures as given in the time sheets were not reliable. This sheet for each machine was filled by a chargeman and this document was not a part of the incentive scheme. For the incentive scheme, the booking of the time on job cards against various jobs was compared against the total time clocked in the gate attendance card. While total utilization could be obtained from these documents, the details of losses of time/could not be ascertained and since the time sheets for different load centres were not considered reliable, the analysis of this firm was given up.

(2) Insignificant Booking Against Idle Time: In one firm, it was noticed that though the proforma was elaborate, the booking

against various heads was negligible. Since breakdowns, power shortages, lack of work and other causes are universal phenomenon, this unusual state of affairs was traced to existence of very slack standard allowed times and a ceiling on incentive bonus.

Suppose total clocked time $= t$

and idle time booked $= t_d$

Then incentive bonus $= k(t - t_d) + t_d \times 0.$

where k is the percentage of incentive bonus earned on time worked. No incentive is payable on idle time

$$\text{Now } k = \frac{\text{Time saved}}{\text{Time taken}} = \frac{\text{Time saved}}{T - t_d}$$

k will increase if time saved increases and in case standard allowed time is more than justified, time saved will always be high and k will approach k' (ceiling percentage).

As incentive bonus $= k'(t - t_d)$

and k in all cases approaches the maximum K, incentive bonus in amount will increase when t_d approaches zero.

Moreover, in this firm, the supervisors' bonus was reduced proportionate to the idle time booked and therefore supervisors never allowed idle time to be booked as far as possible.

Pressure from both workers as well as supervisors was to incorporate the total expected losses in the allowed times. The analysis on the face of it indicated very good capacity utilization with time losses to be very small and incentive bonus percentage nearing the ceiling but in fact, the plant suffered from a deep malady. However, this was not analysed further.

(3) Low Importance of Load Centres: In another firm, the utilization sheets were filled up elaborately for the machine shops and the underutilization was very high. Managements' attitude to this low utilization was not of any particular concern. The firm purchased a bulk of its requirement (about 70 percent) from ancilliary units and under-utilization of any extent in its own shops didn't effect the assembly of final product. Moreover the machine shop itself was not a major investment area of the whole plant. Other shops were mostly assembly shops and were labour intensive. Labour utilization was not recorded. Labour efficiency was fairly low but incentive scheme was not in use and management was trying to improve labour efficiency. There was therefore not much point in analysing the given data at this stage.

5.2.2. Firms Considered for Analysis:

Out of the remaining six firms, four have been picked up for a detailed analysis. Other two have been left out, being similar to the first four.

(A) Firm X1:

(A1). Estimation of Capacity Utilization Through Time Record:

(i) The firm manufactured different products and separate facilities were provided for major products i.e. transformers, switch gear and motors. Analysis was done for direct labour utilization for different shops separately for each product.

Weekly periods are used. (In case of capacity utilization vis-a-vis planned capacity and non-distinction in the cost of different load centres, labour utilization is as good a measure of control as equipment utilization.

Proforma for recording data is given at appendix 5.1. Figures for total of all the three shops only are given.

(ii) Normal hours present = Total direct workman x48 - Absenteeism

Total hours present = Normal hours present + overtime.

Total hours worked = Total hours present - IDLE hours.

Productive hours worked = Total hours worked - Misc. work hours.

(iii) Control indicators

$$\text{Absenteeism percentage} = \frac{\text{Total direct workman} \times 48 - \text{clocked hr.}}{\text{Total direct workman} \times 48\text{x}}$$

$$\text{Overtime percentage} = \frac{\text{Overtime booked}}{\text{Normal hours present}} \times 100$$

$$\text{IDLE time percentage} = \frac{\text{IDLE time}}{\text{Normal time present}} \times 100$$

$$\text{Misc. work hours percentage} = \frac{\text{Misc. work hours}}{\text{Normal time present}} \times 100$$

$$\text{Overall working efficiency} = \frac{\text{Standard hours produced}}{\text{Total hours worked}} \times 100$$

(iv) It can be seen that the breakdown of the idle hours and miscellaneous work hours is substantially detailed. Three categories of idleness due to lack of work have been mentioned as under:

(a) No work - means lack of orders.

(b) Shortage of inside Material - means materials under processing at one load centre and subsequent centres, having no stage inventory are waiting for this material only.

(c) Shortage of purchased material - Though orders exist, load centre is idle due to non-availability of raw material.

Indirect work means booking of direct workers to jobs which are a part of indirect expenditure.

(v) Results of Analysis:

All figures are calculated against normal hours present except absenteeism. To keep, the denominator common, all percentages are converted to a percentage of total time planned.

Item	Percentage of normal time present	Percentage to total time planned
Absenteeism	-	12.0
Idleness	7.3	6.4
Lost in Misc. work	14.1	12.4
Total -	21.4	30.8

(1)

$$\text{Efficiency} = \frac{\text{Standard production hours}}{\text{Total time worked}} \times 100 = 76 \text{ percent}$$

		Analysis of Total time		Analysis of Normal time present
Total time worked	=	100 - (12 + 6.4)		(100 - 7.3)
	=	81.6 percent	=	92.7 percent
Standard production hours as a percentage of total time planned or normal time.	=	$81.6 \times \frac{76}{100}$		$(92.7 \times \frac{76}{100})$
	=	62 percent	=	70.5 percent
Loss in Misc. work	=	12.4 percent	=	14.1 percent
(i) Capacity Utilization time wise	=	100 - 18.4	=	100 - 7.3
	=	81.6 percent	=	92.7 percent
(ii) Capacity Utilization Including Labour efficiency	=	62 percent	=	70.5 percent
(iii) Capacity Utilization for productive work	=	62 - 12.4	=	70.5 - 14.1
	=	49.6 percent	=	56.4 percent
Overtime as a percentage of normal time percentage			=	9.95 percent
Overtime as a percentage of total time planned			=	8.8 percent
(iv) Overall capacity utilization	=	49.6 + 8.8	=	56.4 + 9.95
	=	58.4 percent	=	66.35 percent

(vi) Objections to this reporting:

(a) Direct man hours as a ratio of total man hours available is not given to examine the possibility of converting some indirect men to direct one.

(b) Shift working is not indicated and hence capacity utilization in relation to installed capacity cannot be worked.

(c) All load centres have been considered of equal value or involving same cost.

(vii) Interpretation:

1. Overtime payment for 3021 hours (at the rate of Rs. 5.00 per overtime hour) works to Rs. 15105/-. This is too much when compared to Rs. 3069/- paid as incentive bonus and this is despite a total of 17 percent of idle booking on account of no work, no internal components and no purchases components. This working appears to be unsatisfactory and shows that either the material planning is not right or overtime has to be booked as a matter of extra income to the workers and not as a necessity for lagging work. All the same, overtime improves utilization but is likely to retard the improvement of labour effieiency.

2. Loss of 17 percent of total hours due to non-availability of components, and work orders is a serious loss of capacity. While on one side the order position seems to be poor, this fact also retards any effort to improve losses on other accounts as well as retards efforts to improve labour effieiency.

(viii) Labour Efficiency:

The labour efficiency obtained in 1974-75 and 1975-76 was examined in detail and the variations in efficiencies are as follows:

	1975-76	1974-75
Machine shop	44-108 percent	69-97 percent
Fabricationshop	54-99 percent	66-90 percent
Overall	44-86 percent	64-93 percent

It is thus proved that time standards are such that the desirable efficiency of 100 percent can be attained by workers and thus the reduced efficiencies are not a result of stringent time standards. It appears that sufficiency of orders which can ensure overtime at the expected level also lends itself to improved efficiency.

(A2). Estimation of capacity utilization through work sampling: Results of a work sampling study carried out at the works by the firm itself are given at table 5.1

Table 5.1 Summary of work sampling study:

Element	Percentage time machine busy man idle	Percentage time machine idle man busy	Percentage time man and machine idle
Actual winding	38.65	-	-
Load Former	-	1.01	-
Unload former	-	0.93	-
Arrange material	-	6.53	-
Fit former	-	5.87	-
Reverse coil for former	-	1.03	-
Load and unload copper strip	-	0.46	-
Idleing of operator and m/c	-	-	33.66
M/c idle due to absenteeism	-	-	8.11
M/c idle due to power failure	-	-	2.04
M/c idle due to consultant	-	1.37	-
M/c idle due to breakdown	-	-	0.34
	38.65	17.20	44.15

Capacity utilization = 100 - 44.15 = 53.85 percent

Workers' efficiency results in:

1. work proceeding at slower rate then desired;
2. worker not available at work even though his job card shows him working.

Last of these two elements will be reflected in the above study but not the first one. Even part of the Misc. work (indirect) is included. In indirect booking worker may not be available at his place of work as it was stated that a worker going to office for expressing a grievance is also booked against indirect work. This is reflected in the above study in the element 'both worker and machine idle'.

Slack time standards:

It is seen that the capacity utilization of 53.85 percent is lower than the overall capacity utilization of 66.45 percent (including overtime). It is possible that total utilization including labour efficiency in over time is more and overtime didn't form a part of the work sampling study. Excluding overtime, the overall utilization of normal time present is 56.4 percent.

Even then the capacity utilization obtained by work sampling is less. In a work sampling study, the effect of slack time standards is also introduced and since the utilization obtained is much less than the overall capacity utilization from records, it is quite clear that time standards are slack to some extent. However, time standards are not very much slack, as workers idling may also be a part of their fatigue and personal needs allowance and this is not recognized by the work sampling study. Against this, no rating was recorded to indicate the efficiency with which workers progressed their work.

(A3) Estimation of Capacity Utilization from Output:

Licensed capacity (transformers)	=	11,50,000 KVA
Installed capacity	=	15,00,000 KVA
Total output in 74-75	=	6,90,845 KVA
Total output in 75-76	=	6,77,910 KVA
Total output in 76-77	=	11,16,539 KVA

$$\text{Capacity utilization in 76-77} = \frac{11,16,539}{15,000,000} = 74.4 \text{ percent}$$

This may be contrasted against overall capacity utilization indirect measurement = 66.45 percent,

and overall capacity utilization through work sampling

= 53.85 percent.

The more optimistic figure of 74.4 percent can be due to the fact that -

(i) Calculation of capacity utilization by indirect measurement and work sampling are for short periods which may not be representative.

(ii) Installed capacity is calculated wrongly. The basis of this calculation is not clear. This was the starting objection to measuring capacity by simplified direct means.

(iii) Actual production of 11,16,539 KVA may be a result of a favourable product Mix. It is seen that the following types of transformers are manufactured at this work:

Upto 300 KVA, upto 1600 KVA, 4000 KVA
10000KVA, 25000 KVA, 80000 KVA.

Effort required for each is not proportional to KVA. In short, one 80000 KVA transformer is not equal to twenty 4000 KVA transformers. This was another objection of simplistic direct measurement.

B. Firm X2:

(B1) Capacity Estimation Through Analysis of time Record:

(i) Only points of difference to analysis for X1 are given.

(ii) Data may be seen at appendix 5.2.

(iii) Clocked manhours = planned hours - absenteeism + overtime (thus details of absenteeism and overtime are not given separately).

(iv) Hours lost recorded for maintenance, power, material (all kinds) and miscellaneous are as in X1 and additionally for cranes, inspection, instructions and tools separately. (Though, so many accounting heads don't seem to be justified seeing the amount of booking in each).

(v) Percentage loss due to waiting $= \dfrac{\text{hours lost}}{\text{clocked hours}}$

(vi) Rectification hours are recorded separately. No indirect and replacement hours are given. It appears that distinction between productive and nonproductive is not made as far as calculation for machine utilization is concerned. This is a negative point as, by this procedure the machine utilization recorded may be high and still may not be resulting in any productive result.

(vii) Operator efficiency calculated as before.

(viii) It is however clear that all machines are planned to work only in one shift.

So planned capacity = 33 percent of installed capacity if efficiency in each shift is considered as 100 percent. If however efficiency of second shift is considered 90 percent of the 1st shift and efficiency of 3rd shift 80 percent of 1st shift and ideal number of shifts to work is 2.5 shifts (assumed);

Then total capacity = $100 + 100 \times .90 + \frac{100}{50} \times .80$

$= 100 + 90 + 40 = 230$ percent of 1st shift.

Planned capacity = 100/230 = 43.5 percent of installed capacity.

(ix) Loss due to waiting = 23.4 percent of clocked time.

Loss due to rectification = 8.5 percent of clocked time.

Number of machines = 41.

Planned hours = 41 x 48 = 1968.

Clocked hours = 1992.

So absenteeism and overtime = + 24 hours.

Time utilization of planned capacity = 100 -23.4 = 76.6 percent.

Time and productive utilizationof capacity = 100-(23.4 + 8.5)

= 68.1 percent.

Overall operator efficiency = 64 percent.

Loss due to operator efficiency = 68.1 x (100 - 64 percent)

= 24.5

(100 being the desired efficiency).

Overall capacity utilization = 68.1 - 24.5 = 32.6 percent of planned capacity.

Overall capacity utilization = $33.6 \times \frac{43.5}{100}$ = 14.6 percent of installed capacity

$$\left(\frac{\text{Planned capacity}}{\text{installed capacity}} \times \text{percentage utilization of planned capacity} \right)$$

The stages of capacity can be seen very clearly as follows:

	% of planned capacity	% of installed capacity
(i) Installed capacity	-	100
(ii) Planned capacity	100	43.5
(iii) Budgeted capacity (less requirement of rectification = 8.5 percent)	91.5	39.8
(iv) Actual capacity (less time wasted due to idleness and labour inefficiency)	(91.5 - 23.4).64 = 33.6	$39.8 \times \frac{33.6}{100}$ = 14.6

Note: Since standard time allowed could not be checked, no difference between installed capacity and rated capacity can be identified.

(B2) Capacity Utilization of Critical Machines:

Criticality is determined not on the basis of cost but of delays on that particular load centre. Proceeding as before.

Time utilization to planned capacity = 63.4 percent (37.6 percent waiting).

Time and productive utilization to planned capacity

= 42.4 percent (20 percent rectification).

Overall utilization to planned capacity = 61.4 x 42.4 = 26 %

(61.4 percent efficiency).

Overall utilization to installed capacity = 26 x $\frac{43.5}{100}$

= 11.3 percent.

(B3) Conclusions:

(i) Machine hour costs considered uniform for aggregation but some machines considered separately.

(ii) A very realistic picture of capacity utilization has been possible and is also useful as the machine tools employed are very costly and this low utilization should make the managements feel very concerned.

C Firm X3:

(C1) Estimation of Utilization of Capacity Through Time Records:

a. Salient features different from X1 and X2:

(i) 1st, 2nd and 3rd shift utilizations are calculated separately.

(ii) 1st and 2nd shift are planned for regular working and 3rd shift for over time working.

(iii) Results of one time period are given at appendix 5.3.

(iv) Machine time available = hours available - idle time - time unaccounted.

Unaccounted time refers to absenteeism or vacant position.

(v) Machine utilization = $\frac{\text{Machine time available}}{\text{Total hours available.}}$

(vi) Production index as calculated is equivalent to labour efficiency.

(viii) Time utilization and production index of each shift and total given in table 5.2.

Table 5.2 Utilization of machine (U) and Production Index(PI) for firm X3.

Load Centre	No.of m/cs	Ist shift		II shift		III shift		Total	
		U	PI	U	PI	U	PI	U	PI
Drilling	46	74	92	47	85	0	0	61	89
Centre lathes	11	78	84	67	65	0	92	73	64
Capstan lathes	7	85	92	56	78	0	97	70	86
Automats	5	85	87	76	91	0	87	80	89
Spl.Turning and boring machine	32	71	77	59	72	0	103	65	75
Milling	12	86	58	65	48	0	0	76	54
Grinding	11	76	101	64	101	0	124	70	101

2nd shift utilization is generally less as all problems of non-availability of workers etc. are shifted to 2nd shift. PI shows no trend. It is probably high in 3rd shift due to over time.

Overall utilization index not calculated.

For drilling:

Time utilization of planned capacity = 61

Overall utilization of planned capacity = 54.3 percent (61 x .89)

Overall utilization of installed capacity = 54.3 x .71

= 38.5 percent.

(If third shift is worked only $6\frac{1}{2}$ hours more will be possible

$\frac{\text{Planned capacity}}{\text{Installed capacity}} = \frac{16}{22.5}$ = 71 percent. Assuming same efficiency for all shifts).

Stagewise analysis:

		% planned capacity	% installed capacity
Installed capacity	=	-	100
Planned capacity	=	100	71
Budgeted capacity	=	100	71
Actual capacity	=	54.3	38.5

Note: Budgeted capacity = 100 percent of planned capacity.

D Firm X4:

Salient points different from X1, X2 and X3:

(i) Three shifts working with each shift of $7\frac{1}{2}$ hours.

(ii) Idle time booked against 15 heads.

(iii) Results of one period included in appendix 5.4.

Time utilization to planned/installed capacity = 85.5 percent

(idleness = 14.5 percent)

Time and productive utilization capacity = 83 percent

(setting time 2.5 percent)

Overall utilization of capacity = 83 percent x PI

Production index varies from 43.9 percent to 112.8 percent.

(iv) No effort is made to calculate overall utilization.

(v) Utilization is very high and all losses are indicated to concerned departments.

5.3 Some Behavioural Aspects of Indirect Measurement of Utilization:

(1) Firm X4 proforma is the most elaborate. By logging idle or waiting time against various heads, the responsibility for that loss is also attempted to be fixed. The very fact of recording is likely to keep the various departments on their toes. Each department is supposed to watch the idle time logged against it. This also requires that the departmental responsibility for idle time should be in agreement with the time booked. Depending on Management style, this can lead to effective action by the departments concerned to control idle time by production departments or can lead to bickerings and further waste of time in fixing responsibility.

(2) If incentive scheme documents are integrated with the idle time bookings, as it should be, then a worker will like to book maximum possible idle time on job card to ensure adequate incentive bonus on remaining time. If departments concerned are not penalised for the idle time, the idle time booking will increase. If they are penalised, they will try to obstruct the possible bookings of idle time against their own department. The result can be;

(a) idle time will be booked against heads for which no departments can be clearly held responsible like shortage of power, awaiting instructions etc.

(b) there will be an effort on the part of the departments concerned to intensify their search for explanations for their failures. Departments may demand more staff and facilities and continue to offer shortage of staff and facilities as explanations. Department heads will spend most of their time in developing a strategy for their defense rather than for improving their effectiveness for better production and productivity.

(3) These statements in hands of top executives may detract them from some major issues. Idleness and production index may not be so important as the percentage of planned capacity to installed capacity. If present planned capacity is less, the same may be ignored. Therefore, as far as possible capacity utilization of installed capacity should also be calculated.

(4) If utilization figures become important in the eyes of management, the same will be given importance by the various departments concerned, may be at the cost of real objectives through -

(a) avoiding development work, time consuming difficult work, work where rejections are high, precision work and jobs which have a relatively tight standard time.

(b) this however, can be avoided by finding out the utilization of each machine by including miscellaneous work and giving due weightage to the same.

5.4 Improvement in Utilization of Planned Capacity:

Case 1: Equipment not available - operator available:

This condition arises, when an equipment is under preventive maintenance, electrical or mechanical breakdown or under testing or relocation.

Suppose number of machines installed in a particular load centre = X; and number of operators employed = Y

If $Y < X$, machines to the extent of $X - Y$ can go under breakdown without affecting the utilization of planned capacity if $Y \geq X$ in any of shifts being operated, loss of capacity is inevitable.

Reducing idle time when $Y \geq X$:

(i) Working more shifts: is a solution in such cases. If $Y \geq X$ and one shift working is involved, starting a second shift with the same staff and assuming $Y/2 < X$, loss of capacity due to the reasons of breakdown etc. will be avoided. Similarly if two shift working is already involved, third shift working can be started to achieve the above condition.

Constraints: A load centre must be truly defined (Para 3). In one firm a load centre consisted of 7 HMT lathes, but only two of these were accurate enough and therefore were loaded more than the others. In this case it is better to consider this as a set of two load centres and all operators must be capable of working on all machines in the load centre.

Advantage: 1. Loss of capacity due to breakdowns and maintenance requirement is less.

2. More preventive maintenance time can be permitted leading to less breakdowns.

3. Interruptions of work can be accommodated by moving the worker to a second machine lying spare.

4. In case of power failure, less number of operators are affected and they can also be employed for preparation, loading, unloading operations on more than one machine.

5. Cycle time will reduce. Fewer jobs will be started but will be worked upon double the time thanbefore and shall be completed earlier.

6. Since more operators will work on fewer jobs, loss of capacity on account of 'No work' will be considerably reduced. Suppose the same number of operators, instead of working one shift, are scheduled to work in two shifts. If an engine block, e.g., is loaded for machining on one machine, the same will be taken up by the operator in the second shift, otherwise two blocks would be required to satisfy two operators in one shift.

Disadvantage: 1. For the same staff more supervisors and indirect staff may be required.

2. Some other expenditures may increase in connection with operating an additional shift.

3. In case of ineffective control, efficiency of working & quality of products may suffer in additional shifts.

However, the advantages seem to far outweigh the disadvantages.

(ii) Other methods:

If Y $\geq$ X and the position is to remain like this i.e. no additional shifts can be run either because these are already being operated or as a result of the management decision, than the loss of planned capacity due to breakdown etc. can be reduced as follows:

1. Careful study of the past histories of the time losses on this account of breakdown: It is important to note here that the maintenance departments must agree with the time losses taking place~~s~~ on account of breakdowns. Normally as soon as a machine goes under breakdown, the production departments book the idle time card on this account. Time lost in informing the maintenance department and their recognition of the same after checkup is not considered as the responsibility of production departments. This disputed time is considerable and a good communications system can reduce the machine idle time considerably.

2. A careful study can reveal the right course of action. Preventive maintenance may have to be strengthened. Inventory of maintenance spares might have to be improved. Training of staff in specialised fields of equipment systems, now-a-days prevalent, is necessary. Specialization in hydraulic, electric, electronic, numerical, and computerized controls has become necessary.

Study of machine behaviour statistically to predict failure times and thus improve scheduling of jobs may give good results. Such maintenance models for critical equipment can be tried and the equipment behaviour x can be simulated.

3. Optimal Determination of Planned Capacity:

If planned capacity in a shift corresponds to theoretical 100 percent utilization of equipment without having time for preventive maintenance, then this planning may prove suboptimal because of -

(a) increased breakdown rate;

(b) development of 'queues' on this load centre.

It is better to work more number of shifts if possible. If this is not possible, and 100 percent utilization is a must, then all possible service centres for this equipment need to be adequately strengthened.

Case 2: Machine Available - Operator not Available.

This happens when operator is absent, or malingering.

(1) Planned absenteeism:

Absenteeism upto the agreed extent of leave with pay cannot be avoided and either alternative staff is to be provided or planned capacity is to be considered as correspondingly reduced. If leave reserve is provided, time loss due to absenteeism will reduce considerably. However, management of leave reserve is a difficult job. As specialization increases and number of load centres becomes larger, it is difficult to provide effective leave reserve. Suppose a load centre consists of one load centre and two operators and if leave reserve to the extent of 10-15 percent is needed no leave reserve can be provided as it may prove too costly.

Still, adequate management of leave reserve is crucial to avoid the time loss due to absenteeism and the following recommendation can prove useful:

(i) Providing Leave Reserve in lower Categories:

Suppose the number of skilled staff = 100 (in various trades)

Suppose the number of semiskilled staff = 40 I in various trades)

Suppose the number of unskilled staff = 30.

Whenever skilled staff goes on leave, the requisite number of semiskilled staff should be asked to officiate for the absenting skilled staff.

For the posts falling vacant in semiskilled category, unskilled staff are required to officiate. Thus the leave reserve staff can be provided in the unskilled category.

If leave reserve is 10 percent then total staff required $= \frac{100 + 40 + 30}{10} = 17$. Because of better payments during officiating periods, the staff in lower categories will be motivated to work in these positions and also remain eager to learn various trades of higher skill so as to be able to exploit the opportunity of working in higher categories. For the management, it has a distinct advantage.

If Leave Reserve was to be provided, say, in the same category then leave reserved in skilled category $= \frac{100 \times 10}{100} = 10$.

Now a staff of 10 may not be able to train themselves to work in all the trades of the 100 skilled employees. If semiskilled staff is to officiate, all the forty can learn some trade or the other and effective leave reserve can thus be provided.

(ii) Mobility of Trade: Two or three load centres can be considered one for the purpose of providing leave reserve. It is essential that a few workers be trained to work on more than one load centre. An adequate incentive can bring out a few volunteers who will train themselves to work on more than one load centres as required.

2. Absenteeism on 'on pay' and 'unannounced':

Some impact can be absorbed through the mechanism mentioned in case 1. However, since no time for planning is available the resulting loss is unavoidable.

Low absenteeism incentive, workers education, personal contact of supervisors with staff, liberal policyof management towards persons applying for leave so as to encourage planned absenteeism are some of the positive measures to reduce unaccounced absenteeism. Negative measures like punishment, should be used sparingly and only in cases of habitual offenders.

3. Heavy Absenteeism:

This occurs because of religions festivals, crop timings, social engagements etc. These timings are generally known. In western countries, when this fact is known, the whole firm is closed for a few days. Since the staff going on leave is dispersed in all positions in the firm, their absence will leave an unbalanced work force during that period and the working is bound to become somewhat unproductive. Mobility of trade, pre-planning to the extent possible closing of some departments and concentrating on a few others, closing the entire factory and catch on with lagging schedules of maintenance, stock taking, renovation of tools, jigs and fixtures, can be very helpful in increasing the efficiency of operations when the firm reopens.

4. Chronic Absenteeism:

The workers, who are chronic absentees, have to be relegated to less important jobs while a systematic effort is made to effect improvements in reducing the extent of such workers.

5. Malingering:

(a) First reason of malingering is the slack time standard. In such cases, operators are officially booked on job but are not physically present at work place. This is discussed in Chapter 3.4.1. Work sampling, time standard audit, can be used to review the standard times fixed. Enforcement of such standard time requires good managerial competence, firmness, and adequate incentive schemes.

(b) Malingering as a habit and as a result causing poor production comes under the purview of maintaining discipline. This will definitely be reflected in poor labour efficiency and poor incentive earnings for the man. Some action was suggested in 3.4.2. Adequate supervision and firmness on the part of management are required to check this. It is however better to check malingering by changing the organization behaviour through other means like job enlargement, job rotation, training, group working, group incentives, adequate design of rest pauses, rearranging work schedules and encouraging workers participation in management which should also be introduced though inclusion of workers in formal committees and councils.

Case 3: When Machine and Operators are Available but no Work is Done:

This arises when there are no orders, no purchased raw materials and components or no internally manufactured components at some stages.

No orders can result because of many reasons. Many of them were mentioned in para 3.6. These are deep rooted problems and present-day policy can have long range effects on the adequacy of orders. Market effectiveness as an objective has to be vigorously followed. Market research has to be undertaken.

No purchased materials can result out of a purchase policy of the organization or out of a genuine shortage of raw materials. Normally, due to some component getting forgotten from the purchase list or for a stock item or warning signal not given in time, the whole assembly is held up. Such cases can be reduced by pursuing an efficient material management.

Internally manufactured components are not available either as a result of poor scheduling or schedules getting upset due to load centres becoming non workable or the material getting rejected or needing rectification.

Case 4: Worker available, Machine available - No productive work done:

Apart from regular production work, the shops have to take up a lot of other work like work for maintenance of equipment, work for development, work for rectification of defects produced during manufacture in the present shop due to present operation or a previous operation, replacement of rejected parts, manufacture of parts for jigs, fixtures and anciliaries to be used for production and other kinds of miscellaneous jobs. All these jobs don't result in actual output. Most of the times, these are essential but a clear account has to be kept of time required to manufacture these. As these jobs are one time jobs and standard times cannot be fixed realistically, there is always a danger of time being wasted on this account as well as a result of poor instructions concerning drawing and manufacturing method, repetitions, nonavailability of tooling required, and lack of clearcut responsibility of seeing the job through. These unprogrammed jobs require the maximum attention of the auxiliary dependents of planning, processing, tool designing etc. Such jobs should reach the manufacturing shops only after complete preparations have been made if time loss in the shops is to be avoided.

Case 5: Worker and Machine available - Productive work at poor efficiency:

A full case study at 3.4.2 is devoted to this problem.

5.4.1 Improving Planned Capacity Levels vis-a-vis Installed or Rated Capacity:

This thesis has been developed on the basis that attention to loss of planned capacity has been given more attention whereas planned capacity is generally found to be much less compared to the rated capacity. These aspects have been discussed earlier in Chapter-3.

5.4.2. Even for the nine firms, for which data has been discussed, the data has shown to have a lot of shortcomings. Many other firms were found to be maintaining no data at all or else the records were not kept in a reliable manner. Since the utilization of capacity is of significance for economic growth of the nation, the subject of estimation of capacity and its utilization cannot be left to the whims and fancies of the firms and there is a very important need of introducing statutory measures to force all managements to deal with the estimation and analysis of capacity utilization in an effective manner. This is detailed in Section 5.5.

5.5 Need for Audit of Capacity and Its Utilization:

5.5.0 In this section, a case has been built for introducing formal yearly audit of the capacities of plants and of their utilization. It is true that in a perfectly competitive economy, the entrepreneur, to ensure profitability for his plant, has to utilize the resources optimally or else he will be forced to quit. Our economy is first of all a mixed economy and secondly it is not perfectly competitive. As a result of the introduction of public sector in our economy, the objectives of the Industry underwent a change and profitability did not remain the sole criterion of success. Stability of prices, employee welfare, increase in the employment potential and enhancing the self-sufficiency of the country have emerged as powerful objectives of plants in the Public Sector. This has, however, considerably clouded the thinking in many places. If profitability was reduced as a result of allocative efficiency alone, this was acceptable. However, it is seen that even the partial meeting of the alternative objectives is being advanced as a cover for poor technical efficiency! The net result is that, while on one side market forces can neither push the inefficient units out (even assuming a perfect market), on the other side, no mechanism has been developed to assess the real performance of the units in Public Sector. The lack of perfection in the market and the persistence of shortages of a wide variety of goods has led to a host of malpractices which can ensure adequate profits for the entrepreneur without his trying to worry about the optimum utilization of resources. It will be shown, that capacity audit can be instrumental in improving the efficiency of the mixed economy like ours and preventing the existing malpractices.

5.5.1 Need for Capacity Audit:

(a) Capacity Utilization in the Public Sector:

Before 1972-73, capacity utilization of the units in public sector was not measured at all. Since 1972-73, Bureau of Public Enterprises, in the annual report on the working of Industrial and Commercial Undertakings of the Central Government, has been including a chapter on capacity utilization. Though, this fact, in itself is very significant as it gives due recognition to the importance of the subject, the assessment carried out is far from satisfactory. Table 5.3 summarises the position of capacity utilization in these undertakings.

Table 5.3 Capacity Utilization in Public Sector:

Item	Year 1975-76	1974-75	1973-74
1. Total number of units reported upon.	148	141	120
2. Units under consideration	25	35	28
3. Units with capacity utilization -			
(i) more than 75 percent	69	54	45
(ii) between 50 - 75 percent	28	27	23
(iii) less than 50 percent	15	16	16
4. Units in respect of which data not available.	11	9	1

Source: Annual report Vol.I 1975-76.

Even with the assessment of capacity as defined by various individual firms, the position in Table I is very disappointing. It will be shown later that capacity determination is many cases is faulty. The position in regard to Engineering Firms in public sector was even worse as seen in table 5.3.1.

Table 5.3.1 Capacity utilization for 1975-76 for Engineering Enterprises in Public Sector.

Type of firms	Capacity Utilization more than 75 percent	between 50-75 percent	less than 50 percent
Heavy Engineering	6	4	5
Light Engineering	13	5	3
Transport equipment	6	1	1

Though somee of these ideas have been expressed earlier in Chapter 2, the present discussion relates specifically to the working of the public sector.

(b) Basis of Capacity Estimation:

Capacity of these plants, which forms the basis of determining capacity utilization is not clearly known. According to the annual report 1975-76 Vol.I'....Capacity of a factory is an ambiguous concept. It is not like the full capacity of a milk bottle which may hold one litre of milk but not more under any circumstances; and that capacity should never be considered all by itself but as a part of the bigger picture. A plethora of prefixes are available to qualify 'capacity', such as 'DPR', 'Rated', 'Licensed', 'Attainable', Installed', 'Potential', 'Developed' indicative' of multiple facets of the term. In the absence of a clear picture of capacity limits, targets and budgeted production also stand for capacity".

It is further mentioned that 'the capacity ratings are culled from detailed project reports and enterprise's own assessments or targets of production set by them individually.' It is quite clear that no uniform or consistent method of estimating capacity has been evolved for determining the capacity of the plants. The following defects in the estimation of installed capacity by individual firms can be straightaway noticed (Also given in table 2.0 in Chapter 2).

(i) Capacity has been indicated in numbers or weight units or other physical units without considering the difference in effort required for different items of production.

(ii) When a variety of products are manufactured it is not clarified whether some of the facilities are common to different products and whether the capacities of different items mentioned are maximum limits or based on optimum or some other allocation of common facilities.

(iii) Aggregation of the capacity utilization of various products is nearly impossible.

(iv) Whether capacity considered is DPR rated or budgeted etc. is not clear in any case.

This situation has introduced many errors as can be seen from different cases picked up from the same report.

Case 1: Unrealistic Targets:

Table 5.4 Capacity Utilization in HMT.

Firm	Product	Capacity Nos.	Production 1975-76	Percent capacity utilisation	Remarks by individual firms Percent
HMT Kalamassery	M/c Tools	1000	559	60	108 of target
Hyderabad	,,	1000	166	17	100 of target
Ajmer	,,	248	217	7	72 of target
Bangalore I+II	,,	2000	1301	65	100 of target
Pinjore	,,	1000	633	63	102 of target
Pinjore	Tractors	12000	7000	58	89 of target
Bangalore	Watch	410000	447475	109	104 of target
Srinagar	,,	230000	180465	78	85 of target
Kalamassery	Printing machine	-	216	-	106 of target

With reference to table 5.4 many questions arise:

(i) What is the basis of determining the capacity as mentioned ?

(ii) Was it calculated for the most optimum shift working ?

(iii) What was the basis of aggregation of the vast variety of machine tools produced; each requiring different manufacturing time at different load centres ?

(iv) Are the time standards evolved for working considered satisfactory ?

(v) What labour efficiency was assumed ?

(vi) What standard percentages of idle time due to breakdown, absenteesim and other miscellaneous causes have been assumed ?

It is possible that capacity determination has been done with reasonable consideration of each question but it needs to be checked independently.

Then there is the question of 'target'. In most of the plants actual production has been more than the targets. Firstly it is not understood, how and why, targets were set lower than the capacity. The figures in table 5.4 give an impression that the targets were set lower because of certain serious difficulties and the firms with good effort, overcame those difficulties and produced better results than the targets set. In the absence of a correct verification of the targets, the plant managements will be tempted to get as low a target as possible accepted by higher authorities and then wait to collect the cudos at the end of the working year. The ultimate criterion of profitability is not of much use as, firstly, in case of loss or less profits, cover is taken under other objectives as discussed before and secondly despite under-utilization of capacity, the firm may still earn profit due to the position of monopoly held by many firms and the pricing policy based on cost plus basis. Moreover Public Sector firms have been enjoying a certain price preference in the purchases by the Government and other Public Sector firms.

Case 2: Favourable presentation of capacity picture.

From an entry in the Annual report 1975-76 Vol. I it is seen that Bharat Pumps and Compressors Ltd manufactured 50 machines against a capacity of 230 machines, thus giving a capacity utilization figure of 22 percent.

It is understood from the detailed project report that the installed capacity of the plant was 900 machines and this was further down rated to 600 machines. Rationale of indicating a capacity of 230 machines is not clear. It appears that capacity of 230 machines has been set on the basis of one shift working whereas in the DPR, a three shift working was foreseen.

Thus planned capacity = 230 machines.

From the Chairman's annual report for the same year, it is seen that actual production was 83 percent of the target and since actual output was 50 machines, target appeared to be only for 62 machine.

The hierarchy of capacities can be summarised as under:

Installed capacity	=	900 machines
Rated capacity	=	600 machines
Planned capacity	=	230 machines
Budgeted capacity	=	62 machines
Actual production	=	50 machines

Compared to DPR capacity, capacity utilization

$$= \frac{50}{900} \times 100 = 5.5 \text{ percent}$$

Compared to Rated capacity, CU $= \frac{50}{000} \times 100 = 8.4$ percent

Compared to Planned Capacity, CU $= \frac{50}{230} \times 100 = 22$ percent

Compared to Budgeted capacity, CU $= \frac{50}{62} \times 100 = 83$ percent

While the Annual report of the Bureau of Public Sector has published the utilization figure of 22 percent, the Chairman mentioned 83 percent only in his report and speech at the annual general body meeting and when the target for 1976-77 was set for about 110 machines, it was considered by him very ambitious. All this conceals the very serious underutilization of capacity of the fixed capital.

Case 3: Difference of Opinion on the Estimation of Capacity: Regarding the Braith Waite and Co. Ltd., some capacities have been mentioned by the Bureau. In remarks, it is pointed out that the management of the Enterprise has reassessed capacity which is about 57 percent - 80 percent of various recognised capacities. The basis for either is not independently checked and in the absence of the same, it is difficult to accept any version. Revision of capacity may be one method of escaping underutilization of capacity every year but unless their version is proved incorrect, the managements are unlikely to take any action to improve their underutilization vis-a-vis their original capacity. Similar downward reassessment of capacity has been done by Heavy Engineering Corporation, Mining and Allied Machinery Corporation, Bieco Lawry Ltd, Richardson and Cruddas Ltd., National Newsprint and Paper Mill Ltd, and Burn ISW Ltd and many other firms.

From the three cases considered above, it is clear that incorrect capacity estimates cloud the real working of many enterprises in Public Sector and this also leads to a false sense of satisfaction and complacency on the part of the Plant Management, thus hindering the process of improvement.

(c) Management Cynicism and lack of available data:

A survey was attempted and a questionnaire was circulated to various firms with a view to elicit the views of management on the questions of key objectives, capacity utilization aspects and on the nature of problems as reflected in the firmwise data. Response to this survey was quite disappointing partly because of the inherent difficulties of a questionniare approach and partly because the firms either view these questions as irrelevant or have ~~not~~ never taken time to give a thought to the issues raised through these questions. Capacity audit can be of educational value in such cases. A note on the survey is placed at Appendix 5.5.

5.5.2 Advantages of Capacity Audit:

(a) Causes of Underutilization in Public Sector:

The real identification: Under the chapter on capacity utilization in the annual report Vol. I for 75-76 and 74-75, factors affecting capacity utilization and action by Government are indicated in Paras 5 and 6 respectively. The most surprising thing to note is that the reasons given for underutilization and action are exactly the same for both the years except for the fact that, Industrial unrest as a reason in 74-75 has been dropped in 1975-76, presumably as a consequence of the declaration of emergency. It is quite clear that no quantitative analysis into the causes of underutilization has been attempted. All possible reasons of underutilization applicable generally to some or the other public sector enterprises have just been listed as a routine matter.

One major cause only has been listed against various enterprises and the fact that all factors have an influence has been ignored. In the absence of properly recorded data, the causes of underutilization as advanced by plant managements are likely to be arbitrary in nature and tend to hide their own weaknesses. An audit of capacity utilization is likely to force the firms to maintain adequate data necessary to bring out the real causes of underutilization which can then form the basis for improvements.

(b) Prevention of Misreporting of Capacity:

Very few firms are able to assess their capacities clearly purchase of components from auxiliaries procurementof balancing equipment, improvement of equipment through procurements jigs, fixtures and auxiliaries, and many others of this kind can change the capacity picture considerably, Capacity determination done once in a while will be of no use. In effect, whenever capacity utilization is required to be determined, capacity has to be determined for the situation existing. Dependence upon computer will become inevitable. A very favourable outcome of this exercise will be the categorisation and programming of management decision making process regarding job scheduling, job sequencing and production planning and control. This will of course require calibration of equipement, identification of load centres, availability of standard time for each job, history of time losses taking place, through power failure, breakdowns, absenteeism, lack of materials, lack of orders and average labour efficiencies obtained. Only then, realistic assessment will be possible. Since this country, cannot afford waste of capital resources, the expenditure incurred in introducing capacity audit is likely to pay back many times over.

CHAPTER-6

CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE STUDY

6.1 The objective of this study was firstly, to critically evaluate the existing methods employed by various agencies and individuals to estimate and analyse capacity utilization in industry and secondly to devise more appropriate methods for the estimation and analysis of capacity utilization both at Macro and Micro Level, (Chapter 1).

6.2.1 A review of existing methods (Chapter-2) has revealed that:

(i) there is considerable confusion and difference of opinion in the concept of 'capacity' and capacity utilization.

(ii) the methods employed generally suffer from the following defects:

(a) complete output of the firms is not accounted for.

(b) parameters on the basis of which capacity is estimated are not completely specified and defined.

(c) basis of estimation of capacity is generally not adequate.

(d) aggregation of output, consisting of various dissimilar goods, particularly, in a multiproduct industry, is not done on a scientific and justifiable basis.

(e) the methods are not dynamic in nature i.e. the changes in capacity levels because of changing premises in course of time don't come to light.

(f) the methods don't generally lend themselves to a systematic analysis of the causes of underutilization of capacity and hence can't provide guidelines for improvement.

(iii) The methods employed are generally designed for estimating capacity at micro level.

6.2.2 A review of past studies (Chapter 2) has revealed that:

(i) Conclusions of various studies differ widely. This is expected as a natural corollary to 6.2.1.

(ii) The studies based on the 'monthly statistics of Production are fairly regular but because of 6.2.1(ii) the conclusions reached are not being put to any significant use.

6.3 A six stage model was developed (Chapter 3) with a view to rectify the shortcomings in the earlier methods. From the analysis of the model, it can be concluded that

(i) A considerable loss of capacity takes place at the time of converting available funds into fixed assets as a result of:

(a) purchasing equipment for future expansion programmes but causing underutilization of capacity at present

(b) sub-optimum purchase of fixed assets.

Sub-optimum decisions at this stage can cause serious problems of utilization of capacity and even subsequent operational management of a high standard may not be adequate to rectify the imbalance caused. The resulting capacity is termed 'maximum theoretical installed capacity'.

(ii) The complexity of factors involved in fixing standard operating times and non-availability of managerial talent to tackle these factors, leads to downrating of equipment both in the Public and Private sectors. Resulting capacity is termed 'Maximum theoretical rated capacity'.

(iii) Due to the existence of preconceived notions and imaginary fears amongst the entrepreneurs and due to the inadequacy of cost data available, the optimum shift working is generally not resorted to and this loss of capacity due to the working of less than optimum number of shifts is a very widely prevalent phenomenon. Resulting capacity is called 'Planned Capacity'.

(iv) Lack of demand has often been found to lead to 'Production Budgets' being fixed at lower levels than planned capacity available. (Budgeted Capacity). The causes leading to this lack of demand have either not been understood or have been ignored and entrepreneurs often enough ~~the level~~ behave as if the level of demand for their products is purely exogeneously determined.

(v) Unannounced interruptions of input of raw materials, power, equipment and manpower have been a subject matter of serious discussions particularly at the plant level. However, there is no evidence of adequate record keeping and systematic analysis. There is a tendency to blame the Government rather than develop adequate systems to reduce the occurence of such interruption, and to reduce the resulting loss due to such interruptions.

6.3.1 (i) Any of the measures of capacity i.e. Maximum theoretical capacity of funds, maximum installed capacity, maximum rated capacity, planned capacity or budgeted capacity can be used for determining. Capacity utilization, and all measures are useful for analysis in different circumstances.

(ii) All measures must be used as a complete system of analysis. Concentrating on a few aspects at the cost of others will lead to an inadequate analysis and an inadequate improvement of capacity utilization in the long run.

6.4 Estimation and Analysis of Capacity Utilization at Macro Level:

6.4.1 (i) At the macro level (Chapter 4) the best method of constructing capacity utilization series is to use output in terms of value of output less the materials consumed (both deflated to base year prices) and to use capacity in terms of investment in fixed assets (deflated to base year prices). While output to capital method has been used before, a number of significant changes have been brought about in the method as used here. Changes are:

(i) Output has been defined in real terms and the effect of materials purchased has been offset.

(ii) Fixed capital has been defined in real terms.

(iii) Comparison of the ratio of output/fixed capital has been made in a limited group of firms in one industry or for a group of nearly similar industries.

(iv) For inter industry comparison, output/capital ratio has not been used as such but a percentage to the best ratio available has been calculated. This takes care of the disparities that may be existing in different industries regarding the output/capital ratio because of its inherent structure.

(v) A set of influencing variables have been identified to explain inter region or inter industry or temporal differences in the levels of capacity utilization.

6.4.2 Important conclusions reached as a result of analysis of the type mentioned at 6.4.1 (Chapter 4) are:

(i) There is a wide difference in the levels of capacity utilizations in different regions and different years of an Industry as well as in different industries.

(ii) Comparison with the best ratio of output/capital achieved by a region in a particular year still leaves undisclosed the element between the available and the best possible. This difference cannot be estimated in the absence of relevant data.

6.4.3 As a result of the multiple X-sectional regression analysis (inter region) the following factors have emerged as significant:

(i) Working capital (real terms) to fixed capital (real terms) ratio is positively and significantly correlated to capacity utilization. In the event of increasing fixed capital in an industry, non consideration of working capital requirements can lead to an adverse effect on capacity utilization and make budgeted capacity to be less than planned capacity.

(ii) Employees/unit ratio is negatively and significantly correlated to capacity utilization. There appears to be an optimum size in terms of employees beyond which capacity utilization appears to be adversely affected because of increasing group pressure of employees on management.

(iii) Semi-finished and raw material inventory to gross production ratio is negatively and significantly correlated to capacity utilization. The adverse effect of increasing inventory on working capital and increasing cost of maintaining inventory at higher level seem to be responsible for this.

(iv) Rate of change of capital is negatively and significantly correlated to capacity utilization. Since additions to capital tax the managerial abilities available, the rate of change has to be adequately planned.

(v) Emoluments per employee is negatively and significantly correlated to capacity utilization. This factor, in conditions prevailing in India even now, represents the union strength. 9

(vi) Fixed capital per worker ratio is negatively and significantly correlated to capacity utilization. The factor can be decreased only by increasing number of workers for the same capital or by decreasing the sophistication of capital employed for same number of workers or both. ?

(vii) Auxiliary staff/workers ratio is positively and significantly correlated to capacity utilization. It indicates the possibility of improving utilization rates by

~~by~~ employing more number in 'staff' functions.

(viii) By and large, the following variables were not ~~found~~ found significantly correlated to capacity utilization.

(a) Manhours per worker

(b) Electricity purchased per worker

(c) Value added per worker

(d) Fixed capital employed per unit

(e) Number of firms in a region or Industry (+ve)

(f) Finished goods inventory to gross production ratio (-ve)

(g) Wages to value added ratio

(h) Machinery and plant/fixed capital ratio.

The trend in case of (e) and (f) when applicable (though not significant at 10 percent level) is indicated in front of each of the variable.

(ix) For pooled analysis for one industry the following variables have been found significant,(in bracket is shown the type of correlation):

(a) Employees per unit (-ve)

(b) Working capital to fixed capital ratio (+ve)

(c) Semifinished inventory to gross production ratio (-ve)

(d) Auxiliary staff per worker (+ve)

(e) Finished inventory to gross production ratio (-ve)

(f) Number of firms (+ve)

6.4.4. For inter industry comparisons, the following additional factors were found to be significantly correlated to capacity utilization.

(a) Output to capital ratio for each industry (-ve). Industries with higher ratios attract more capital and become saturated easily and because of the higher ratio, the levels of profits at which the entrepreneurs are satisfied, are reached at lower utilization rates.

6.5 Estimation and Analysis of Capacity Utilization at Micro Level:

6.5.1 A concept of time balance can be used to estimate the capacity utilization at various load centres as well as for the whole plant. Based on the indirect measurement of capacity utilization, capacity utilization improvements can be tried more effectively as identification of the course of action is easy. However, it was noticed from data collected that:

(a) Very few firms maintain a system of keeping adequate records of the idleness of manpower and equipment and of labour efficiency and distribution of working time between direct and indirect jobs.

(b) A few firms maintain such records but the data kept was found unreliable. In some cases the idle times booked in time sheets did not tally with the job card punchings and in other cases, the allocation of the idle time amongst the various heads ~~of~~(reason wise) was arbitrary.

(c) In some firms, even though record was kept, the same was not used for any significant analysis. Even when such analysis was made, the same was not complete and was directed at a few factors at random.

(d) Where the analysis could be made, the following categorization could be found useful from the point of view of action:

(i) In case 1, man is available but machine is not available due to this being under break down, maintenance etc. Realistic provision of equipment, distribution of staff in more number of shifts and improving equipment reliability can be examined as possible courses of action.

(ii) In case 2, machine is available but man is not available due to absenteeism and this loss of capacity calls for a thorough study of all aspects of absenteeism, provision of leave reserve and working out of optimum work plans with reduced work force in case of seasonal and heavy absenteeism.

(iii) In case 3, both machine and operator are available but no work is done due to power failure, nonavailability of materials, lack of orders etc.

(iv) In case 4, while work is done, it is not production in the sense that the output is not for sale. Some output of indirect nature is necessary but a clearcut control is required to avoid misutilization of resources on this count.

(v) In case 5, production output of hours worked is low due to poor labour efficiency which becomes the focal point of management attention.

6.5.2. All the materials presented before point to the need of 'capacity audit' of each and every plant.

Conflicting conclusions on the level of capacity utilization in the Public Sector as well as private sector point out to the need of 'capacity audit'. Our country cannot afford the luxury of underutilization of resources and capacity. Audits will not only create a strong and reliable data. Base for better planning of investments but also help individual entrepreneurs to improve their levels of efficiency. Proper understanding of the resources of under-utilization of capacity will also lead to less misunderstanding and suspicious between Government, entrepreneurs and labour. While to start with, the models presented in this study can be used, more realistic and useful models will automatically develop as more and more capacity audits are undertaken.

6.6. Recommendations for future study:

1. Application of linear programming model for the selection of the right type of product mix with a view to minimise the cost of production (by minimising the cost of idleness) to a firm will result in refining the model as well as throw useful hints to the firm in improving its utilization. Application, however is a very long drawn affair and calls for the following steps:

(a) Selection of a firm for study. Firm should be willing to have this study undertaken.

(b) The firm should have a data base existing regarding load centre identification, times allowed and various time losses taking place and cost of various load centres.

(c) In case the data base is not available, the data base has to be built.

(d) Linear programming model can consider all types of constraints of capacity, raw materials, demand etc. The existence of constraints, if affecting the utilization of resources, can be the subject of further intensive study.

2. Determination of the optimum planned capacity:
For the types of costs incurred in specific plants located at different places, the most optimum shift working can be decided by determining the total costs for various levels of output at various combinations of shift working. Since data of one firm will not do, similar firms have to be studied in detail to determine the effect of working more or less number of shifts on cost of unit production.

3. Further validations of the results of econometric analysis by undertaking similar study of different industries, different industry groups and inter-firm comparisons is necessary. The explaining variables can be further traced to the exact decision making parameters and in case of inter-relationships, multi-equation models can be tried.

4. Simulation of production units has to be undertaken and computer programs developed with a view to enable firms to take quick and appropriate corrective action in case of variations from plans and decisions regarding proper production scheduling under changing circumstances. A start can be made with smaller units or these units which have more

automatic equipment and less number of unprogrammed decision-making. Effect of simulation studies on capacity utilization within the existing constraints of power supply can also be studied.

5. Application of Group Technology is particularly recommended for a detailed study as this holds a great promise for industries in India where due to frequent changes in setup of equipment, a lot of equipment time is wasted, and labour efficiency is reduced. Group Technology can considerably improve capacity utilization.

6. Work sampling studies are required to be undertaken to estimate the loss of capacity taking place due to loose time standards. Time study on an 'audit' basis can also be used in the studies.

7. A detailed study of the fixed capital purchase policies of the public and private sector industries will reveal the losses due to sub-optimum purchases. This study can also involve the effect on utilization of equipment of such decisions.

8. A close study on the 'Demand' forecasting techniques employed by firms, planning commission, Industries and ministries will prove useful in underscoring the reasons for unbalanced sectoral growth.

9. Methodological studies for multiobjective decision making having a bearing on capacity utilization.

10. Study of capacity utilization problem as a problem of interrelated systems.

Appendix 1.1

CAPACITY UTILIZATION AND GROWTH RATES IN SELECTED INDUSTRIES:

Sr. No.	Industry/ Item	Weight in the General Index (1970-100)	⌀age change in Production in 1976-77 over 1975-76	⌀age capacity Utilization 75-76	76-77
1	2	3	4	5	6
Basic Industries					
1.	Aluminium	0.5496	+ 13	79	84
2.	Copper	0.0095	+ 16	36	42
3.	Zinc	-	- 3	73	71
4.	Lead	-	+ 20	95	114
5.	Cement	1.1700	+ 9	82	89
6.	Nitrogenous fertiliser	0.8662	+20	62	61
7.	Phosphatic fertiliser	0.5192	+ 36	49	63
8.	B.H.C (Tech.)	0.1008	-	84	84
9.	DDT	-	+ 1	105	107
Intermediate Industries:					
10.	Paper and paper board	2.1735	+ 6	78	81
11.	Newsprint	0.0210	+ 9	71	77
12.	Caustic Soad	0.3156	+ 8	82	79
13.	Soad Ash	0.2226	+ 2	88	90
14.	Sulphuric Acid	0.0396	+ 21	55	61
15.	Liquid Chlorine	0.0574	+ 10	54	46
16.	Stable Bleaching powder	0.0121	- 6	101	77
17.	Oxygen Gas	0.0513	+ 15	67	74

1	2	3	4	5	6
18.	Dissolved Acetylene Gas	0.1226	+ 18	49	56
19.	Photographic Paper	0.0700	+ 17	121	100
20.	Blasting explosives	0.1617	+ 6	105	82
21.	Vat Dyes	0.4094	+ 22	76	93
22.	Auto tyres	1.1007	+ 16	78	88
23.	Bicycle tyres	0.1685	- 10	76	68
24.	<u>Man-made fibres</u>:				
(a)	Viscose tyre cord	0.3535	- 13	94	81
(b)	Viscose filament yarn	0.1488	+ 15	89	103
(c)	Nylon tyre cord	-	+ 37	74	74
(d)	Nylon filament yarn	0.4395	+ 11	89	101
(e)	Polyster fibre	0.1404	+ 36	66	91
25.	<u>Thermoplastics</u>				
(a)	PVC resins	0.1210	+ 77	68	72
(b)	Polystyrene	0.0300	+ 46	53	77
(c)	LDPE	0.0249	- 6	99	93
(d)	HDPE	0.0194	+ 19	100	119
26.	Synthetic rubber	0.0965	- 8	84	77
27.	DMT	-	+ 27	79	100
28.	Caprolectum	-	+ 28	67	85
29.	Ball and roller bearings	0.4756	+ 14	84	89
30.	<u>Wires and cables</u>:				
(a)	Winding wires	0.2411	+ 12	44	48
(b)	PVC/VIR	0.1825	+ 35	31	45
(c)	ACSR/AAC	0.0527	+ 39	52	66

1	2	3	4	5	6
Consumer Industries including durables					
31.	Baby food	0.3300	+ 23	75	92
32.	Biscuits	0.3100	+ 23	57	70
33.	Soap	0.6091	+ 5	118	123
34.	Synthetic detergents	0.0083	+ 14	51	55
35.	Paints, enamel and varnishes	0.2351	+ 14	52	59
36.	Matches	0.2601	+ 10	92	79
37.	Cigarettes	2.2100	+ 11	84	70
38.	Rubber footwear	0.4389	+11	67	74
39.	Leather Footwear				
	Western type	0.0300	+ 5	61	64
	Indian type	0.3100	+ 1	75	76
40.	Wrist watches	–	+ 87	66	96
41.	Clocks	0.1300	+ 26	49	47
42.	Sewing machines	0.0478	+ 43	50	72
43.	Bicycles	0.3652	+ 13	61	71
44.	Typewriters	0.1382	+ 10	61	65
45.	Domestic referigerators	0.1341	+ 35	51	69
46.	Electric fans	0.2437	+ 19	97	111
47.	Electric lamps	0.2896	+ 21	83	100
48.	Flourescent tubes	0.0864	– 4	136	89
49.	Dry batteries	0.3171	+ 21	40	48
50.	Storage batteries	0.2160	– 2	63	62
51.	Radio receivers	0.9687	+ 9	52	57

1	2	3	4	5	6
52.	Razor blades	0.1255	- 7	84	78
53.	Drugs				
(a)	Pencillin	1.0765	+ 6	71	74
(b)	Streptomycin	1.0829	+ 23	73	90
Capital Goods Industries:					
54.	Machine tools	0.5367	- 1	86	76
55.	Forged Hand tools	0.1617	+ 13	107	90
56.	Twist drills	0.1542	+ 6	82	75
57.	Threading tools	0.0591	+ 6	61	65
58.	Measuring tapes	0.0814	- 30	58	41
59.	Grinding wheels	0.2764	+ 6	74	79
60.	Tungsten carbide (tipped tools)	0.0306	+ 5	98	96
61.	Boilers	0.5422	+ 10	131	104
62.	Paper and pulp machinery	0.0792	- 17	51	42
63.	Chemical and Pharm. Machinery	0.1051	+ 29	69	89
64.	Rubber machinery	-	+ 25	82	71
65.	Transformers	1.4835	+ 7	62	63
66.	Electric Motors	0.3521	-	56	57
67.	Steel castings	0.6125	+ 1	39	39
68.	Structurals	0.4727	+ 9	25	28
69.	Transmission towers	0.1221	+ 8	58	58
70.	Steel pipes and tubes (Black and galvinised)	0.7164	+ 41	23	31
71.	Agricultural tractors	0.3308	- 1	71	68
72.	Diesel engines (Stat)	0.6857	- 20	47	38

1	2	3	4	5	6
73.	Power Driven pumps	0.2295	+ 12	76	85
74.	Air and Gas compressors	0.2469	+ 7	46	50
75.	Road rollers	0.0905	- 66	36	12
76.	Earth Moving equipment	0.0595	+ 23	56	57
	Dumpers, scrappers, crawlers tractors, graders, shevels/ excavators.				
Transport Equipment					
77.	Commercial vehicles	1.2499	+ 6	68	68
78.	Passenger cars	0.4936	+ 67	46	77
79.	Jeeps	0.1448	+ 17	55	64
80.	Scooters	0.1095	+ 39	56	70
81.	Motor cycles	0.1093	+ 4	54	86
82.	Mopeds/scooterettes	-	+ 1	50	44
83.	Three wheelers	0.0296	+ 51	63	83
84.	Railway wagons	1.1282	- 2	36	39

Appendix 1.2

WORKSHOP ON CAPACITY UTILIZATION AND GROWTH PROSPECTS

Arising out of discussions at the above workshop the following points/suggestions emerged for increasing industrial production and capacity utilization:

1. Power shortage had been the main and decisive factor in reducing capacity utilization. With better performance of power plants, there is scope for generating additional power of 20 to 25 per cent from the existing/installed capacity.

2. The recent improvement in the power supply position should not be taken as granted and a continuous watch must be kept.

3. While power intensive industries such as aluminium, fertilizers, etc. are being allowed to have captive power plants, the difficulty pertaining to availability of funds should be looked into resolved.

4. Credit squeeze has also affected capacity utilisation in a number of industries. In order to assess the credit needs of industry, Government have set up an inter-ministerial group which would examine past production, amount of credit utilised, etc. by different industries and recommend suitable credit relaxations.

5. Capacity utilisation in the large scale sector has also been affected because certain items had been reserved for manufacture in the small scale sector, such as diesel engines, matches etc.

6. In some cases, a cause for under-utilization of capacity is due to consumers preference for quality and resistance to high prices. In order to step up demand it would be advisable for industry to have proper quality control and market studies.

7. The incidence of indirect taxation and other levies formed a sizeable proportion in the cost of production and there is little scope to reduce cost. Cost of infra-structure facilities has also gone up. It would therefore be advisable to rationalise the excise duty and other levies.

8. Industry should concentrate on exports, especially of such commodities where internal demand has gone down. In this context it was recognised that export procedures were cumbersome and there were multiplicity of authority dealing with exports. Therefore there is need to have streamlined export procedures wherein the exporter will have to meet the minimum number of agencies.

9. It is desirable not to attenuate export incentive schemes at this particular stage.

10. If bonded warehouses are set up at ports, this would facilitate exports.

11. The establishment of marketing organisations is important for pushing up sales internally as well as externally. However, Government still seemed to take a restrictive view in this behalf, and there has to be a policy change.

12. Where indigenous production of important raw materials is carried out by a single firm, either buffer stock should

be created or more units should be licensed to manufacture such items.

13. In order to improve production Government are identifying projects which have been licensed and necessary arrangements for provision of capital, foreign exchange, etc. were being thought of so that such projects are commissioned early. Such units should also be allocated raw materials on priority basis.

14. In sugar industry, utilisation of capacity was low due to inadequate supply of sugarcane, particularly in factories located in East U.P., Bihar, Punjab, Rajasthan, Madhya Pradesh, Kerala, West Bengal etc. With the adequate supply of cane, 4.3 lakh tonnes of additional sugar can be produced.

15. In number of industries, many units were lying closed due to one reason or the other. Such units however could not be merged with other working units as the incom-tax law does not permit depreciation and accumulated losses of the merged units as allowable expenditure for the purpose of corporate taxation. The income-tax law should therefore be suitably amended to ease merger of closed units.

16. Anti-pollution measures and ecological and environmental precautions will have to be taken by industry in advance so as to avoid loss of production after commissioning of the plants.

17. Government should allow diversification in such industries where a shortfall in demand was feared. Import of components

and parts to carry out diversification be allowed.

18. If industry desires to upgrade its technology, it would mean an automatic increase in production. The Industrial Licensing Policy should therefore be flexible enough to take note of and give approval to such expansion.

19. Government purchases had gone down steeply and this had affected demand of certain items. There was need to review the Government purchases.

20. It was felt that with proper maintenance production can be increased by about 15 percent.

21. The DGTD had carried out studies on capacity utilization and had located the industries where capacity utilization was most affected. The DGTD would be prepared to share such information with the FICCI for coordinated plan of action. For this purpose, constitution of a working group consisting of representatives from industry and Government may be thought of.

Appendix 2.1 Directorate General of Technical Development (Policy, Plan and Coordination Division)

Production Targets and Achievements (Advance Information upto March '77).

Sr. No	Industry	Weight in the General Index (1970=100	Accounting Unit	Annual Plan Targets 76-77	Production					
					Jan. to March 1977	Jan. to March 1976	Percentage Growth Rate	1976-1977	1975 to 1976	Percentage Gr wth Rate
1	2	3	4	5	6	7	8	9	10	11
	Plan Industries									
1.	Baby Food	0.33	Th.Tonnes	29.0	0.1	8.3	+ 10	27.1	22.1	+ 23
2.	Cigarettes	2.21	Bill.pcs.	72.0	15.8	15.6	+ 1	67.4	60.8	+ 11
3.	Paper and paper board	2.17	Th.tonnes	900.0	224.0	212.0	+ 6	891.0	836.0	+ 7
4.	(a) Cultural paper	-	Th.tonnes	-	134.0	127.0	+ 6	535.0	502.0	+ 7
4.	News Print	0.02	Th.tonnes	60.0	14.7	14.3	+ 2	57.7	52.9	+ 9
5.	Auto tyres	1.10	Mill.nos.	6.0	1.62	1.24	+ 31	6.24	5.39	+ 16
	(a) Scooter tyres		Th.nos.	-	309.0	249.0	+ 24	1180.0	853.0	+ 38
	(b) Tractor tyres		Th.nos.	-	110.0	93.0	+ 18	439.0	371.0	+ 18
	(c) Giant tyres (Truck and bus)		Th.nos.	-	763.0	590.0	+ 29	2897.0	2742.0	+ 6
6.	Cycle tyres(organised sector (only)	0.17	Mill.nos.	-	30.0	4.91	- 23	21.94	24.47	- 10
7.	Nitrogenous fertilisers(N)	0.87	Mill.tonnes	1.85	0.52	0.46	+ 9	1.84	1.53	+ 20

1	2	3	4	5	6	7	8	9	10	11
8.	Phosphatic fertilisers(P_2O_5)	0.52	Th.tonnes	450	130	91	+ 43	457	337	+ 36
9.	Caustic soda	0.32	Th.tonnes	520	126.9	126.1	+ 1	594.9	467.1	+ 8
10.	Soda ash	0.22	Th.tonnes	600	153.9	151.1	+ 2	568.0	555.1	+ 2
11.	Calcium carbide	0.06	Th.tonnes	-	20.3	20.5	- 1	83.6	76.3	+ 10
12.	Man-made fibres									
	(a) viscose filament yarn	0.15	Th.tonnes	37	10.0	10.7	- 7	41.1	35.6	+ 15
	(b) viscose tyre cord	0.35	Th.tonnes	20	4.5	4.5	-	17.1	19.7	- 13
	(c) nylon tyre cord	-	Th. tonnes	5.0	1.6	1.2	+ 33	5.9	4.3	+ 37
	(d) nylon filament yarn	0.44	Th. tonnes	15	3.9	3.9	-	15.8	14.2	+ 11
	(e) polyester fibre	0.14	Th. tonnes	22	5.3	4.3	+ 23	22.9	16.8	+ 36
13.	Thermo plastics									
	(a) polystyrene	0.03	Th.tonnes	12	3.1	2.0	+ 55	13.4	9.2	+ 46
	(b) P.V.C. resins	0.12	Th.tonnes	48.0	13.1	12.3	+ 7	46.7	43.8	+ 7
	(c) L.D.P.E.	0.02	Th.tonnes	28.0	6.5	7.0	- 7	26.0	27.6	- 6
	(d) H.D.P.E.	0.02	Th.tonnes	23.0	4.8	3.9	+ 23	23.7	20.0	+ 19
14.	Synthetic rubber	0.10	Th.tonnes	30.0	7.1	7.4	- 4	23.2	25.2	- 8
15.	Caprolactum	-	Th.tonnes	-	4.4	3.0	+ 47	17.0	13.3	+ 28
16.	D.M.T.	-	Th.tonnes	-	4.7	5.4	- 13	24.1	19.0	+ 27
17.	Pesticides									
	(a) BHC(Tech)	0.10	Th.tonnes		6.8	6.3	+ 8	24.3	24.3	-
	(b) DDT	-	Th.tonnes	40.0	1.16	1.20	- 3	4.48	4.42	+

1	2	3	4	5	6	7	8	9	10	11
	(c) Malathion	0.05	Th. tonnes	40.0	0.54	0.41	+ 32	1.89	1.64	+ 15
18.	Drugs and Pharmaceuticals									
	(a) Antibiotics:									
	(i) Penicillion	1.08	MMU	275	82.13	72.66	+ 13	270.81	256.63	+ 6
	(ii) Streptomycin	1.08	Tonnes	203	58.94	52.20	+ 13	230.32	187.20	+ 23
	(iii) Chloramphenicol	0.32	Tonnes	-	27.22	19.80	+ 37	100.72	65.40	+ 54
	(b) Sulpha drugs	0.20	Tonnes	1100	284.55	301.51	- 6	1202.64	1256.91	- 4
	(c) Vitamin-A	0.12	MMU	36.0	9.68	10.99	- 12	42.37	33.76	+ 26
19.	Soaps	0.61	TH. tonnes	280	73.5	62.3	+ 18	279.6	266.8	+ 5
20.	Synthetic detergents	0.01	Th. tonnes	80	23.6	17.1	+ 38	85.3	74.6	+ 14
21.	Matches	0.26	Bill boxes	4.45	0.93	0.90	+ 3	3.97	3.63	+ 10
22.	Cement	1.17	Mill. tonnes	18.2	4.88	4.83	+ 1	18.7	17.24	+ 8
23.	Aluminium	0.55	Th. tonnes	220	51.6	52.7	- 2	210.6	186.6	+ 13
	(a) aluminium EC grade		Th. tonnes	-	31.6	27.0	+ 17	126.2	95.7	+ 32
	(b) aluminium CG grade		Th. tonnes	-	20.0	25.7	- 22	84.4	90.9	- 7
24.	Copper	0.01	Th. tonnes	36.0	8.1	9.1	- 11	23.7	20.5	+ 16
25.	Lead	-	Th. tonnes	8.0	2.1	1.4	+ 50	6.2	5.2	+ 19
26.	Zinc	-	Th. tonnes	48.0	7.7	7.5	+ 3	27.0	27.8	- 3
27.	Boilers	0.54	Rs. crores	150	51.8	44.4	+ 17	155.7	141.9	+ 10

1	2	3	4	5	6	7	8	9	10	11
	Industrial Machinery									
28.	Sugar mill machinery	0.19	Rs.crores	36	9.75	7.68	+ 27	39.83	32.98	+ 21
29.	Cement mill machinery	0.21	Rs.crores	10	4.88	2.15	+116	11.79	5.79	+104
30.	Machine tools	0.54	Rs.crores	120	33.84	37.66	- 10	113.11	114.09	- 1
31.	Agricultural tractors	0.33	Th.nos.	35.5	6.8	10.3	- 34	33.1	33.3	- 1
32.	Transformers	1.48	Mill.KVA	15.5	5.3	4.4	+ 20	14.7	13.7	+ 7
33.	Electric motors	0.35	Mill.H.P.	3.7	1.10	0.98	+ 12	3.62	3.61	-
34.	Electric lamps									
	(a) incandescent filament	0.29	Mill.nos.	155	38.28	36.59	+ 5	160.95	132.83	+ 21
	(b) fluorescent tubes	0.09	Mill nos.	18	4.16	4.32	- 4	16.7	17.4	- 4
35.	Dry cells	0.32	Mill.nos.	600	158.8	127.9	+ 24	625.2	517.0	+ 21
36.	Storage batteries	0.22	Mill.nos.	1.5	0.37	0.39	- 4	1.39	1.41	- 2
37.	Electric fans	0.24	Mill. nos.	2.4	0.74	0.57	+ 30	2.55	2.14	+ 19
38.	Domestic referigerators	0.13	Th.nos.	-	33.5	14.9	+115	125.7	93.2	+ 35
39.	Air conditioners	0.01	Th.nos.	-	5.0	2.8	+ 77	17.3	8.3	+107
40.	Radio receivers	0.97	Th.nos.	1600	400	400	-	1676	1536	+ 9
41.	House service meters	0.21	Th.nos.	-	474.3	443.9	+ 7	1766	1690	+ 4
42.	Railway wagons	1.13	Th.nos.	11.5	3.85	3.16	+ 22	11.98	12.18	- 2

1	2	3	4	5	6	7	8	9	10	11
43.	Automobiles									
	(a) commercial vehicles	1.25	Th.nos.	50.0	12.0	12.2	- 2	46.4	43.8	+ 6
	(b) passenger cars	0.49	Th.nos.	25.0	10.3	5.6	+ 84	36.5	21.8	+ 67
	(c) jeeps	0.14	Th.nos.	8.0	2.89	1.37	+ 111	8.37	7.13	+ 17
	(d) scooters	0.11	Th.nos.	188	37.2	32.9	+ 13	156.8	112.5	+ 39
	(e) mopeds/scooterettes		Th.nos.	-	7.7	9.7	- 21	34.3	34.1	+ 1
	(f) three wheelers	0.03	Th. nos.	17.0	4.9	3.8	+ 29	20.0	13.3	+ 50
	(g) motorcycles	0.11	Th. nos.	76.0	17.1	17.8	- 4	72.6	70.1	+ 4
	Non-plan items									
44.	Bicycles	0.37	Th.nos.	2475	674	677	neg	2640	2332	+ 13
45.	Diseal engines(stat.)	0.69	Th.nos.	140	34.0	33.5	+ 1	110.6	137.6	- 20
46.	Power driven pumps	0.23	Th.nos.	314	87.4	68.3	+ 28	307.4	274.4	+ 12
47.	Air/gas compressors	0.25	Th.nos.	-	1.81	1.89	- 4	6.67	6.23	+ 7
48.	Structurals	0.47	Th. tonnes	142	35.7	25.0	+ 2	124.7	114.2	+ 9
49.	Transmission towers	0.12	Th.tonnes	-	24.2	25.7	- 6	101.7	94.0	+ 8
50.	Steel pipes and tubes									
	(a) black and galvanised	0.72	Th.tonnes	-	144.6	90.3	+ 60	495.0	351.0	+ 41
	(b) seamless	0.07	Th.tonnes	-	6.9	9.1	- 24	30.6	33.5	- 9

1	2	3	4	5	6	7	8	9	10	11
51.	Welding electrodes	0.62	M.R.M.	440	136.3	119.8	+ 14	520.0	415.8	+ 25
52.	Cranes	0.12	Th. tonnes	16.9	5.1	5.0	+ 2	18.9	18.4	+ 3
53.	Lifts	0.07	Nosl	-	174	234	- 26	707	843	- 16
54.	Wire Ropes	0.47	Th. tonnes	-	5.9	7.3	- 19	25.7	28.1	- 9
55.	Steel Castings	0.61	Th. tonnes	-	17.2	16.5	+ 4	63.2	61.9	+ 2
56.	C.I. Spun pipes	0.11	Th. tonnes	-	50.4	69.3	- 27	221.4	289.8	- 24
57.	Steel forgings	-	Th. tonnes	-	24.7	24.7	- 1	93.4	91.3	+ 2
58.	Small and cutting tools.									
	(a) forged hand tools	0.16	Rs. crores	-	5.93	5.05	+ 17	21.63	19.19	+ 13
	(b) grinding wheels	0.28	Rs.crores	-	2.90	2.34	+ 24	10.23	8.91	+ 15
	(c) twist drills	0.15	Moll. nos.	-	3.28	3.53	- 7	13.78	12.98	+ 6
59.	Sewing machines	0.05	Th.nos.	300	108.0	84.9	+ 27	383.8	269.2	+ 43
60.	Typewriters	0.14	Th. nos.	55	16.6	15.6	+ 6	59.2	52.9	+ 12
61.	Razor Blades	0.13	Mill.nos.	1235	226.4	211.3	+ 7	927.0	995.9	+ 7
62.	Ball and Roller Bearings	0.48	MillNos.	27	6.67	6.55	+ 2	27.65	24.23	+ 14
63.	M.S. Bolts and Nuts	0.43	Th.tonnes	30	6.4	6.8	- 6	26.2	27.5	- 5
64.	Motor starters contractors	0.40	Th.nos.	-	246	232	+ 6	949	879	+ 8

1	2	3	4	5	6	7	8	9	10	11
65.	Wires and Cables									
	(a) winding wires	0.24	Th.tonnes	16	5.1	4.6	+ 11	20.2	18.9	+ 7
	(b) PVC/VIR	0.18	Mill.C.M.	450	144.3	100.4	+ 44	527	393	+ 34
	(c) wire rods for ACSR	0.23	Th.tonnes	-	17.6	14.4	+ 22	67.3	44.3	+ 53
	(d) P.I.L.C.	0.15	K.M.	-	831	614	+ 35	3373	2667	+ 26
	(e) ACSR/AAC	0.05	Th.tonnes	70	21.4	23.0	- 7	85.40	60.89	+ 41
66.	Rubber and Plastic Accessories	0.07	Mill. nos.	-	2.60	2.58	+ 1	11.13	9.56	+ 16
67.	Aluminium sheets and circles	0.36	Th. tonnes	-	10.4	6.8	+ 53	40.8	33.5	+ 22
68.	Aluminium foils	0.19	Th. tonnes	-	1.52	1.79	- 15	6.68	5.60	+ 19
69.	Brass/copper sheets and circles	0.32	Th. tonnes	-	2.8	3.14	- 11	13.4	11.3	+ 19
70.	Aluminium extruded products	0.19	Th.tonnes	-	3.7	1.85	+100	13.7	10.0	+ 37
71.	Dyes and dyestuffs									
	(a) vat dyes	0.41	tonnes	-	307	312	- 2	1405	1154	+ 22
	(b) optical whitening agents	0.22	tonnes	-	249	179	- 39	876	626	+ 40
	(c) azo dyes	0.08	tonnes	-	730	708	+ 3	3045	2276	+ 34

1	2	3	4	5	6	7	8	9	10	11
72.	Paints, enamels and varnishes	0.24	Th. tonnes	-	17.0	17.6	+ 2	73.9	64.8	+ 14
73.	Wheat flour	0.80	Th. tonnes	-	445	413	+ 8	1698	1718	- 1
74.	Beer	0.69	Mill. ltrs.	-	21.1	13.9	+ 52	88.9	53.5	+ 66
75.	Biscuits	0.31	Th. tonnes	-	18.6	15.4	+ 21	73.5	59.8	+ 23
76.	Tooth powder	0.12	Tonnes	-	368	306	+ 20	1361	982	+ 39
77.	Tooth Paste	0.08	Th. tonnes	-	2.14	1.35	+ 59	7.61	4.87	+ 56
78.	Leather cloth	0.43	Mill. Mtrs.	-	3.2	3.5	- 9	13.7	9.5	+ 44
79.	Linoleum	0.11	K.M.	-	207	330	- 37	1190	1259	- 5
80.	Blasting explosives	0.16	Th. tonnes	-	12.12	11.89	+ 2	47.85	45.11	+ 6
81.	Industrial Gases:									
	(a) Oxygen	0.05	Mill. Cu.M.	68.5	18.36	16.86	+ 9	72.87	63.29	+ 15
	(b) D/A Gas	0.12	Mill. Cu.M.	-	2.58	2.00	+ 29	8.73	7.38	+ 18
82.	Footwear									
	(a) rubber	0.44	Mill. pairs	-	9.96	9.12	+ 23	42.36	38.22	+ 11
	(b) western type leather	0.03	Mill. pairs	16.0	1.19	1.4	+ 36	8.8	8.4	+ 5
	(c) Indian type leather	0.31	Mill. pairs		2.1	1.9	+ 11	7.2	7.1	+ 1*
83.	Wrist watches	-	Th. Nos.	-	764	319	+139	1704	912	+ 87
84.	Clocks	0.13	Th. nos.	-	63	46	+ 37	227	180	+ 26

1	2	3	4	5	6	7	8	9	10	11
85.	Zip fastners	0.78	K.M.	-	520	260	+ 100	1746	1388	+ 26
86.	Pencils	0.19	Mill.nos.	-	44.01	14.75	+ 198	123.83	61.67	+ 101
87.	Graphite Electrodes and anodes	0.02	Th. tonnes	-	2.4	2.1	+ 14	9.4	8.4	- 12
88.	Paper and pulp machinery	0.08	Rs.crores	20.0	3.34	3.26	+ 2	15.10	18.18	- 17
89.	Mining machinery	0.05	Rs.crores	12.0	5.85	5.01	+ 17	15.26	10.95	+ 39
90.	Matallurgical machinery	0.02	Rs.crores	9.33	2.44	4.54	- 46	11.29	12.11	- 7
91.	Steel plant equipment		Rs.crores	33.0	13.85	13.67	+ 1	45.82	36.84	+ 24
92.	Chem. and Pharm.machinery	0.11	Rs. crores	52.0	21.34	17.26	+ 24	71.44	51.29	+ 39
93.	Printing machinery	-	Rs.crores	4.0	0.82	0.91	- 10	2. 95	3.46	- 15
94.	Rubber machinery	-	Rs.crores	9.0	2.27	1.95	+ 16	9.99	8.02	+ 25
95.	Road rollers	0.09	Nos.	76.0	84	133	- 37	187	544	- 66
96.	Earth Moving equipments. Dumpers,scrappers,loaders Crawlers,tractor,motor Craders and Shovels/ Excavators.	0.06	Nos.	947	436	401	+ 8	1068	888	+ 23
97.	Hurricane Lanterns	0.04	Th.nos.	-	393	519	- 24	2077	1904	+ 9

Appendix 2.2 Licensed and Installed - Capacity and Production

Sr. No.	Description	Licensed Capacity					Production on				
		72-73	73-74	74-75	75-76	76-77	72-72	73-74	74-75	75-76	76-77
1.	Air Compressors	2796	2736	2736	2376	2376	814	723	811	690	720
2.	Air and Gas Compressors (High Capacity and Heavy duty)	-	60	60	60	60	-	10	15	9	12
3.	Gas Compressor (High Pressure)	-	-	-	-	20	-	-	-	-	2
4.	Air Compressor (High Pressure)	-	-	-	-	20	-	-	-	-	5
5.	Rock Drills	*1800	*1800	*1800	*1800	*1800	355	424	447	170	562
6.	Sump Pumps	*240	*240	*240	*240	*240	141	169	188	114	207
7.	Pneumatic Tools	*2832	*2832	*2832	*2832	*2832	1187	1113	1926	1960	1760
8.	Rock Drill Rods	-	50000	50000	50000	50000	-	-	-	-	6937
9.	Ref.Compressor	1200	1200	1200	1200	1200	146	149	149	128	308
10.	Compressors and components for Ref. and Air conditioning unit.	2400	2400	2400	2400	2400	264	298	533	230	284
11.	Air conditioning anf Ref. Equipment for transport.	-	600	600	600	600	-	-	-	10	34
12.	Power Transmission Equipment (Torque Convertors)	2400	2400	2400	2400	2400	188	110	238	72	71
13.	Reverse - Reduction Gears.	1900	1900	1900	1900	1900	194	249	255	149	172
14.	Controlable Pitch Propellers and Standard Propallars.	-	-	-	200	200	-	-	-	-	-
15.	Fluid Couplings.	-	-	-	-	750	-	-	-	-	15

Note: (1) Installed Capacity - Most of the Plant and Machinery being common for different Products manufactured by the company and installed capacity being dependent on product mix. which in turn is decided by the actual demand for various products from time to time, and also on availing of sub- contracting facilities, it is not feasible

(2) * on single shift basis.

Appendix 4.1

Industry: 370-1.1 - Electric Generation Equation.

Region: Andhra.

Year	Fixed capital M & P	Fixed capital Total	Working capital Mat.	Working capital SF	Working capital Finished	Total	No. of firms.	No. of workers	Total employees	Man-Hrs. worked	Total wages etc.
1960	151	213	-	-	-	101.3	2	110	126	256	119
1962	479	788	655	679	-	828.0	3	199	219	446	235
1964	926	1594	2266	653	55	1473.0	5	313	410	746	620
1965	956	2850	2673	1150	75	1930.0	3	297	295	706	796
1966	67788	278122	76750	16256	762	62254.0	4	1584	2379	3711	8365
1968	155927	303237	80400	134332	511	68107.0	5	2189	4110	5209	21417
1969	3185	5109	4319	1358	2255	5713.0	4	273	399	630	1300

Year	Elec. purchased	Gross value of output
1960	44	931
1961	-	-
1962	169	2540
1964	366	9051
1965	362	13037
1966	5544	28916
1968	12548	131584
1969	726	17205

Gross value (Materials consumed and purchase value of goods sold in the same condition)	Value added	Description
809	93.5	-
-	-	-
1669	614	108
6209	1999	270
9249	2660	161
21947	(34,12,730)	6690
87826	12519	25231
11968	3078	277

PAGE

APPENDIX 4.2

```
// JOB     0006

LOG DRIVE   CART SPEC   CART AVAIL   PHY DRIVE
  0000        0016        0016         0000

V2 M11   ACTUAL 16K   CONFIG 16K

// FOR                                                                  YP
*LIST SOURCE PROGRAM
*IOCS(1403 PRINTER,1442 PUNCH,2501 READER,KEYBOARD,DISK)
*ONE WORD INTEGERS                                                      YP
      DEFINE FILE 101(300,56,U,MREC)
      REAL C7(300)
      INTEGER IP(13)
       REAL A(22),C(26),CP(13)
       REAL TITLE(20)                                                   YP
      REAL YMAX(22),YMIN(22)
       DATA NRD/8/,NPT/5/,IYEAR/0/,NREGI/0/, I/0/                      YP
        DATA  M/1/
      PAUSE 777
       READ(NRD,82)TITLE                                                YP
      WRITE(NPT,91)TITLE                                                YP
82    FORMAT(20A4)                                                      YP
91    FORMAT(1H0,20A4/)
       READ(NRD,82)CREG,LAST
      WRITE (NPT,91)CREG,LAST
      READ(8,500)IPN
500   FORMAT(13I2)
      READ(8,500)(IP(I),I=1,IPN)
      I=0
      READ(NRD,993)YMAX
      READ(NRD,993)YMIN
      WRITE(NPT,994)
      WRITE(NPT,993)YMAX
      WRITE(NPT,993)YMIN
994   FORMAT(' DATA EDIT LIMITS ENTERED'//' UPPERBOUND AND LOWERBOUND'/)
993   FORMAT(8F10.0)
395   CONTINUE
      READ(NRD,82)REGIN, YEAR,(A(J),J= 3,22)                            YP
      IF(REGIN-LAST)209,396,209
209   CONTINUE
        IF(YEAR)210,200,210                                             YP
210   CONTINUE                                                          YP
      DO 26 J =3,22
      IF(KEDIT(A(J),YMAX(J),YMIN(J)))36,26,26
36    WRITE(NPT,996)I,REGIN,YEAR,J
996   FORMAT(' ***INPUT DATA EXCEEDS LIMIT SPECIFIED**'/' RECORD NO. ',
     *I5/' REGION ',A4, ' YEAR ',F10.0,' VAR NO.',I5/)
      PAUSE 777
      GO TO 395
26    CONTINUE
       IF(REGIN-CREG)50,40,50
50    K=1                                                               YP
      NREGI = NREGI +1
        WRITE(NPT,99)IYEAR                                              YP
99    FORMAT(' NO. OF YEARS FOR THE ABOVE REGION(DATA AVAILABLE) ',I5//)YP
      IYEAR = 1                                                         YP
       WRITE(NPT,97)REGIN,YEAR                                          YP
      GOTO 30                                                           YP
40    K = 2                                                             YP
      IYEAR=IYEAR+1                                                     YP
30    CONTINUE                                                          YP
      GOTO(60,70),K                                                     YP
60    C(1) = A(4) + A(22)                                               YP
      C(2)=C(1)*100/(100+((A(18)-100)/2))
       C(3) = C(2) -  A(22)                                             YP
         GO TO 100                                                      YP
70    C1=C(1)
      C2=C(2)
      C3=C(3)
       C(1) = A(4) -A4 + A(22)
      IF(C(1))80,80,90                                                  YP
80    C(2)=C(1)*C3/(A4+A22)                                             YP
       GO TO 95
90    IF(C1)400,400,410
400   CSUM=C1+C(1)
415   IF(CSUM)431,431,440
431   GO TO 430
410   IF(CSUM)420,420,450
420   CSUM=CSUM+C(1)
      GO TO 415
430   C(2)=C(1)*C3/(A4+A22)
      GO TO 95
440   C(2)=((C1*C3)/(A4+A22))+CSUM*100/A(18)
      GO TO 95
450   C(2)=C(1)*100/A(18)                                               YP
95    C(3) = C(3) + C(2) -A(22)                                         YP
100   A4 = A(4)
17    A22=A(22)
```

```
20      C14=C(14)
        C(4) = A(5) * 100./A(19)                                          YP
        C(5) = A(16)*100./A(20)                                           YP
         C(6) = C(4)-C(5)                                                 YP
         C(7) = C(6)/C(5)                                                 YP
        C(10) = C(3) /A(10)                                               YP
        C(11) = (A(11) -A(10))/A(10)                                      YP
        C(12)=.01*C(3)/A(9)
        C(13)=.01*A(11)/A(9)
          C(14) = (A(8)*100./A(20))/C(3)                                  YP
        C(15) = ((A(5) + A(6))*100./A(20))/A(10)                          YP
         C(16) = A(7)/A(15)                                               YP
        C(17) = A(3) /A(4)                                                YP
        C(18) = A(12)/A(10)                                               YP
        C(19) = (A(11)*100./A(21))/A(11)                                  YP
         C(20) = A(14) /A(10)                                             YP
           C(21) = A(13)/A(17)                                            YP
        C(22) = ((A(5) + A(6))/A(15))*100.
         C(23) = A(17)/A(10)                                              YP
        C(25) = A(9)
        IF(REGIN-CREG)711,712,711
   711  C(24)=C(14)
        C(26)=0
        GO TO 713
   712  C(24)=.5*(C14+C(14))
        IF(C2)601,602,601
 601    C(26)=(C(2)+C2)/C3
        GO TO 713
 602    C(26)=(C(2)+.5*C2)/C3
 713    CREG=REGIN
        I = I +1                                                          YP
        C7(I) = C(7)                                                      YP
        WRITE(101'I)REGIN,YEAR,C                                          YP
        KSW=0
        IF(KSW-1)140,150,140                                              YP
 150    MYEAR = YEAR
        WRITE(NPT,96)REGIN,YEAR,(A(J),J=3,22)
        WRITE(9,98)REGIN ,MYEAR,(A(J),J=3,22)
 98     FORMAT(A4,I6,7F10.2/(8F10.2))
 97     FORMAT(' DATA RECORD FOR REGION            ',A4    , ' YEAR ', F10.0//)
 140    CONTINUE
        GO TO 395
 200    CONTINUE                                                          YP
        AMAX = C7(M)
        DO 260  J= M,I
        IF(AMAX-C7(J))250,260,260                                         YP
 250    AMAX = C7(J)                                                      YP
 260    CONTINUE                                                          YP
        DO 120  K=M,I
         READ(101'K)REGIN,YEAR,C                                          YP
           C(8) = AMAX                                                    YP
        C(9) =(C(7)/C(8) )*100.                                           YP
        WRITE(NPT,992)REGIN,YEAR,C                                        YP
        WRITE(101'K)REGIN,YEAR,C                                          YP
        DO 605  II=1,IPN
        IA=IP(II)
        IF(IA-26)600,603,600
 603    IF(C(IA))604,600,600
 604    CP(II)=0
        GO TO 605
 600    CP(II)=C(IA)
 605     CONTINUE
        WRITE(9,700)(CP(II),II=1,IPN)
 700    FORMAT(13F6.2)
        MYEAR=YEAR
        IF(KSW-1)120,130,120                                              YP
   130  WRITE(9,98)REGIN,MYEAR,C
  120   CONTINUE                                                          YP
        M= I+1
         GOTO 395
 396    CONTINUE
        WRITE(NPT,991)I,NREGI                                             YP
        FORMAT(' NO. OF RECORDS ENTERED',I5,/' FOR THE TOTAL REGIONS',I5//)YP
 991    FORMAT(4X,A4,2X,7F10.0/(8F10.0))
 83     FORMAT(1X,A4,F10.0/(1X,8F15.2/))
 992    FORMAT(1X,A4,F10.0/(1X,8F15.2/))
 96     CALL EXIT                                                         YP
        END                                                               YP

UNREFERENCED STATEMENTS
 17       20

FEATURES SUPPORTED
 ONE WORD INTEGERS
 IOCS

CORE REQUIREMENTS FOR
 COMMON        0  VARIABLES       930  PROGRAM     1446
```

Appendix 4.3. Capacity Utilization - Inter Industry 1969

(a) Description of Variables — X-section regression analysis computer statement.

Variable Number	Variable description
1	Capital per unit
2	Employees per unit
3	Maximum output/capital ratio
4	Capital per worker
5	Auxiliary staff/workers ratio
6	Working capital/fixed capital ratio
7	Finished inventory/gross production
8	Man hours per worker
9	Emoluments per employee
10	Electricity per worker
11	Percentage of wages to value added
12	Semifinished inventory/gross production
13	Value added per worker
14	Rate of change of capital
15	Capital utilization

(b) Averages

VAR(1) = 2351.42, VAR(2) = 277.34, VAR(3) = 2.85

VAR(5) = 0.40, VAR(6) = 0.81, VAR(7) = 0.08

VAR(9) = 1.84, VAR(10) = 2.34, VAR(11) = 0.67

VAR(13)= 9.12, VAR(14) = 0.32, VAR(15) =75.84

(c) Standard Deviations

VAR(1) = 4108.99, VAR(2) = 245.22 VAR(3) = 1.32

VAR(5) = 0.49, VAR(6) = 0.96, VAR(7) = 0.04

VAR(9) = 0.41, VAR(10) = 1.81, VAR(11) = 0.25

VAR(13) = 4.56, VAR(14) = 0.39, VAR(15) = 24.30

STEP NUMBER 1 ENTER VARIABLE 14

STANDARD ERROR OF ESTIMATE = 20.289

MULTIPLE CORRELATION COEFFICIENT = 0.575

GOODNESS OF FIT,F(1, 24) = 11.8794

CONSTANT TERM = 87.3553

VAR	COEFF	STD DEV COEFF	T VALUE	BETA COEFF
14	-35.2519	10.2278	-3.4466	-0.5754

STEP NUMBER 2 ENTER VARIABLE 8

STANDARD ERROR OF ESTIMATE = 20.204

MULTIPLE CORRELATION COEFFICIENT = 0.603

GOODNESS OF FIT, F(2, 23) = 6.5912

CONSTANT TERM = 93.0640

VAR COEFF STD DEV T VALUE BETA COEFF
COEFF

8	-2.2095	2.0147	- 1.0966	-0.1833
14	-34.0611	10.2426	- 3.3254	-0.5559

STEP NUMBER 3 ENTER VARIABLE 5

STANDARD ERROR OF ESTIMATE = 19.977

MULTIPLE CORRELATION COEFFICIENT = 0.636

GOODNESS OF FIT, F(3, 22) = 5.0030

CONSTANT TERM = 90.7462

VAR	COEFF	STD DEV COEFF	T VALUE	BETA COEFF
5	10.9865	8.8951	1.2351	0.2218
8	- 3.2439	2.1610	-1.5011	-0.2691
14	-31.8741	10.2812	-3.1002	-0.5202

STEP NUMBER 4 ENTER VARIABLE 11

STANDARD ERROR OF ESTIMATE = 19.879

MULTIPLE CORRELATION COEFFICIENT = 0.661

GOODNESS OF FIT, F(4, 21) = 4.0939

CONSTANT TERM = 103.3161

VAR	COEFF	STD DEV COEFF	T VALUE	BETA COEFF
5	12.4480	8.9499	1.3908	0.2513
8	-3.4476	2.1583	-1.5973	-0.2860
11	-17.9322	16.2488	-1.1036	-0.1844
14	-33.1632	10.2970	-3.2205	-0.5412

STEP NUMBER 5 ENTER VARIABLE 12

STANDARD ERROR OF ESTIMATE = 19.902

MULTIPLE CORRELATION COEFFICIENT = 0.680

GOODNESS OF FIT, F(5, 20) = 3.4577

CONSTANT TERM = 101.1695

VAR	COEFF	STD DEV COEFF	T VALUE	BETA COEFF
5	12.0544	8.9694	1.3439	0.2433
8	- 2.7374	2.2802	-1.2005	-0.2271
11	-28.2034	19.3791	-1.4553	-0.2901
12	0.1727	0.1771	0.9752	0.2015
14	-35.8288	10.6654	-3.3593	-0.5848

STEP NUMBER 6 ENTER VARIABLE 4

STANDARD ERROR OF ESTIMATE = 19.050

MULTIPLE CORRELATION COEFFICIENT = 0.730

GOODNESS OF FIT, F(6,19) = 3.6168

CONSTANT TERM = 103.7974

VAR	COEFF	STD DEV COEFF	T VALUE	BETA COEFF
4	- 1.2055	0.7166	- 1.6823	- 0.3581
5	13.3752	8.6210	1.5514	0.2700
8	- 2.5757	2.1846	- 1.1790	-0.2137
11	-35.5976	19.0626	- 1.8674	-0.3662
12	0.3931	0.2142	1.8349	0.4586
14	-32.0071	10.4582	- 3.0604	-0.5224

STEP NUMBER 7 ENTER VARIABLE 1

STANDARD ERROR OF ESTIMATE = 18.343

MULTIPLE CORRELATION COEFFICIENT = 0.768

GOODNESS OF FIT, F(7, 18) = 3.6997

CONSTANT TERM = 113.3380

VAR	COEFF	STD DEV COEFF	T VALUE	BETA COEFF
1	0.0029	0.0018	1.5787	0.5016
4	-2.3680	1.0091	-2.3466	-0.7034
5	14.1029	8.3139	1.6962	0.2847
8	-3.0367	2.1237	-1.4298	-0.2519
11	-39.3689	18.5101	-2.1268	-0.4050
12	0.2706	0.2203	1.2280	0.3157
14	-23.5800	11.3974	-2.0688	-0.3848

STEP NUMBER 8 ENTER VARIABLE 3

STANDARD ERROR OR ESTIMATE = 15.738

MULTIPLE CORRELATION COEFFICIENT = 0.845

GOODNESS OF FIT, F(8, 17) = 5.3288

CONSTANT TERM = 160.8407

VAR	COEFF	STD DEV COEFF	T VALUE	BETA COEFF
1	0.0062	0.0020	3.1015	1.0509
3	-16.0043	5.8632	-2.7296	-0.8711
4	- 5.2594	1.3680	-3.8443	- 1.5624
5	22.4696	7.7640	2.8940	0.4536
8	- 0.2711	2.0849	-0.1300	-0.0224
11	-28.3057	16.3908	-1.7269	-0.2912
12	- 0.0278	0.2184	-0.1275	-0.0325
14	9.8487	15.6720	0.6284	0.1607

STEP NUMBER 9 ENTER VARIABLE 10

STANDARD ERROR OF ESTIMATE = 14.292

MULTIPLE CORRELATION COEFFICIENT = 0.882

GOODNESS OF FIT, F (9, 16) = 6.2564

CONSTANT TERM = 158.8484

VAR	COEFF	STD DEV COEFF	T VALUE	BETA COEFF
1	0.0075	0.0019	3.9357*	1.2844
3	-19.5250	5.5710	-3.5047*	-1.0627
4	-7.8185	1.7212	-4.5422*	-2.3227
5	11.6298	8.6704	1.3413***	0.2348
8	0.2333	1.9078	0.1223	0.0193
10	7.6855	3.5778	2.1480**	0.5751
11	-14.9894	16.1240	-0.9296	-0.1542
12	-0.0261	0.1983	-0.1318	-0.0305
14	29.8867	17.0166	1.7563***	0.4878

Note: 1 Since standard error of estimate increases, the regression analysis terminated here.

2 * - Significant at 1 percent level

3 ** - significant at 5 percent level

4*** - significant at 10 percent level.

APPENDIX 5.1

WEEKLY LABOUR ANALYSIS SUMMARY OF DIRECT WORKMEN,

FORM No. IED—4

TRANSFORMER, SWITCHGEAR, MOTOR UNITS.

Week-From 26.5.77 To 1.6.77

Actual Working Days

DEPT./SECTION	LOST TIME (HOURS)							Direct Workmen	HOURS WORKED			Std. Hrs. Produced	MISCELLANEOUS WORK						% Age					Bonus Payable in Rs.
	No work	Power Failure	Machine Break-down	Shortage of Inside materials	Shortage purchased materials	Misc.	Total		Normal	O. T.	Total		Recti-fication	Rework	Repair	Mainte-nance	Indirect	Total	Overall Efficiency	Lost Hrs. Attended Hrs %Age	Misc. work	O. T.	Absent-ceism	
													TRANSFORMER											
FABRICATION																								
M/c. Shop																								
Fitting & Welding																								
C/Box, Curb & Channels																								
Tank Testing																								
Painting																								
SUB TOTAL																								
ASSEMBLY																								
Insulation																								
Core Building																								
Coil Winding																								
Assembly Group I																								
Assembly Group II																								
SUB TOTAL																								
Tanking & Finishing																								
TOTAL TRANSFORMER																								
													SWITCHGEAR											
Fabrication																								
Assembly																								
Wiring																								
SUB TOTAL																								
Component M/c. Shop																								
TOTAL SWITCHGEAR																								
													MOTOR											
Rotor Die Casting																								
Machine Shop																								
Stator Assembly																								
Motor Assly.																								
Painting & Finishing																								
TOTAL MOTOR																								
TOTAL ~~NAINI WORKS~~	938	72	128	413	–	3	1554	507	21407	2131	23538	16330	4	330	264	48	2375	3021	76	7.3	14.1	9.95	12.7	13067

Remarks

APPENDIX 5.2

M/c Group	Nos. of m/c	Details of waiting time in hours.							Total waiting hrs.	Clocked Hours	Rectification Hours.	Total time taken for comp. job.Hrs.	Total time allowed job.Hrs.	Efficiency in %	
		Mainte.	Power	Crane	INSP.	Total	Job. Material	Other						Operator	Supervisor
Centre Lathe Turret Lathe	21	32.00	141.00	1.75	5.41	8.33	48	72	236.49	1036	120.75	505.08	340.50	67.4	
Radial Drill	5		45.25					4	45.25	244	25.00	117.50	79.90	68.0	
Vertical Turret	5	37.25	65.50						102.75	240	5.00	231.75	133.25	57.5	
Horz. Boring	4	6.25	27.59					4	33.75	196	15.00	175.50	118.00	67.2	
P. Milling	1		10.50	4.00					14.50	48		4.00	2.50	62.5	
Slotting	1		1.00				25		26.00	48	2.50	18.50	12.25	66.3	
Milling	3	2.50	19.00					8	21.50	132	2.50	110.25	62.20	56.5	
Grinding	1		6.00					8	5.90	48		53.50	27.70	52	
Total for all m/cs.	41	78.00	315.75	5.75	5.41	8.33	73	96	486.24	1992	170.75	1216.05	776.33	64	76.6
CRITICAL MACHINE															
H.B.I.	1		11.00						11.00	48	15.00	-	-	contd.	
H.B.II.	1		7.50						7.50	48	-	135.50	90.00	66.4	
VTL 36"	2	33.25	12.25						45.50	96	5.00	81.75	47.75	58.4	
VTL 46"	3	4.00	53.25						57.35	96		150.00	88.50	57.0	
P.Milling	1		10.50	4.00					14.50	48		4.00	2.50	62.5	
WD160	1	6.25	4.00					4	10.25	48		-	-	contd.	
G.Drill	1	16.50							16.50	48		31.50	21.66	68.7	
Total for all Critical machines	10	60.00	98.50	4.00				4	162.50	432	20.0	402.75	247.61	61.4	62.4

MACHINE UTILISATION STATEMENT FOR AV PLANT FOR OCTOBER 1977

Appendix 5.3

M/C GRPS	M/C DESCRIPTION	SH FT	OPRTR TIME	M/C TIME	HOURS AVAIL	NON-PRODUCTIVE 1	2	3	4	5	8	TOT-IDL TIME	STD-PRD HOURS	STD-HRS OUTPUT	USAGE TIME	TOTAL UTLIS %	PROD INDX.	NO-OF M/C.
01-05	DRILLING M/C	1	6881	7108	9568	55	600	0	0	4	0	659	6556	6027	1802	74	92	46
01-05	DRILLING M/C	2	4204	4533	9568	34	2230	0	0	0	0	2264	4272	3619	2772	47	85	46
01-05	DRILLING M/C	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	46
01-05	DRILLING M/C		11084	11640	19136	89	2830	0	0	4	0	2922	10828	9641	4574	61	89	46
10-13	CENTRE LATHES	1	1205	1783	2288	8	84	0	0	0	0	92	1655	1067	414	78	64	11
10-13	CENTRE LATHES	2	976	1537	2288	32	332	0	0	0	0	364	1435	926	387	67	65	11
10-13	CENTRE LATHES	3	74	112	0	0	0	0	0	0	0	0	112	103	0	0	92	11
10-13	CENTRE LATHES		2181	3320	4576	40	416	0	0	0	0	456	3090	1993	801	73	64	11
14-18	CAPSTANS & TURRET	1	1289	1234	1456	5	144	0	0	13	18	180	943	867	43	85	92	7
14-18	CAPSTANS & TURRET	2	781	817	1456	2	444	0	0	0	5	451	707	550	189	56	78	7
14-18	CAPSTANS & TURRET	3	19	26	0	0	0	0	0	0	0	0	26	25	0	0	97	7
14-18	CAPSTANS & TURRET		2069	2050	2912	7	588	0	0	13	23	631	1649	1417	232	70	86	7
21-24	AUTOMATS	1	575	980	1040	0	84	0	0	0	0	84	880	769	76	85	87	5
21-24	AUTOMATS	2	444	790	1040	32	216	0	2	0	0	250	790	716	0	76	91	5
21-24	AUTOMATS	3	126	163	0	0	0	0	0	0	0	0	163	145	0	0	89	5
21-24	AUTOMATS		1071	1678	2080	32	300	0	2	0	0	334	1670	1485	76	80	89	5
25-28	SP-TURN-BORE M/C	1	3165	4733	6656	35	928	3	0	9	2	977	4401	3389	946	71	77	32
25-28	SP-TURN-BORE M/C	2	2423	3930	6656	48	1320	0	2	16	0	1386	3669	2651	1340	59	72	32
25-28	SP-TURN-BORE M/C	3	504	679	0	0	0	0	0	0	0	0	614	635	0	0	103	32
25-28	SP-TURN-BORE M/C		5588	8663	13312	83	2248	3	2	25	2	2363	8069	6039	2286	65	75	32
30-33	MILLING MACHINES	1	1410	2157	2496	2	64	0	0	0	4	70	2048	1184	269	86	58	12
30-33	MILLING MACHINES	2	949	1626	2496	5	476	0	1	4	0	486	1498	723	384	65	48	12
30-33	MILLING MACHINES	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
30-33	MILLING MACHINES		2359	3783	4992	7	540	0	1	4	4	446	3546	1908	653	76	54	12
50-54	GRINDING	1	2443	1742	2288	17	228	0	0	0	4	249	1554	1577	297	76	101	11
50-54	GRINDING	2	2086	1470	2288	7	296	0	0	4	16	322	1292	1305	496	64	101	11
50-54	GRINDING	3	26	30	0	0	0	0	0	0	0	0	29	36	0	0	124	11
50-54	GRINDING		4528	3212	4576	24	524	0	0	4	20	572	2846	2882	792	70	101	11

25/1/1978
sak
Work Study Dept.

M/CNO	02	04	06	08	10	12	14	16	SET	ASSD	%O/P	DEVP	JOBW	%UTL
GR/NO	01	03	05	07	09	11	13	15	T.IDL	UTIL	PROD	MANT	R/WK	MISC
01 24	0	0	0	60	0	0	0	0	180	7890	112.8	0	0	97.8
	0	0	0	0	0	0	0	0	60	7860	8901	0	0	120
01 33	0	0	0	0	0	0	0	0	240	6930	87.3	0	0	85.9
	240	0	0	0	0	0	0	0	240	7620	6048	0	630	270
01 35	0	0	0	0	0	0	0	0	210	6750	91.1	0	0	84.1
	840	150	0	0	0	0	0	0	990	6400	6149	0	0	300
01 37	0	0	0	0	0	0	0	0	120	5040	43.9	0	0	63.3
	1260	0	0	0	0	0	420	0	1680	6300	2215	0	1110	180
01 41	0	0	120	270	60	0	0	0	150	5670	57.2	0	0	78.9
	450	360	0	0	0	0	0	0	1260	6690	3242	0	0	450
01 45	0	0	0	0	0	0	0	0	360	2700	142.2	0	0	43.3
	870	1290	0	0	0	0	0	0	2160	5580	3840	0	1680	750
01 50	0	0	0	0	0	0	0	0	270	5880	111.1	0	0	92.6
	0	360	0	0	0	0	0	0	360	7470	6532	0	240	0
01 53	0	0	60	0	0	0	0	0	60	5460	80.9	0	0	67.4
	840	1260	0	0	0	0	480	0	2640	5400	4415	0	0	0
GRPTL	0	0	180	330	60	0	0	0	1590	46320	89.3	0	0	76.7
	4500	3420	0	0	0	0	900	0	9390	53820	41342	0	3660	2070
PERCT	00.0	00.0	00.3	00.5	00.1	00.0	00.0	00.0	02.5	71.5		00.0	00.0	
	06.9	05.3	00.0	00.0	00.0	00.0	01.4	00.0	14.5	83.1	63.8	00.0	05.5	03.2

M/C.REJ. 1484 2.3% CAST.REJ. 1317 2.0% NO.OF M/CS. 8 AVAILABLE TIME 64800

02 03	150	0	0	30	0	0	0	0	420	6900	86.3	0	0	85.2
	0	300	60	0	60	180	420	0	1200	6480	5955	0	0	0
02 09	0	0	60	0	0	0	0	0	540	5040	70.6	420	0	81.9
	420	210	240	0	0	180	180	0	1290	6270	3560	0	0	180
02 10	0	0	0	120	0	0	0	0	975	4950	63.1	180	0	96.3
	0	0	60	0	0	120	0	0	300	6825	3125	0	0	0
GRPTL	150	0	60	150	0	0	0	0	1935	16890	74.8	600	0	87.8
	420	510	360	0	60	480	600	0	2790	19575	12640	0	0	180
PERCT	00.6	00.0	00.2	00.6	00.0	00.0	00.0	00.0	08.0	69.5		02.5	00.0	
	01.7	02.1	01.5	00.0	00.2	02.0	02.5	00.0	11.5	80.6	52.0	00.0	00.0	00.7

M/C.REJ. 84 0.3% CAST.REJ. 1348 5.5% NO.OF M/CS. 3 AVAILABLE TIME 24300

IDL TIME CODES:-(01) OPERATOR ABSENT (02) NO OPERATOR / OPERATOR NOT ALLOTED (03) MAINTENCE (04) NO POWER
(5) NO LOAD / LOAD CH. (6) TOOL STORES. (7) GAGE STORE. (8) TOOL ROOM.
(09) DRAWING STORES (10) INSPECTION (11) CRANE /HELPER (12) INSTRUCTIONS
(13) MISCELLANEOUS. (14) RECONDITIONING. (15):-XXXXXXXXX (16):-XXXXXXX

Appendix 5.4

Appendix 5.5

Survey of Management Attitudes

Questionnaire, Rationale and Response:

1. A questionnaire (Annexure 1) was circulated amongst top executives of a number of Engineering firms. The questionnaire is in two parts. Ist part is designed to ascertain the attitudes and information base concerning capacity utilization of top executives and part 2 is designed to collect information on performance of the company during the past few years with a view to arrive at some conclusions regarding the position of capacity utilization in these firms.

2.1 Rationale of Part A:

In question 1: Objectives of the company were to be ranked in order of preference. These objectives included are based on the listed objectives of General Electric Co. USA, who claim that all these objective are equally important and non-attainment of any one objective can geopardise their position as leader in Industry. As seen before, poor R and D resulting in poor and outdated product design, poor market effectiveness resulting in limited markets, labour problems, managerial limitation in face of expansion and antagonism of public at large to the profiteering of Industrial Enterprises are now proving deterimental to effective utilization of capacity in Industry.

Through question 2, the methodology of capacity determination was requested. Methods included are these generally noticed as well as those desired. Through question 3, information is requested on a particular lacuna in capacity determination. Question 4, concentrates on shift working and causes for sub optimum working. A number of commonly advanced reasons were listed out of which those applicable were to be ticked.

Through question no. 5, an appreciation of the standard times allowed was required to be given. This, as seen before, is crucial in fixing rated capacity lower than the installed capacity.

Through question no. 6, the executives, own assessment (qualitative) of the reasons for underutilization was to be given. Common reasons were listed for recapitulation.

In question no. 7, the executives were required to reply whether they preferred to increase production and if so why did not try it and if they did not want to increase production, reason for the same.

2.2 Rationale of Part B: Question 1 related to data on types of products manufactured and weightage factor of every product to the standard product in terms of time allowed and cost of load centres involved.

Question 2 required the actual production to be recorded vis-a-vis licensed and installed capacity firstly as recorded in the firm and secondly in desirable units mentioned in question no. 1.

In question no. 2a, more information was requested on number of shifts worked, staff employed including indirect, supervisory and managerial.

In question no. 3, record of machine idleness on account of worker absenteeism, power failure, breakdown and no work. was requested.

Question no. 4 related to use of working hours for non-productive work.

Last question i.e. question no. 5 related to overtime worked.

Data from question no. 1 and question no. 2 was to be used for direct measurement of capacity utilization by first measuring actual production in terms of standard production and then comparing this to capacity expressed in the same units. Data from question no. 3 to question no. 5 was to be used for indirect measurement of capacity utilization by balancing the machine hours available and worked.

3. Response:

Response to the questionnaire was not encouraging partly because of the recent explosion in questionnaire form of research resulting in indifference of the firms to reply to such questionnaire. Another reason for the poor response was the real difficulty of the firms to completely reply to the questions either due to data not being maintained for replying to Part B or due to unsettled thinking on many questions of Part A particularly question no. 1.

Many firms have never thought of objectives of the firm other than 'Profitability' and perhaps 'Productivity' and are either unaware of the importance of other objectives or view this with cynicism.

They are reluctant to reply as they don't want to reveal this unawareness or cynicism. Moreover extensive discussions were held with some managers in some firms and it was found that one important feature of the delay in reply, even if the management was keen to provide it, was the managements' uncertainty as to the nature of replies. However a few answers have been received to give some insight into the attitudes of entrepreneurs or executives Firms who have replied are: Kirloskar Prematic, Kesoram Mills, Appolo Tyres, Sudershan Engg. Works and Holman Climax Pvt. Ltd. and a few others.

Response to Question No. 4 Ref. Table No. 5.5.1:

Profitability is No. 1 preference in all the responses except one. Productivity is No. 2 preference in all the responses except one. Market effectiveness is No. 3 preference in all the responses except one. Innovation and R D and Managerial development have been ranked 7th and 6th generally.

Public responsibility and employee welfare have been rated in a varying manner. One gets a feeling from the responses that the exact nature of these objectives is not clearly known and since the objectives are mentioned in the questionnaire, some ranking has been given.

Response to Question No. 2:

Response from two firms has been No. 3 i.e. based on your own calliberation of machine and rate fixing. It indicates that most of the firms had means to undertake time studies and fix production standards. Two firms indicated 'Licensed Capacity' as their capacity. One firm indicated the basis as 'Based on increasingly set targets of production'. No body could send detailed account ofcapacity. Interviews with executives revealed that no body is really working out capacity levels. Most of the firms are comparing production of one period with another with all the faults mentioned earlier.

Response to Question No. 3:

The specific enquiry revealed both types of replies indicating no clear concensus amongst the Managers (three 'NO' and two 'YES').

Response to Question No. 4:

Only existing shift working has been indicated by the firms without indicating any reason for working less number of shifts. Two firms - 3 shifts, 1 firm - 2 shifts.

Two firms - 2.75 shifts 1 firm - 1 shift.

Demand Anxiety was given as reason for less utilization.

Response to Question No. 5:

Most of the firms indicated that they think that there is scope for improvements in time standards fixed.

Table No. 5.5.1

Objectives	Firm 1	2	3	4	5	6
Profitability	1	1	1	1	2	1
Productivity	2	2	5	2	1	-
Public Responsibility	6	-	2	6	5	-
Market Effectiveness	3	-	3	3	4	-
Employee Welfare	5	-	4	5	3	-
Managerial Development	4	-	6	4	6	-
R and D	7	-	7	7	7	-

Table No. 5.5.2

Reason	Firm 1	2	3	4	5	6
Less no. of shifts	4	6	-	5	-	1
Poor worker efficiency	5	3	3	4	-	2
Inadequate Power supply	2	1	2	6	-	6
Excessive breakdown of equipment	6	2	4	7	-	5
Absenteeism	3	5	5	2	1	3
Shortage of raw material	1	4	-	3	-	4
No demand	-	7	1	1	-	7

Response to Question No. 6:(Table No. 5.5.2)

Most important reason of poor utilization is as follows:

No demand - 2 firms

Raw material - 1 firm

Absenteeism - 1 firm

Inadequate power supply - 1 firm.

It only goes to show that the reasons are widely dispersed and micro analysis is urgently needed to pinpoint the problems of different firms.

Response to Question No. 7:

Firm No. 1 - Reply Yes - No other details

2 - Reply Yes - Lack of demand

3 - Reply Yes - Lack of demand

4 - Reply Yes - Space restriction for installing more equipment.

5 - Reply Yes - Complication with Govt. machinery.

Response to Part B:

Firm 1:- Answer to Question No. B 2a

Year	1972	73	74	75	76	77
No. of shifts	982.5	1006.5	955.5	944.25	942.25	744.5

Since no other information was supplied, no comments can be given.

Firm 2:- Employment of staff consistent from 1972 to 77- Q.No. B_{2a}

Percent B/D, Power failure, Absenteeism range - between 2 to 4 percent, 2 -5 percent, 8 - 10 percent respectively - Q. No. B_3

Over time between 4 to 15 percent - Q No. B_5

Production data not given.

Firm 3 :- Reports total idleness of 30 percent out of which 24 percent is due to no work and remaining 6 percent due to B/D, power failure absenteeism and Misc. reasons.

Firm 4 and 5:- Not filled.

In the absence of any massive data, the purpose of administering this proforma was deflated but one thing was established that the data base of the firms is very weak.
No. of firms to whom questionnaire sent is at annexure 2.

Annexure 1:

A1 Please rank the company objectives in order of importance you attach:

1. Profitability
2. Productivity
3. Public responsibility
4. Market effectiveness
5. Employee welfare
6. Managerial development
7. Innovation, R and D
8. Others.

A2 What in your view point, has been the mechanics of determining the installed capacity ?

1.	Same as licensed capacity	Yes/No
2.	Manufactures/Collaborators specification	Yes/No
3.	Based on your own calliberation of machine and rate fixing	Yes/No
4.	Based on increasingly set targets of production	Yes/No
5.	Based on past peak production	Yes/No
6.	Optimization though linear programming	Yes/No
7.	Experience with other plants	Yes/No

Note: I shall greatly appreciate if you would send a detailed assessment/report/--indicating how were the installed capacity determined in different years and your own comments about the appropriateness of the methods employed.

A3 Do you include obsolete and uneconomic equipment in determining the plant capacity ? Yes/No

A4 What do you think about the optimal level of number of shifts that could be operated in your unit:1,2,2.5,3.

In case of less/more than optimal use, please state the reasons, preferably in order of importance, contributing to this.

1. Transport problems to workers in 2nd and third shift
2. Generally low off in third shift.
3. Reluctance of workers to come in 2nd/3rd shift.
4. No demand to justify working in 2nd/3rd shift.
5. Some category of staff not available.
6. Future uncertainty of demand does not justify present expansion.
7. No thought given.

Note: Rank by giving number, 1,2,...,3 otherwise tick only.

A5 Have you prescribed certain standards of production to be achieved by different categories of workers like time standard/standard time/allowed time Yes/No

If yes, do you think there is a scope of improving those standards ? Yes/No

If yes, please write how were the standards determined and how can the standards be improved ?

A6 Can you please rank, in order of importance you attach, the factors having a bearing on the capacity utilization.

1. Less number of shifts worked.
2. Poor worker efficiency.
3. Inadequate power supply.
4. Excessive breakdown of equipment.
5. Absenteeism.
6. Shortage of raw material.
7. No demand.

(Kindly add extra sheets for details and if space inadequate).

A7 Do you want to produce more ?

If no why ? Price too low/effort/other reasons

If yes, why not ? Demand

(source of demand why failed/marketing efforts/Govt. purchase).

Note: Kindly enclose a broachure giving details of design and performance of various products, if available.

After filling up Part A, kindly pass on Part B.

Proforma B:

B1

S.No.	Model of product no. of description	Wt.attached	Percent components interchangeable with other models
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			

(The following formation may be of special assistance to you in answering the above question).

$$\text{Weight of product} = \frac{j \, \Sigma \, t_{ij} \, W_j}{j \, \Sigma \, t_{ij} \, W_j}$$

where t_{ij} = time allowed for ith product on jth machine

W_j = (OH rate + direct rate) for jth machine.

t_{ij} = time allowed for ith product on jth machine.

B2

Year	Licensed capacity	Installed capacity	Actual Production Complete	Spares
1972				
1973				
1974				
1975				
1976				
1977				

B2 a

Year	No. of shifts employed	Direct	Employees indirect workers	Supervisors	Managers	Total
1972						
1973						
1974						
1975						
1976						
1977						

B3 Do you compile information regarding idleness hours of M/s and plant when planned to work ? Yes/No

If yes, can you indicate the following:

M/s idle due to

Table

Year	B/D	Power failure	Absenteeism	No. work	Miscellaneous
1973					
1974					
1975					
1976					
1977					

B4 What % direct labour is used for repair and maintenance, replacement of rejected parts, and other unscheduled work ?

Year	Repair and maintenance	Replacement of rejected parts	Unscheduled work
1973			
1974			
1975			
1976			
1977			

B5 What was the extent of overtime worked in hours during

Year	Overtime hours	% of total hours worked
1973		
1974		
1975		
1976		
1977		

Annexure 2

1. Air and Gas Compressors: Installed capacity : 13.2 Th.nos. p.a.

M/s. Kirloskar Pneumatic Co. Ltd., Poona.

M/s. K.G.Khosla and Co. Pvt. Ltd., New Delhi. Factory in Haryana (Faridabad).

M/s. Consolidated Pneumatic Co.(P) Ltd., Bombay.

M/s. SLM Manekial Industries Ltd., Bombay.

M/s. Ingersol Rand (India) P. Ltd., Naroda.

M/s. Atlas Capco(I) Pvt. Ltd., Poona.

M/s. Holman Climax Mfg. Ltd., Calcutta.

M/s. Tecalemit (I) Ltd.,24-Parganas (West Bengal).

M/s. Elgi Equipment (P) Ltd., Coimbatore.

M/s. Bharat Pump and Compressors Ltd., Allahabad.

M/s. Bharat Heavy Electricals Ltd., Hyderabad (Not reporting since January 1977).

2. Commercial Vehicles: Installed Cap: 68.5 th. nos. per annum.

M/s. Ashok Leyland Ltd., Madras.

M/s. Ashok Leyland Ltd., Madras.

M/s. Tata Engineering and Locomotive Co. Ltd., Bombay (Unit located in Jamshedpur).

M/s. Hindustan Motors Ltd., Hoogly.

M/s. Premier Automobiles Ltd., Bombay.

M/s. Standard Motor Products of India Ltd., Madras.

M/s. Bajaj Tempo Ltd., Poona.

M/s. Mahindra and Mahindra Ltd., Bombay.

3. Bicycles: Installed cap: 4 mill nos. per annum.

M/s. Speed craft Pvt. Ltd., Patna (Not reporting/not yet started production).

M/s. Atlas Cycle Industries Ltd., Sonepat, (Haryana).

M/s. Avon Cycles (Pvt.) Ltd., Ludhiana.

M/s. Everest Cycles Ltd., Gauhati, (Assam).

(not sending any production returns for the last so many years - presumed to be closed since 1974).

M/s. Hero Cycle Industries, Ludhiana.

M/s. Hind Cycles Ltd., Bombay.

M/s. Hind Cycles Ltd., Ghaziabad.

M/s. Marshall Cycles, Ghaziabad.

M/s. Roadmaster Industries of India (P) Ltd., Rajpura.

M/s. Sen Releigh Ltd., Calcutta.

M/s. T.T. Cycles of India Madras.

M/s. Wearwell Cycle Co. (I) Ltd., Garidabad. (not reporting presumed close)

M/s. Deepak Industries, Ludhiana.

M/s. Super Cycles, Ludhiana.

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