OCCASION

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

DISCLAIMER

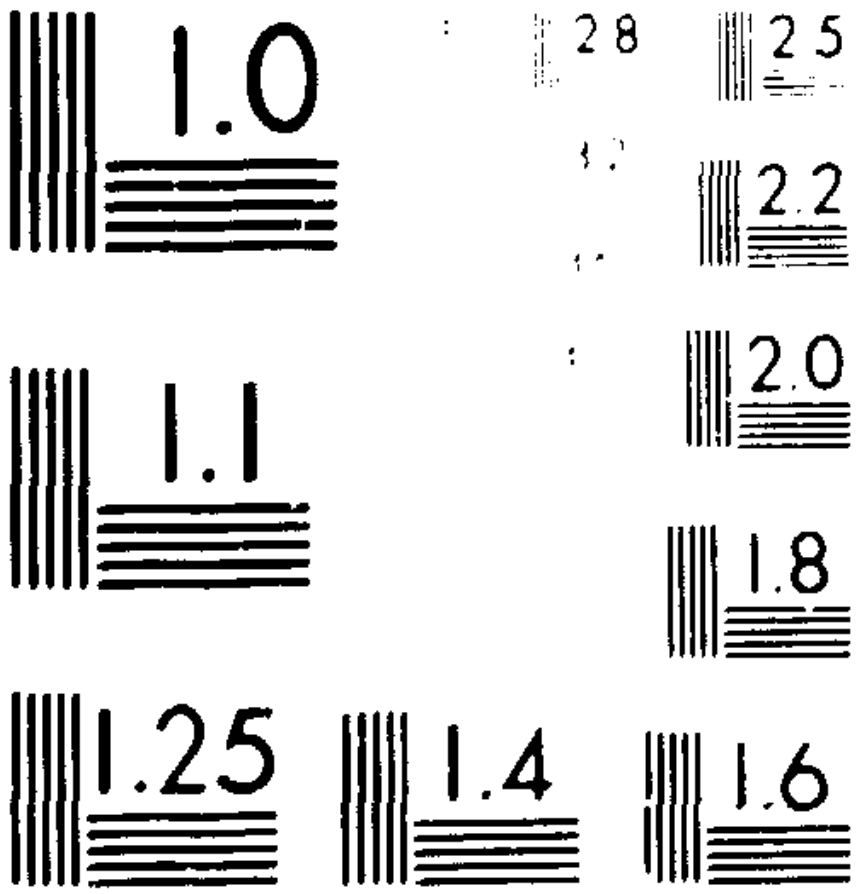
FAIR USE POLICY

CONTACT

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

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

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



11627

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

Distr.:
LIMITED

UNIDO/IO.501
26 April 1982

ENGLISH

SOME FACTORS AFFECTING INDUSTRIAL CAPACITY UTILISATION IN DEVELOPING COUNTRIES*

- OUTLINE FOR REVIEW AND ACTION ON A RELEGATED PHENOMENON -

by

E. Zorrilla-Vazquez

Factory Establishment and Management Section
Division of Industrial Operations

* This document has been reproduced without formal editing.

CONTENTS

I. INTRODUCTION

1. Capacity Utilisation (CU) of factory, plant and equipment concerns public and private enterprises in the industrial sector. Its importance is directly related to social and economic productivity which in turn implies, among other elements, the highest possible use of production facilities within a framework of efficient utilisation of scarce resources.

2. Difficult as it is to deal with capacity utilisation conceptually, as well as to define and measure industrial capacity, it is a well known fact that substantial under-utilisation exists - indeed voluntary and involuntary - within the industrial development context of developing countries.

3. Industrial economic practice today bears out that insufficient or inefficient use of installed capacity is becoming one of the major problems of developing countries, hindering their growth and often creating a tendency towards economic stagnation in real terms.

4. The Lima and New Delhi Declarations and Plans of Action 1/ come to bear directly on the subject by virtue of the concensus reached regarding certain tendencies and needs in the developing world, namely:

4.1. the awareness of the under-utilisation of resources and the increasing costs of industrial inputs.

4.2. the existence of obstacles of an internal and structural nature which are inhibiting expansion.

4.3. the need for progressive mastery of different production and management techniques to facilitate the absorption of modern technologies.

1/ Lima Declaration and Plan of Action on Industrial Development and Cooperation March 1975, UNIDO.
New Delhi Declaration and Plan of Action on Industrialisation of Developing Countries and International Cooperation for their Industrial Development, February 1980.

4.4. the necessity for promoting exports of finished and semi-finished manufactured products.

4.5. the need for increased intra-regional industrial complementarity taking into account scale economies and specialisation based on resource endowment and market volume of each country.

4.6. the requirement for training of professional management staff to achieve fullest possible use of available resources.

These considerations underlie in a direct or indirect manner CU questions.

5. The dynamic nature of the industrial development process itself, and the technical progress to satisfy socio-economic needs and wants in changing societies induce CU problems demanding ex-post diagnosis and evaluation in order to arrive at a subsequent corrective measure proposals regarding fait-accompli industrial investments. Ex-ante investment decision evaluations ranging from matters concerning market magnitudes, economies of scale through and into design, process or manufacturing engineering, the conditions of or for the transfer of technology, training, and very especially the need for building up the management cadres to articulate manpower, equipment, materials and financial resources, etc., need to be strengthened.

6. At the least, CU reflects the quality, breadth, and depth of the ongoing industrial development process, particularly with respect to the efficiency of scarce financial resource allocations, cost-price structures, market dynamics, level of and potential employment, level of and quality of management skills, and to a substantial degree, industrial planning strategies, and economic and financial policy and instrument application. The CU phenomenon may mirror, as

well, the nature of attitudes existant between the public and private sectors in thepolicy areas of industrial investment, foreign exchange management, state of manufacture export promotion, and fiscal policy pertaining to specific industrial objectives. Top management effectiveness might reflect as well the extent to which canonry and favoritisms are prevalent.

7. CU, whether related to sector, branch, enterprise, or factory, is affected by numerous variaties of an internal end external nature, some of which are junctural and others structural; with the former often converting to the latter in the medium and long run. As the frontiers of the system subjected to analysis are extended, the variables increase rapidly, and their "controllable" or "uncontrollable" character increases as well. In each case, however, system bounderies for analysis should be defined to avoid diagnostic indigestion.

8. On the premise that it is more important for the developing countries to find out why scarce invested capital is underutilised than to determine the exact degree of underutilisation (although not to the exclusion of definitions, measurements and standards), this paper presents a brief analysis of the problem and attempts to explore core areas susceptible to UNIDO's technical assistance and available services to assist industrial enterprises in developing countries to deal with inadequate industrial capacity utilisation.

II. SOME WORKING DEFINITIONS

9. Technical or engineering capacity at the factory or plant level is commonly referred to as theoretical and nominal (rated). At the branch and sectorial level the same applies as a gross summation of the production components' capabilities. However, the usual question arises of first determining homogenous assessment parameters, and uniform measurement techniques and nomenclature: a difficult and often hazardous

task when industry types and product-mixes are intermingled.

10. Factory, plant and /or equipment specifications for CU analysis often refer to a range of productive capacity: overall, departmental, by item of equipment, unit or manufacturing operation, by process, etc. Dimensional specifications in manufacturing facilities relate more to the type and size of work to be done leading to product manufacturing analysis by virtue of which machine output capability may be determined.

11. Nominal capacity usually refers to maximum output over a specific time without interruptions. Theoretical capacity, especially in the process industries, is often greater than nominal and its attainment will be some function of the degree of overdesign and/or operational practices prevailing in the particular industry.

12. Economic capacity is usually related to resource allocation either in the sense of economic welfare or in relation to marginal efficiency of capital criteria. A subconcept of the former is "business" capacity which often refers to that output at wich revenue is maximised or associated with effectiveness criteria such as the maximisation of financial returns. The cost-capacity concept, closely related to economic capacity is usually defined as the rate of output produced at the minimum average (long run) total cost per unit of output.

13. Economic and related capacity levels are usually lower than physical (engineering) capacity and therefore it is important to define enterprise objectives to design realistic plans and to harness supportive managerial policies and skills. The rate of economic capacity is susceptible to price and cost variations reflecting pricing, demand, and factor supply variations and imperfections; whereas physical capacity, given certain engineering

and input specifications, is primarily affected by factory or plant work and operating skills and management techniques and the capability to employ them effectively.

14. For practical purposes capacity can be interpreted as it is generally accepted, i.e., the estimated maximum sustained level of production during specific time parameters for which process and/or equipment is rated, or for which machine capability has been determined, allowing for downtime for maintenance and other foreseeable or estimated interruptions of production.

15. It is noted that sheer volume output related to stream or time parameters will not necessarily reflect physical input-output yields on the production line or work stations, be it process or unit operations, and will affect physical capacity coefficients in the material flow and balances: aspects which are related to quality, process control and machine capability factors intimately related to CU.

16. On the other hand, if one allows an increasing number of imponderables and an excess of qualitative elements to enter the CU problem, it may become an increasingly unwieldy, subjective question. From the standpoint of this presentation, it is surmised that recognizably and reliable engineering-economic and cost criteria exist to improve output potential at the factory-plant and equipment levels as per defined productive system or subsystem with some degree of confidence.

III. THE PLANT SIZING PROBLEM

17. The complex question of plant sizing has received increasing attention through the use of simulation, optimisation and probability

models. During factory and plant feasibility evaluation and/or basic engineering stages, over-scaled capacity frequently depends on the magnitud of minimum-scale standards and practices and specific process and equipment indivisibilities. This is particularly the case for continuous process operations and, to a lesser degree, for batch mode production.

18. Engineering economy criteria are used to tie the technological and economic factors together by means of incremental cost-revenue analyses. For practical purposes, examination of this question implies evaluation of alternatives, based on achieving a maximum acceptable return on investment or social surplus, taking into account current and projected capital market interest rates or pre-determined social marginal rates of interest within the particular context of socio-economic, national and industrial policies. In accordance with these objectives, well-known qualitative and quantitative cost-benefit analyses contemplate social productivity factors for socially-oriented industrial investment where deemed necessary or convenient. For example:

a) The natural limit to plant size in a growth market may be determined by comparing the present worth of revenue from incremental capacity with that of the increased manufacturing costs incurred in operating the larger scale factory or plant. External opportunity costs derived from foregone financial allocations to other industrial branches or sectors, or alternative projects, may be incorporated into analysis depending on national policy criteria referred to socio-economic priorities and internal and external capital availability.

b) Practicality may point to decision criteria based on savings achieved in manufacturing costs by not investing in the larger scale plant, and accruable to return on investment or social surplus estimated for the smaller scale option. The prospective income of foregone sales would be a counterbalancing factor to take into this account.

19. Plant sizing often breaks down to optimum size selections of specific equipment, specially in batch and job-lot processes. However, standard specifications or high capacity ranges thereof are commonly due to technology dependency, generating in-built diseconomies due to over-sizing. Scaling ahead of demand is more related to specific dynamics of growth industries as the consequence of policy or managerial judgment.

20. The batch, job-lot, and in some cases repetitive production facilities lend themselves to sizing for different work-day and various shift operations, facilitating financial options and varying employment effects, under given market conditions.

21. Sizing factory or plant facilities involves diverse indicative key factors, classified as follows, in brief:

a) MARKET
- Real
- Potential
- Preferences and alternates
- Income distribution patterns
- Price elasticities

b) DISTRIBUTION
- Competition
- Presentation/Packaging
- Pricing
- Location
- Modes of transport

c) INDUSTRIAL STRUCTURE
- Monopolistic-Oligopolistic
- Cartels
- Informal Agreements
- Competitive

d) FINANCING
- Budgeting
- Scheduling
- Foreign Exchange
- Discount Rate
- Capitalisation

e) INDUSTRIAL POLICY
- Tariff/non-tariff barriers
- Incentives 2/
- In-plant MVA regulations
- Price-ceilings
- Exchange controls
- Trade concessions

f) HUMAN FACTORS
- Skilled labour
- Specialised skills
- Managerial skills
- Scale of values
- Training

g) TECHNOLOGY
- Design
- Inquiries/tendering
- Trade practices
- Scale economics
- Negotiations
- Assistance agreements
- Guarantees (Warrants)

22. In-depth market behaviour, technological alternatives assessment, and cost revenue analyses can hardly be substituted solely by intuition and good judgement in modern management. Basic, reliable and suitably processed technological information, as well as conscientious scrutiny of tenders and details of the nature of technology transfer involved are the keystones of adequate sizing.

IV. SOME CAUSES OF CU DEFICIENCIES

23. The following is an explanatory list of underlying causes of

---

2/ MVA: manufacturing value added.

inadequate CU. They have been divided into macro and micro factors, depending whether these emanate from constraints of an economic or social nature, political, institutional, legal, technological, physical, environmental, organizational in the industrialisation process. Furthermore, each factory or plant has unique requirements, operating characteristics, varying control needs, etc., which need to be taken into account. The standard application of analysis, programmes and corrective measures of universal value is not practical.

23.1. Macrofactors

1) Dynamic nature of industrial development processes under socio-economic needs and demands.
2) Transition from commercial to industrial and/or agricultural to industrial models or structures.
3) Policy regarding new factory or increased production entry into existing supply structure.
4) Absence or near absence of industrial planning and/or sectorial programming and/or branch objectives.
5) Policies towards (national) autarchic, non-dependent industrial development, and degree of horizontal and vertical integration.
6) Risk and seed capital availability.
7) Labour mobility and level of skills.
8) Capital and intermediate goods: import policies
9) Domestic industrial investment policies, promotion and stimuli.
10) Supply bottlenecks: infrastructure and intermediate inputs.
11) Indivisibilities of plant and equipment and over-

sophistication or over-design.

12) Aggregate demand structure and growth.

13) Domestic price policy and control to support export policies and stimuli of sales abroad.

14) Domestic regulations regarding in-plant value-added and degree of in-plant integration.

15) State of credit, distribution and marketing mechanisms.

16) Level of expertise of personnel in developmental institutions and/or governmental office involved.

17) Policies and regulations regarding transfer of technology and contractual agreement monitoring.

18) Export promotion and assistance infrastructure.

19) Internal profit-levels vis-a-vis increased capacity utilisation.

23.2. Microfactors

1) Reliability of market surveys.

2) Reliability of raw material assessment.

3) Process and/or equipment selection.

4) Utilities' availability.

5) Degree of lead of capacity design ahead of demand.

6) Terms of reference for engineering design.

7) Material and energy balances.

8) Plant layout and materials handling.

9) Work design and line-balancing.

10) Scrutiny and evaluation of proposals and bids.

11) Negotiation and formalisation of technology.

12) Capitalisation and funding policies: specially working capital estimates.

13) Plant functional organization and communications system.

14) Pre-start training for workers and technicians.
15) Start-up tests, procedures, and certification.
16) Work methods, measurement and standards.
17) Production planning and control.
18) Process and manufacturing engineering monitoring.
19) Financial and accounting management.
20) Effectiveness of plant and maintenance engineering functions.
21) Effectiveness of industrial relations functions: work stoppages, absenteeism, worker motivation.
22) Wage incentives and on-the-job training programmes.
23) Quality, price and timeliness of supply of specific labour, raw materials and components.
24) Energy stoppages and scarcities.
25) Level of strategic and operative management skills: purchasing, inventories, production, sales, markets, finance and cost accounting.
26) Objectives and content of supervisory level technical training in intermediate educational centres.
27) Objectives and content of management and industrial engineering training in higher level education.
28) State and use of general industrial and manufacturing consultancy services.

V. ACTION ORIENTED PROGRAMMES FOR IMPROVING CU.

24. It is well to ponder if the CU problem is indeed an inevitable result of industrialisation processes and policies or is it more a question of project design, implementation, administration, and operations management. In the final analysis, it appears to be influenced by both; however, it is a fact that CU can be improved by effective management. In the light of the Second and Third

General Conferences of UNIDO it appears that the topic should pervade the framework of national scope policies and measures, as well as various facets of industrial relations and cooperation between developing countries.

25. Observation of the phenomenon indicates that systematic enquiry and analysis at the plant and branch levels through technical assistance projects and local institutions can become an effective instrument to identify and produce action-oriented programmes for dealing with the microfactors involved which are often the major impeding factor. By the same token, analysis at the institutional and policy-making levels added to meetings for interchange of information and experience as well as workshops for case study and analysis will provide further insights into the design of solution-oriented policies and instruments.

26. A renewed consultation effort for the interchange of ideas and information and for drawing up guidelines for corrective or preventive action during the next five years - is necessary if not to eliminate, to abate the CU problem. Revitalizing the issue will uncover the depth and magnitudeof the question at hand, and help to determine UNIDO's role.

27. Multilateral, non-governmental and other ways and means have to be harnessed to catalyze this process and to underpin the actions for the design of specific measures complementary to short-term cause-related technical assistance. For this purpose the following are specifically suggested:

27.1. Expert seminars - to review the problematic and its magnitude.
- terminology and nomenclature

- nature and forms of the problem
- extent and degree of the problem
- CU and its relation to the industrial development processes
- CU in the framework of the target for the developing countries' share of world output
- the role of government and non-governmental organizations

27.2. Formulation of plant level factorial analysis checklists, extending and detailing the sample information (please see Annex I) in the following areas:

- Process mode
- Batch mode
- Job-lot mode
- Line production in several globally relevant prototypes from each of the following industries:
  a) Agro-Based
  b) Engineering
  c) Metallurgical
  d) Chemical

27.3. Programmed work-shops, dealing with CU and related plant-level management functional topics, such as:

- Process/machine selection, capability and loading
- Materials flow and handling
- Production planning and control/monitoring
- Maintenance: preventive and corrective
- Quality control at the work place and process levels

- Plant engineering services
- Negotiation and provisions for technical assistance and supplies and follow-up.

28. The activities implied in 27.2 and 27.3 are envisaged as parallel endeavours: and together with the activities referred in 27.1, may open renewed avenues for increased awareness and, indeed, concentrated efforts to improve capacity utilisation of scarce and expensive investment resources in developing countries.

FACTOR ANALYSIS FOR ONGOING PRODUCTIVE FACILITIES*

A series of factors may be analysed and/or calculated to afford some insight into ongoing productive facilities. Performance levels can be gauged to similar plants of which there is available knowledge, to managerial practical know-how, to standard operating procedures of technology suppliers: to specific expertise.

1. Machinery and facilities

   1.1. Production equipment utilisation rates
   1.2. Maintenance cost rates
   1.3. Machine capacity growth rate
   1.4. Machine breakdown rate
   1.5. Manufacturing occupancy as percent of available feet
   1.6. Processing time related to total production cycle time
   1.7. Inventory turnover rate
   1.8. Machine and labour idle time

2. Materials and Inventories

   2.1. Production throughput rate
   2.2. Materials in process, related to throughput
   2.3. Waste recovery rate
   2.4. Ratio of production and inventory control employees to total plant employment
   2.5. Percentage of items for which no receipts or distribution was made
   2.6. Scheduled versus actual levels of inventory for raw materials, work in progress, and finished goods.

3. Manpower

   3.1. Productivity per man hour
   3.2. Number of employees

---

* The following is not presumed to be a comprehensive list: the parameters vary markedly from country to country and among factory-plants, nevertheless these are considered indicative.

3.3. Man hours on daywork, incentives, standards, etc.

3.4. Employee turnover rate

3.5. Employee attendance and punctuality

3.6. Accident frequency and severity

3.7. Work stoppages

3.8. Indirect labour distribution

4. Energy

4.1. Utility consumption rates

4.2. Electric power factor

4.3. Load versus consumption rates

4.4. Stand-by supplies and prevision

4.5. Energy savings scrutiny

5. Quality

5.1 Rejects: no. and rate

5.2. Reworks: no. and rate

5.3. Returns: no. and rate

5.4. Scrap totals and percentage

6. Materials Handling

6.1. Ratio of total moves to total number of operations

6.2. Percentage of usable cubic footage usefully occupied

6.3. Percentage of available time that material handling equipment is used

6.4. Percentage of floor space occupied.

7. Maintenance

7.1. Sq. m. of manufacturing area per maintenance employee

7.2. H.P. of connected electric load per maintenance worker and/or 1000 sq. m. of manufacturing area

7.3. Crew weeks of current backlog

7.4. Percentage of operating time lost in downtime owing to maintenance reasons

7.5. Percentage of time that maintenance force is gainfully employed

8. Purchasing

8.1. Percentage of rejects in goods received

8.2. Percentage of shortages in scheduled production material

8.3. Schedule requirements versus on-line delivery

8.4. Iventory versus production

8.5. Average lead time

8.6. Vendor's performance against promised time and quality

8.7. Sub-contractor performance against time, quality and cost.

———— o ————