Chapter III

Productivity profile of BHEL, Trichy
CHAPTER-III

PRODUCTIVITY PROFILE OF BHEL, TRICHY

BHEL - An overview

Background

Heavy Electricals (India) Ltd., was set up at Bhopal in August 1956 as a public sector unit with a view to reach self-sufficiency in the production of industrial products and power equipment which are essentially needed for industrialisation of our country.

To meet the demand for heavy electrical equipment, Bharat Heavy Electricals Limited another public sector unit came into being in November 1964. Three manufacturing plants were established by BHEL, a Central Government undertaking, viz.,

- High Pressure Boiler Plant, Trichy (TN), May 1965
- Heavy Power Equipment Plant, Hyderabad (AP), December 1965

As there was need for an integrated approach to the development of power and equipment manufacture in India and also with a view to optimally utilise the resources, Heavy Electricals (India) Ltd., Bhopal was merged with BHEL in 1974.

Present position

Bharat Heavy Electricals Ltd., today is one of the largest engineering and manufacturing organisation of its kind and rank among the top ten international manufacturers in terms of annual production of power equipment. The undertaking represents a leadership that has come from the production of most comprehensive range of equipment and services for thermal, hydel and nuclear power generation and a total power service to customers from concept to commissioning.

BHEL's four manufacturing units, with the utmost modern and sophisticated facilities, have been designed to produce a complementary range of products to meet the entire needs of power generation, transmission, distribution and utilisation. As a part of a programme
for greater self-reliance, BHEL has launched five more manufacturing units which are set up to meet the increasing demand for Transformers, Forgings and Castings, Seamless steel tubes, Control equipments and Insulators. Fully equipped Research and Development centres and a complement of over 7000 highly trained Engineers provide technical support to the manufacturing plants.

BHEL's role in the past decade has been significant in taking India from a state of near total dependence on imports for power equipment to complete self-reliance today. To date, BHEL has manufactured and supplied power equipment for generation of over 30000 MW. BHEL's current rate of production is around 4000 MW power generating equipments per annum. With its substantial capacity, BHEL is not only meeting India's own projected power requirements, but sizeable export needs as well.

Today BHEL has an important commitment to industry. Fertilizers, Petroleum, Petro-chemicals, Steel, Aluminium, Paper, Mining, Cement and Railways are some of the vital industrial sectors being served by BHEL with sophisticated equipment and services.
The ceaseless search for expert know-how and technology has resulted in a series of collaborations with world leaders from Czechoslovakia, France, Italy, Sweden, Switzerland, the United States of America, the United Kingdom, the Union of Soviet Socialist Republic and West Germany. Now, BHEL has the production capacity to offer turbine key power projects to countries the world over.

BHEL as a whole, has a work-force of 74464 including 10000 Executives, 12000 Supervisors and 27500 highly skilled Artisans as on March 1991. Employees belonging to Scheduled Castes and Tribes constitute about 15.2% of the manpower, Industrial relations in all establishments of BHEL are generally cordial and peaceful. BHEL is the first public sector organisation in India to secure the Best Industrial Relations Award for the year 1983, instituted by the All India organisation of employers for outstanding achievement in Industrial Relations. In order to provide in-house orientation and training besides continuously developing managerial engineering and technical skill. BHEL has established its own Central Management Development Institute. In addition, each manufacturing division
has its own training institute to impart fresh skills to the Artisans/Supervisors and Executives.

**Personnel Organisation in BHEL**

The Corporate Personnel objectives enshrined in the Company's corporate plan first issued in 1974 are:

- To evolve a participative style of management which will ensure good working conditions and job satisfaction to all employees, wages commensurate with their performances, career advancement and goodwill amongst all employees and respect for the human individual.

- To ensure continuous development of competent managerial personnel and to make the best use of both the human and material resources of the business.

The document detailing the Growth Perspective in the 80's (April 1982) further strengthened these objectives in this regard stating as follows:

'To invest in Human resources development, sustained Research and Development, strive for excellence in management and other long range activities to ensure a leadership status for BHEL.'
The BHEL has certain laudable objectives to achieve:

1. Mission

   Its mission is to achieve and maintain a leading position as suppliers of quality equipment, system and services to cater to the national and international markets in the field of energy. The areas of interest would be the conservation, transmission, utilisation and conversion of energy for applications in the power, industrial and transportation fields and to strive for technological excellence and market leadership in these areas, and to ensure a steady growth in business so as to fulfil national expectations from BHEL and expand international operations.

2. Profitability

   It aims at providing a reasonable and adequate return on capital employed, primarily through improvements in operational efficiency, capacity utilisation and productivity, and generate adequate internal resources to finance the Company's growth.

3. Image

   With a view to build up a high degree of customer confidence, BHEL sustains international standards of
excellence in product quality, performance and service, particularly in regard to supply of spares and after-sales-service and BHEL aims at fulfilling the expectations which stock holders like Government as owners, employees and customers and the country at large have from BHEL.

4. Continuity

BHEL strives to invest in human resources development, sustained research and development, strive for excellence in management and other long range benefits to ensure a leadership status for it.

Human Resources Mobilisation

In line with the changing environment, BHEL has organised itself along with other business sectors. In this framework, the manufacturing divisions would continue to be the main activity centres within the organisation. The business groups would have an integrating role, take a lead in all marketing activities and ensure that the company plans meet with the national plans.
In BHEL, a continuous audit of existing manpower is carried out to assist in long-term manpower planning and human resources development exercise. It also looks critically at the skills and qualifications of the existing employees and their utilisation to ensure profitable use of the human resources.

All important aspects of human resource management, e.g., acquisition, development, motivation, maintenance and evaluation are periodically reviewed and adapted in BHEL to meet the changing needs of the organisation. BHEL gives top priority to training and management development since it moves towards more advanced technologies and newer management software to sustain a desirable growth rate. This ensures a steady supply of trained manpower to BHEL to meet the organisational requirements.

BHEL has a constructive relationship among its employees because of its participative style of management. The members of the BHEL family have committed themselves to work for the growth of the organisation and also to share the benefits and fruits of the Company's performance.
In order to achieve the objectives, BHEL's personnel function is headed by a full time functional Director and is organised to develop a style of personnel management best suited to an industry of this type in public sector and to bring about an increased sense of belonging and team spirit among the employees. In keeping with the Corporate Policy of 'centralised policy making and decentralised administration', the personnel activities in BHEL are performed at two tiers, viz., the Corporate level and the Unit level. Decisions on personnel matters are effected through a hierarchy of advisory/decision making bodies. BHEL also reorients the personnel function and the associated policies for wider participation and improved team work of the employees. These efforts are reflected in its production and productivity and the production trend for the past years of BHEL is depicted in the Annexure.

High Pressure Boiler Plant (HPBP)

At Tiruchirapalli, in the State of Tamil Nadu (South India), stands the High Pressure Boiler Plant of BHEL, the unit under the study. The Plant specialises in the manufacture of steam generators for thermal and nuclear power stations of Unit sizes upto 500 MW and 232 MW respectively, along with all related auxiliary equipments.
It also manufacturers industrial process steam-boilers in different sizes to meet the requirements of fertilizers, petrochemicals, steel and paper industries. These are designed for a wide range of fuels, viz., coal, oil, gas, black liquor and any other combination thereof.

In order to meet the growing demand for power, the Tiruchy plant is geared to produce the equipment equivalent to 4000 MW per annum - worth hundreds of crores of rupees.

Today, the Trichy complex consists of the High Pressure Boiler Plant, the Seamless Steel Tube Plant, Welding Research Institute, Coal based Research Project, Piping Centre in Madras and the Boiler Auxiliaries Plant at Ranipet. In addition, Magneto Hydro Dynamics, a research project of BHEL, is also situated near this complex.

Overseas Collaboration

Over the years, BHEL, Trichy has established contacts and entered into collaboration with a number of world leaders in the field.
The High Pressure Boiler Plant was originally set up with the collaboration of Skodaexport, Czechoslovakia, for limited designs of thermal power station boilers and small steam generators for process industries. It commenced production in 1965. The need for high capacity boilers of 200 MW and above for larger power stations, as well as improved know-how on process industries, led to a fresh collaboration agreement with Combustion Engineering Inc., USA. For almost a century, Combustion Engineering have enjoyed an international reputation for the manufacture of highly dependable steam generators and allied equipment. Their entire product line incorporates the most modern boiler design and manufacturing technology, a lot of which has been pioneered by themselves. Now BHEL, Trichy in collaboration with Combustion Engineering, has developed a wide range of design configuration and sizes to meet the requirements of thermal and nuclear power stations all over the world and many process industries. Each product, therefore, carries an assurance of dependability, durability and economy of operation.
High capacity boilers like 200 MW and 500 MW brought about a need to update the design know-how for boiler auxiliaries. Hence, a number of fresh collaborations have been entered into.

Air Preheater, which was earlier of a tubular stationary type, has been replaced with Ljungstrom Rotary Regenerative Air Preheaters. The Ljungstrom Air Preheaters are currently manufactured at BAP/Ranipet. The range of manufacture covers fully shop-assembled package units and very large field-assembled Air Preheaters.

BHEL, Trichy also manufactures and supplies Electrostatic Precipitators. The electrostatic precipitators are manufactured at Ranipet Plant. BHEL had earlier collaboration with Flakt of Sweden, a leader in air handling systems since 1918. Flakt has pioneered the manufacture of dust collaborators which removes fly ash and other minute particles from exhaust gases by mechanical, electrostatic and chemical means. These are widely used in power stations, incineration plants, pulp industries, metallurgical industries, cement and other process industries.
BHEL, Trichy had a collaboration agreement with KKK (Kuhnle Kopp and Kaush) or Frankenthal/Pfalz, West Germany, pioneers in the design and manufacture of Axial and Radial Fans which have wide applications in many fields.

BHEL, Trichy is also engaged in the manufacture and supply of safety valves, safety relief valves, forged steel valves, etc., for various applications. These are manufactured in collaboration with Dresser Industries Inc., USA.

The high pressure and low pressure bypass valves along with the associated controls are being manufactured in collaboration with M/s Sulzer Brothers of Switzerland and supplied by BHEL for use in the reheat cycle of the boiler.

These collaborations and in-house R and D have enabled BHEL, Trichy to introduce a wide range of sophisticated boiler house equipment to international standards.
Human Resource Development

The main force behind the success story of BHEL, Trichy is a strong team of 1500 engineers and scientists, 3000 technicians and more than 10000 skilled and unskilled employees. The strength of today is acquired through planned training over the years and constant striving to keep abreast of technological developments worldwide.

The Human Resource Development (HRD) Centre, established in 1963, which is the nerve centre of skill development has imparted training in various skills to more than 5000 artisans. Since 1968, i.e., the year of induction onwards, 24 Gold Medals, 44 Silver Medals and 133 Bronze Medals have been won by its Apprentices in All India Skill Competitions. This HRD has also been awarded the President's Trophy as the best training establishment in the country, on four occasions.

While planned programmes take care of the internal development of technological and managerial skills aiming at very high quality, the need for proper operation and maintenance of power plants was felt and courses are being conducted for customer Engineers and operators.
The HRD Centre is well equipped and the facilities are being continuously updated to provide the latest teaching techniques. In addition to a Model Room, an audio-visual production centre with facilities for making slides, tapes, charts, transparencies and other learning aids are available to make both teaching and learning faster.

At Trichy, the BHEL team is always ready to meet the challenges of tomorrow. They remember with nostalgia the achievements of yesterday. They reflect with enthusiasm the technology of today. They look forward with confidence to their role in shaping the future.

A look at the organisational structure which is depicted in the Organisation Chart, will enable one to understand the structural setup behind the tremendous achievement in this unit.

Organisation chart

The superior-subordinate relationships are defined by organisation charts, which are formal documents that indicate the chain of command and the roles that have been assigned to the Managers and other personnel.

The Figure 1 is the first line organisation chart of BHEL, Trichy.
The Executive Director is the Chief Executive of the Unit. For each and every product there is one head called the Product Manager and similarly the head of the functional area is also called the functional manager. The departments acting under the control of the Executive Director are classified productwise and functionwise like Fossil Boilers, Valves, Quality and Finance. The first vertical box columns indicate the departments classified on the productwise and the second vertical box columns indicate the departments classified on functionwise. For some functional areas, the head is in the cadre of Deputy General Manager, Addl. General Manager or General Manager. All the heads of product and functional areas directly come under the control of the Executive Director and directly report to the Executive Director.

The Executive Director is assisted by the Long Range Planning Department. This department takes care of the objectives of the organisation, the collaboration agreements medium and long range planning and control of the organisation. The responsibility of preparing the budget lies with the respective product and
functional heads. Each product and functional head
will have to prepare the budget annually in tune with
the Unit's objectives and get orders for their pro-
ducts and services and they execute the order. Under
each Product Manager, there are Executives, Super-
visors and Workers in the department. Each depart-
ment has got Executives at E1, E2, E3, E4 and E5
levels. E1 indicates Engineer, E2 Senior Engineer,
E3 Deputy Manager, E4 Manager and E5 Senior Manager.
Supervisors and Workers work under their control. All
these employees work towards accomplishment of their
departmental goals.

Similarly for each product in BHEL, the depart-
ment would frame the chart separately. Figure 2 is
an example of organisation chart drawn for Fossil
boilers. Likewise, the organisation charts are drawn
for other products like Valves, Piping etc.
First Line organisation Chart of Fossil Boilers

General Manager

DGM (Product Engineering)

DGM (Commercial)

Manager (Shipping)

DGM (Production)

Manager (Personnel)

DGM (Planning)

DGM (Factory Civil)

SM (Modernisation)

DGM (Materials)

SM (Finance)

SM (Ancillary Development)

SM (Maintenance and Services)

SM (Stores)

SM (Material Planning)

SM (Purchase)

Internal Transport (Operation and Maintenance)

Mechanical Maintenance

Cranes (Operation and Maintenance)

Gas Services (Operation and Maintenance)

Electrical Maintenance

LEGEND
DGM - Deputy General Manager
SM - Senior Manager

Figure 2

Source: Industrial Engineering Department, BHEL, Trichy
General Manager (Fossil boilers) is the head of Fossil boilers section. Deputy General Manager/Product Engineering, Deputy General Manager/Commercial, Senior Manager/Finance, Senior Manager/Ancilliary Development, Deputy General Manager/Civil factory, Deputy General Manager/Production, Deputy General Manager/Planning, Deputy General Manager/Maintenance Services, Senior Manager/Modernisation and Deputy General Manager/Materials are under the direct control of General Manager (FB). Transport operation and Maintenance section, Gas service operation and maintenance, mechanical maintenance, Electrical maintenance and Cranes operation and maintenance are reportable to Deputy General Manager/Maintenance and Services. Deputy General Manager/Materials is in-charge of the Stores, Materials Planning and Purchase sections.

Figure 3 shows the organisation chart of Personnel department.
Chart depicting Organisation of Personnel Department

Deputy General Manager
(Personnel)

Manager
(Industrial Relations)

Manager
(Law)

Senior Personnel Officer
(Systems)

Manager
(Co-ordination-External Agencies)

Deputy Manager
(Welfare and Canteen)

Manager
(Establishment and Recruitment)

Senior Personnel Officer
(Canteen)

Personnel Officer
(Welfare)

Personnel Officer
(Executive Establishment)

Manager
(Piping Products)

Manager
(Fossil Boilers)

Deputy Manager
(Valves)

Senior Personnel Officer
(Engineering)

Figure 3

Source: Industrial Engineering Department, BHEL, Trichy
Deputy General Manager (DGM) is the head of Personnel department. Manager/Industrial relations, Deputy Manager-Welfare and Canteen, Manager/Establishment and Recruitment, Manager-Law, Senior Personnel Officer-Systems, Manager-Coordination and external agencies are coming under the direct control of Deputy General Manager/Personnel. Area Personnel Executives of Piping products, Fossil boilers, Valves and Engineering section also report to Deputy General Manager. Senior Personnel Officer - Canteen and Personnel Officer/Welfare report to the Deputy Manager in-charge of Welfare and Canteen. Deputy Manager who is incharge of Recruitment and Personnel Officer - Establishment section are under the direct control of Manager/Establishment and Recruitment.

Productivity in Trichy, BHEL

Productivity is the relationship between the output generated by a production or service system and the input provided to create the output. Productivity may thus be defined as the efficient use of resources - labour, capital, energy, materials, information - in the production of various goods and services.
Higher productivity means accomplishing more with the same amount of resources or achieving higher output in terms of volume and quality for the same input. This is usually stated as:

\[
\text{Productivity} = \frac{\text{Output}}{\text{Input}}
\]

Productivity can also be defined as the relationship between results and the time it takes to accomplish them. Time is often a good denominator since it is a universal measurement and it is beyond human control. The less time taken to achieve the desired result, the more productive is the system. The definition of productivity is complex and it is not only technical but also managerial problem. If productivity is defined for the individual worker as a relation of the volume of specific work done to the potential capacity of the worker (in numerical, cost or time terms), then for the enterprise or sector it can be expressed as the relationship between value added and the cost of all input components.

In a BHEL, Productivity is looked upon as a comprehensive measure of how efficiently and effectively
organisations satisfy the following five aims:

- Objectives,
- Efficiency,
- Effectiveness,
- Comparability and
- Progressive trends.

A positive climate for productivity improvement exists at BHEL, Trichy, as evident from the productivity improvement activities of the Management. An effective suggestion scheme is in operation at Trichy which embraces both productivity improvement projects and cost reduction projects. It was observed that a general awareness about productivity exists at all levels of employees in BHEL, Trichy.

The entire focus on productivity at Trichy is on Productivity Improvement Programme (PIP). The activities are well organised. A number of projects and their financial savings against identified thrust areas are budgeted at the beginning of the year itself and the progress is carefully monitored. This system has proved to be successful and produced the desired results. But this productivity monitoring exercise would be
more meaningful if these measurement systems indicate how the various resources, viz., labour, capital, material, etc., are consumed to produce the goods.

Each department prepares its own productivity plan. Management services coordinate and consolidate and monitor the plan in order to integrate the productivity improvement process with the main planning process of the Company. To meet the targets of various functional and product groups, brain-storming sessions and identification of special projects in the following thrust areas are resorted to:

1. Energy conservation
2. Value engineering
3. Material utilisation
4. Project management
5. Capacity utilisation
6. Systems improvement
7. Awareness generation
8. Indigenisation
9. Maintenance management
10 Computerisation
11. Material handling
12. Economic buying
13. Inventory management
14. Marketing and commercial management
15. Office administration
16. Tax and claim management
17. Packaging, despatch and transportation
18. Human resource development
19. Cycle time reduction
20. Scrap reduction
21. Low cost automation.

Thus, about 15 or 20 thrust areas have been identified under which the productivity projects are taken up. These activities are coordinated by the Productivity Services and Industrial Engineering Department, which is involved towards productivity improvement activities. This has been schematically shown in Figure 4.
Figure 4

Framework of Organisation Support on Productivity

Productivity Improvement Programmes

Productivity Improvement Programs
Suggestion Scheme
Quality Improvement Programs
Quality Circle
Training and Development on Productivity

Productivity Services and I.E.D.
Productivity Services and I.E.D.
Quality Assurance
Quality Control Dept.
Training and Development

Agencies Responsible

Source: I.E.D. Department, BHEL, Trichy.
Although the productivity improvement activities are coordinated by Productivity Services and Industrial Engineering Departments, other departments are also involved in carrying out the projects under various thrust areas. Regarding the structural support existing within BHEL, Trichy, there is a department known as 'Management Services' which is headed by the Deputy General Manager reporting to the General Manager. The Activities currently undertaken by this department organised under different sections are shown in the Annexure 2.

To sum up there has been total realisation of the potential of the productivity improvement activities and the appropriate organisational support for productivity growth existing in the unit are constantly under review by the management.

Productivity consciousness

A systematic effort is taken to create productivity consciousness at all levels. Some of the steps taken are:

1) In order to involve all levels of employees, a Joint Negotiating Committee consisting of the representatives from all participating Unions of BHEL and
Management representatives meet and discuss the subject of productivity and everybody reaffirm his belief on continuous improvement in productivity in his own interest, the interest of the organisation and the country at large.

2) A separate department called the Productivity Improvement Cell has been created for monitoring the process.

3) Key results are identified and the following cells are formed to achieve the targeted productivity improvement:

   a) Value Engineering Cell,
   b) Material Economy Cell,
   c) Indigenous Development Cell,
   d) Scrap Disposal Cell,
   e) Modernisation Cell,
   f) Manpower Planning Cell.

4) For involving the maximum number of employees in the productivity movement, training programmes are organised wherein latest audio visual facilities are made use of.
5) All productivity projects taken up are compiled in the form of a booklet for wide circulation and for better monitoring.

6) Productivity slogans, safety posters are displayed in the shop-floor and in the Colony for disseminating the message.

7) During Republic Day and Independence Day celebrations, token awards and certificates are given to the individuals who have participated in the productivity programme for motivating them.

8) A detailed procedure covering the methodology of awarding efforts, its suggestion scheme, productivity improvement projects, house keeping and safety has been introduced. The maximum award under the suggestion scheme and productivity scheme is Rs.5000.

9) Depending upon the merit of the suggestion, apart from cash awards, employees are awarded certificate either from the Head of the Department, Product Manager or the Executive Director.
Production Planning

BHEL had made elaborate arrangements for planning, execution and implementation of productivity improvement programmes.

Planning

Key result areas are identified and the following groups are formed to achieve productivity improvement in a multipronged way. A separate group 'Productivity Improvement Cell' is formed to coordinate the activities of these groups and to give a regular feedback to the Management about the progress.

Productivity Improvement Cell

The Productivity Improvement Cell assists in planning productivity projects by departments and plan productivity programmes for the whole unit. It also reports the progress to the Head of the Unit/Corporate Productivity Group. It coordinates lead agency role given to the Unit and assists departments in implementing projects. It also aims at implementing a suitable suggestion scheme wherein good number of useful suggestions can be obtained from all sections of employees. It identifies new potential areas of savings and appraises the unit head on the same periodically and
also gives necessary impetus to promotional efforts for spreading productivity concepts amongst the employees. It also helps in organising massive training programmes to cover all the employees.

A massive training programme is organised to cover all the employees through a well-structured scheme to educate the employees on the need for productivity, tools and techniques available to achieve them, etc. Projects voluntarily initiated by various groups are compiled in the booklet for monitoring progress. An integrated system for budgeting, monitoring and evaluating tangible gains of productivity improvement is being developed. Budgeting intangible benefits are likewise being brought out and are being monitored through a monthly management information report.

**Productivity Monitoring**

1. Identified projects are compiled in the form of a booklet.

2. Progress of the projects is monitored by the working groups regularly through interaction with the project leaders.

3. Periodic review meetings are held at department level for assessing the progress.
4. The Chief Executive reviews the progress every month along with the production review.

5. Once in a quarter, Corporate Office calls for detailed review meeting wherein policy guidelines are given.

6. For completed projects, an evaluation sheet has to be filled up by the project leader, checked by the productivity coordinator and verified by Finance.

7. Auditing of the implemented projects is carried out as a routine.

Reward System for Achieving Productivity Targets

The productivity content in each project suggestion will be measured by five indices, viz., \(I_1\), \(I_2\), \(E_1\), \(E_2\) and \(V\) (ideas, effort and vigil) on a 1 to 10 scale each.

- \(I_1\) = Idea ranging from 'missed by others'
- \(I_2\) = Idea ranging from complex to simple
- \(E_1\) = Effort ranging from voluntarily taken to carry out under directives
- \(E_2\) = Effort ranging from 'voluminous/against odds' to routine effort/little effort
- \(V\) = Vigil ranging from 'timely direction missed by others' to 'everybody aware'.
Moderated award

Amount = Award amount (as per table) as per procedure \( x I_1 I_2 + E_1 E_2 + 10 V \) or \( l \)

whichever is less each one of the basic factor IEV i.e., \( I_1, I_2, E_1, E_2 \) or \( 10 V \)

can produce a total rating of 100% independently.

Productivity growth in BHEL

With a view to quantify the growth in productivity, the researcher attempted to measure productivity in BHEL through selective productive ratios and human resource factors. In other words, the research had measured the productivity quantitatively as well as qualitatively. The following selective productivity ratios are used to measure the productivity.
Table 3.1

<table>
<thead>
<tr>
<th>Productivity criteria</th>
<th>Productivity indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total factor productivity</td>
<td>Value added</td>
</tr>
<tr>
<td></td>
<td>Value of (labour + Capital + Material + Energy)</td>
</tr>
<tr>
<td>Manpower productivity</td>
<td>Value added</td>
</tr>
<tr>
<td></td>
<td>Rupees of wages, salary and benefits</td>
</tr>
<tr>
<td>Capital productivity</td>
<td>Value added</td>
</tr>
<tr>
<td></td>
<td>Cost of capital</td>
</tr>
<tr>
<td>Material productivity</td>
<td>Value added</td>
</tr>
<tr>
<td></td>
<td>Cost of material and components consumed</td>
</tr>
<tr>
<td>Energy productivity</td>
<td>Value added</td>
</tr>
<tr>
<td></td>
<td>Cost of energy consumed</td>
</tr>
</tbody>
</table>

Valued added as stated already is measured as follows:

\[ V = S - (V_2) - (V_1) \]
Value added

\( V = \) Value added

\( S = \) Sale value of production

\( V_2 = \) Value of raw material and components consumed

\( V_1 = \) Value of power and fuel consumed.

**Manpower productivity**

Manpower productivity is the ratio of value added to the cost of obtaining the manpower. The cost includes the cost of obtaining and maintaining the human factor in production.

**Capital productivity**

Capital productivity is the ratio between the cost of capital and value added. Capital, for this analysis, refers to the cost of capital.

\[
\text{Cost of capital} = \text{Net fixed asset} \times r_1 + \\
\text{Working capital} \times r_2
\]

\( r_1 = \) minimum rate of return (say 12%)

\( r_2 = \) minimum rate of return (say 18%)

**Material productivity**

Material productivity is the ratio between the cost of raw material components consumed and value
added. Value added per rupee of material consumed is found for measuring the material productivity.

**Energy productivity**

Energy productivity refers to the ratio between the value of power and fuel consumed and value added. In the present day context, energy productivity assumes greater significance.

Using the criteria of value added concept, labour, capital, energy and material productivity had been arrived at.

**Price Level Adjustment**

The output and various inputs are measured in terms of rupee value. These values are required to be adjusted for inflation and price changes. It is, therefore, necessary that all these values are stated in terms of constant value or real rupee value. Constant value has to be referred to a base year. A convenient procedure is to call the year in which the first productivity measurement is made as the base year. Then actual rupee value in subsequent years is converted into their base year equivalent by applying appropriate price deflators. The price indices most representative
of the measurements, are carefully selected. In the present analysis, 1984-85 has been taken as the base year and the index of industrial production in different years obtained from RBI Bulletins has been used for price level adjustment.

**Index numbers used for price level adjustment**

The researcher had taken 1984-85 as the base year and had worked out index numbers of industrial production for the period of study based on the Index number published in RBI Bulletin.

Table 3.2 Table showing Index numbers of Industrial Production

<table>
<thead>
<tr>
<th>Year</th>
<th>Index number (Keeping the index number of 1984-85 = 100)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1984-85</td>
<td>100.00</td>
</tr>
<tr>
<td>1985-86</td>
<td>104.16</td>
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<tr>
<td>1986-87</td>
<td>110.63</td>
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<tr>
<td>1987-88</td>
<td>114.80</td>
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<tr>
<td>1988-89</td>
<td>123.75</td>
</tr>
</tbody>
</table>

Source: RBI Bulletin, August 1987, p 14

The various price deflators and their values used in this analysis are given in the following chart.
### Table 3.3 Value Added
(Base year 1984-85) (Rs. in lakhs)

<table>
<thead>
<tr>
<th>Year</th>
<th>Index No.</th>
<th>Value added</th>
<th>Actuals deflated</th>
</tr>
</thead>
<tbody>
<tr>
<td>1984-85</td>
<td>100.00</td>
<td>12529</td>
<td>12529</td>
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<tr>
<td>1985-86</td>
<td>104.16</td>
<td>13100</td>
<td>12576</td>
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<tr>
<td>1986-87</td>
<td>110.63</td>
<td>14700</td>
<td>13287</td>
</tr>
<tr>
<td>1987-88</td>
<td>114.80</td>
<td>16300</td>
<td>14198</td>
</tr>
<tr>
<td>1988-89</td>
<td>123.75</td>
<td>16500</td>
<td>13333</td>
</tr>
</tbody>
</table>

### Table 3.4 Cost of Labour (Wages, Salary and Benefits)
(Base year 1984-85) (Rs. in lakhs)

<table>
<thead>
<tr>
<th>Year</th>
<th>Index No.</th>
<th>Cost of Wages, Salary and Benefits</th>
<th>Actuals deflated</th>
</tr>
</thead>
<tbody>
<tr>
<td>1984-85</td>
<td>100.00</td>
<td>3964</td>
<td>3964</td>
</tr>
<tr>
<td>1985-86</td>
<td>104.16</td>
<td>4616</td>
<td>4431</td>
</tr>
<tr>
<td>1986-87</td>
<td>110.63</td>
<td>5119</td>
<td>4627</td>
</tr>
<tr>
<td>1987-88</td>
<td>114.80</td>
<td>5448</td>
<td>4745</td>
</tr>
<tr>
<td>1988-89</td>
<td>123.75</td>
<td>6625</td>
<td>5353</td>
</tr>
</tbody>
</table>
### Table 3.5 Cost of Materials
(Base year 1984-85) (Rs. in lakhs)

<table>
<thead>
<tr>
<th>Year</th>
<th>Index No.</th>
<th>Cost of materials</th>
<th>Actuals deflated</th>
</tr>
</thead>
<tbody>
<tr>
<td>1984-85</td>
<td>100.00</td>
<td>29282</td>
<td>29282</td>
</tr>
<tr>
<td>1985-86</td>
<td>104.16</td>
<td>38020</td>
<td>36501</td>
</tr>
<tr>
<td>1986-87</td>
<td>110.63</td>
<td>45938</td>
<td>41523</td>
</tr>
<tr>
<td>1987-88</td>
<td>114.80</td>
<td>49712</td>
<td>43303</td>
</tr>
<tr>
<td>1988-89</td>
<td>123.75</td>
<td>50306</td>
<td>40651</td>
</tr>
</tbody>
</table>

### Table 3.6 Cost of Capital
(Base year 1984-85) (Rs. in lakhs)

<table>
<thead>
<tr>
<th>Year</th>
<th>Index No.</th>
<th>Cost of capital</th>
<th>Actuals deflated</th>
</tr>
</thead>
<tbody>
<tr>
<td>1984-85</td>
<td>100.00</td>
<td>3623</td>
<td>3623</td>
</tr>
<tr>
<td>1985-86</td>
<td>104.16</td>
<td>3874</td>
<td>3719</td>
</tr>
<tr>
<td>1986-87</td>
<td>110.63</td>
<td>4042</td>
<td>3653</td>
</tr>
<tr>
<td>1987-88</td>
<td>114.80</td>
<td>4494</td>
<td>3914</td>
</tr>
<tr>
<td>1988-89</td>
<td>123.75</td>
<td>5082</td>
<td>4106</td>
</tr>
</tbody>
</table>
Note: Cost of energy is kept as such and not deflated due to non-availability of data. The following are other figures used in the calculation of total factor productivity.

Table 3.7 Cost of energy and payment to sub-contractors
(Base year 1984-85) (Rs. in lakhs)

<table>
<thead>
<tr>
<th>Year</th>
<th>Cost of energy</th>
<th>Payment to subcontractors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1984-85</td>
<td>-</td>
<td>1681</td>
</tr>
<tr>
<td>1985-86</td>
<td>-</td>
<td>2120</td>
</tr>
<tr>
<td>1986-87</td>
<td>603</td>
<td>2200</td>
</tr>
<tr>
<td>1987-88</td>
<td>497</td>
<td>1883</td>
</tr>
<tr>
<td>1988-89</td>
<td>486</td>
<td>2995</td>
</tr>
<tr>
<td>------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>12</td>
<td>(10702 x \frac{12}{100})</td>
<td>(10301 x \frac{12}{100})</td>
</tr>
<tr>
<td>18</td>
<td>(8993 x \frac{12}{100})</td>
<td>(8784 x \frac{12}{100})</td>
</tr>
</tbody>
</table>

\[= 1284 + 2339 = 1236 + 2638 = 1147 + 2895 = 1054 + 3440 = 1079 + 4003 = 5082\]

\[= 4494 = 4042 = 3874 = 3623\]
Labour Productivity

Labour productivity in BHEL is measured as a ratio between the cost of obtaining and maintaining the human factor of production and value added. Labour productivity so measured is given in table 3.10 and figure 5.

Table 3.9 Labour productivity ratio
(Rs. in lakhs) (Base year 1984-85)

<table>
<thead>
<tr>
<th>Year</th>
<th>Value added</th>
<th>Cost of labour</th>
<th>L.P.* ratio</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1984-85</td>
<td>12529</td>
<td>3964</td>
<td>3.16</td>
<td>100</td>
</tr>
<tr>
<td>1985-86</td>
<td>12576</td>
<td>4431</td>
<td>2.84</td>
<td>90</td>
</tr>
<tr>
<td>1986-87</td>
<td>13287</td>
<td>4627</td>
<td>2.87</td>
<td>91</td>
</tr>
<tr>
<td>1987-88</td>
<td>14198</td>
<td>4745</td>
<td>2.99</td>
<td>95</td>
</tr>
<tr>
<td>1988-89</td>
<td>13333</td>
<td>5353</td>
<td>2.49</td>
<td>79</td>
</tr>
</tbody>
</table>

*L.P. ratio is calculated by dividing the total value added by the total cost of labour.

The labour productivity ratio has shown a downward trend, the reason being a steady increase in the wages and fringe benefits paid to the workers in the period of study and the increasing cost of recruitment, training etc. The labour productivity ratio measures show how effectively the manpower has been utilised in the organisation.
Labour Productivity Ratio

Value added per Rupee of salary & wages

Year

Figure 5
Capital productivity

The capital productivity ratio is a comparison of the value added to the cost of capital employed in productive efforts. It measures how effectively capital has been utilised. The trend for the period is shown in Table 3.11 and Figure 6.

Table 3.10 Capital productivity ratio
(Rs. in lakhs) (Base year 1984-85)

<table>
<thead>
<tr>
<th>Year</th>
<th>Value added</th>
<th>Cost of capital</th>
<th>C.P. * ratio</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1984-85</td>
<td>12529</td>
<td>3623</td>
<td>3.46</td>
<td>100</td>
</tr>
<tr>
<td>1985-86</td>
<td>12576</td>
<td>3719</td>
<td>3.38</td>
<td>98</td>
</tr>
<tr>
<td>1986-87</td>
<td>13287</td>
<td>3653</td>
<td>3.64</td>
<td>105</td>
</tr>
<tr>
<td>1987-88</td>
<td>14198</td>
<td>3914</td>
<td>3.63</td>
<td>105</td>
</tr>
<tr>
<td>1988-89</td>
<td>13333</td>
<td>4106</td>
<td>3.25</td>
<td>94</td>
</tr>
</tbody>
</table>

*Capital productivity ratio is arrived by dividing the total value added by the total cost of capital.

From the above table, it can be seen that there has been a steady downward trend in the capital productivity ratio indicating the fact that the increase in the cost of capital has been greater than the increase in the value added.
Capital Productivity Ratio

Value added per Rupee of Capital

Year  1984-85  85-86  86-87  87-88  88-89
3.46  3.38  3.64  3.63  3.25

Figure 6
Material productivity

The material productivity ratio is a ratio between the cost of materials used and the value added and indicates the effectiveness in the use of materials. The trend of this ratio for the period of study is given in Table 3.11 and Figure 7.

Table 3.11 Material productivity ratio
(Rs. in lakhs) (Base year 1984-85)

<table>
<thead>
<tr>
<th>Year</th>
<th>Value added</th>
<th>Cost of material</th>
<th>M.P.* ratio</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1984-85</td>
<td>12529</td>
<td>29282</td>
<td>0.428</td>
<td>100</td>
</tr>
<tr>
<td>1985-86</td>
<td>12576</td>
<td>36501</td>
<td>0.345</td>
<td>81</td>
</tr>
<tr>
<td>1986-87</td>
<td>13287</td>
<td>41523</td>
<td>0.320</td>
<td>75</td>
</tr>
<tr>
<td>1987-88</td>
<td>14198</td>
<td>43303</td>
<td>0.328</td>
<td>77</td>
</tr>
<tr>
<td>1988-89</td>
<td>13333</td>
<td>40651</td>
<td>0.328</td>
<td>77</td>
</tr>
</tbody>
</table>

*Material productivity ratio is calculated by dividing the total value added by the total cost of material.

It is found that there has been a steady trend in this ratio during the period 1986-87 to 1988-89 though it is less than the base year 1984-85. This suggests the impact of the hike in the cost of material of all types and its impact on productivity.
Material Productivity Ratio

Value added per Rupee of material cost

0.428
0.345
0.32
0.328
0.328

Year

1984-85  85-86  86-87  87-88  88-89

Figure 7
Energy productivity

Energy productivity ratio shows the ratio between the cost of energy consumed and value added, which is the most important cost in the modern industrial set up. The ratio is worked out for a period of three years only i.e., 1986-87 to 1988-89 since figures for the earlier years are not available.

Table 3.12 Energy productivity ratio (Rs. in lakhs) (Base year 1984-85)

<table>
<thead>
<tr>
<th>Year</th>
<th>Value added</th>
<th>Cost of energy</th>
<th>E.P. ratio*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1986-87</td>
<td>13287</td>
<td>603</td>
<td>22.0</td>
</tr>
<tr>
<td>1987-88</td>
<td>14198</td>
<td>497</td>
<td>28.6</td>
</tr>
<tr>
<td>1988-89</td>
<td>13333</td>
<td>486</td>
<td>27.4</td>
</tr>
</tbody>
</table>

*Energy productivity is calculated by dividing the total value added by the total cost of energy.

The Table 3.12 and Figure 8 indicate a very encouraging position as far as energy productivity is concerned.
Energy Productivity Ratio

Value added per Rupee of energy cost

Year

1986-87  87-88  88-89

22       28.6   27.4

Figure 8
Total factor productivity

The overall factorial productivity which is a measure of the cumulative effects of labour, capital, material and energy resources is worked out by the ratio of the total value added to the cost of labour, material and energy.

The trend of the overall productivity ratio is given in Table 3.13 and Figure 9.

Table 3.13 Total factor productivity ratio
(Rs. in lakhs) (Base year 1984-85)

<table>
<thead>
<tr>
<th>Year</th>
<th>Value added</th>
<th>Total cost of labour, capital, material, energy and payment to contractors</th>
<th>T.F.P.R*</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1984-85</td>
<td>12529</td>
<td>38550</td>
<td>0.325</td>
<td>100</td>
</tr>
<tr>
<td>1985-86</td>
<td>12576</td>
<td>46771</td>
<td>0.269</td>
<td>83</td>
</tr>
<tr>
<td>1986-87</td>
<td>13287</td>
<td>52606</td>
<td>0.253</td>
<td>78</td>
</tr>
<tr>
<td>1987-88</td>
<td>14198</td>
<td>54342</td>
<td>0.261</td>
<td>80</td>
</tr>
<tr>
<td>1988-89</td>
<td>13333</td>
<td>53591</td>
<td>0.249</td>
<td>77</td>
</tr>
</tbody>
</table>

*Total factor productivity ratio is derived by dividing the total value added by the total cost of labour, capital, material and energy.
Total Factor Productivity Ratio

Figure 9
It is clear from the Table 3.13 that there is a decreasing trend from the year 1984-85 to 1988-89 in BHEL, because of non-receipt of orders, though the level of productivity has been only roughly 3/4 of the base year.

The production trend for the past five year 1984-85 to 1988-89 and the consolidated table of productivity in percentage for the past five years in BHEL, Trichy for the years 1984-85 to 1988-89 are shown in the Annexure 3, 4 and 5 respectively.

A positive climate for productivity improvement exists at BHEL, Trichy. There has been a total realisation of the potential of the productivity improvement activities and the appropriate organisational support for productivity growth existing in BHEL are constantly under review by the management. It was observed that a general awareness about productivity exists at all levels of employees in BHEL, Trichy. An effective suggestion scheme is on operation at Trichy which embraces both productivity improvement projects and cost reduction projects.