A CRITIQUE OF THE MANPOWER PLANNING APPROACH : AN ANALYSIS OF ENGINEERING MANPOWER PROJECTIONS IN INDIA

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by
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Certified that this dissertation entitled "A Critique of the Manpower Planning Approach: An Analysis of Engineering Manpower Projections in India" submitted by Mr. Varghese N.V. in fulfilment of eight credits out of the total requirements of twentyfour credits for the Degree of Master of Philosophy of this University is a bonafide work to the best of my knowledge. It is certified that the same has not been previously submitted for any other degree of this or any other University.

This dissertation may be placed before the examiners for evaluation.

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CONTENTS

Page(s)

ACKNOWLEDGEMENT

CHAPTER-I

INTRODUCTION 1-10

I.1 - Need for a Wider Meaning of Manpower Planning
I.2 - Categories of Manpower Projections
I.3 - A Preview

CHAPTER-II

THE DIMENSIONS OF MANPOWER PLANNING 11-28

II.1 - Definitions
II.2 - The Static and the Dynamic Elements of Manpower Planning
II.3 - Classical View of Labour Market
II.4 - H.Q.M.Planning

CHAPTER-III

PROBLEMS AND DILEMMAS FOR DEVELOPING ECONOMIES 29-45

III.1 - Manpower Problems in the Development Process
III.2 - Some Dilemmas in H.Q.M.Planning

CHAPTER-IV

PROJECTIONS ON ENGINEERING MANPOWER IN INDIA 44-68

IV.1 - The Necessity of Projections
IV.2 - Classifications of Projections
IV.3 - Indian Projections - A Review

CHAPTER-V

THE CONFLICTING FACTS IN INDIAN PROJECTIONS 69-81

V.1 - The Problem of Non-comparability and the Discrepancy
V.2 - The Projections Vs Reality

Page(s)

CHAPTER-VI

SUMMARY AND CONCLUSIONS 82-90

VI.1 - The Emerging Concept of Manpower Planning for Developing Economies

VI.2 - The Purpose and Limitations of Manpower Studies in India

VI.3 - Some Suggestions on Further Study

APPENDIX - A

TABLES 91-108

APPENDIX - B

TABLES 109-116

BIBLIOGRAPHY 117-121

CHAPTER - I

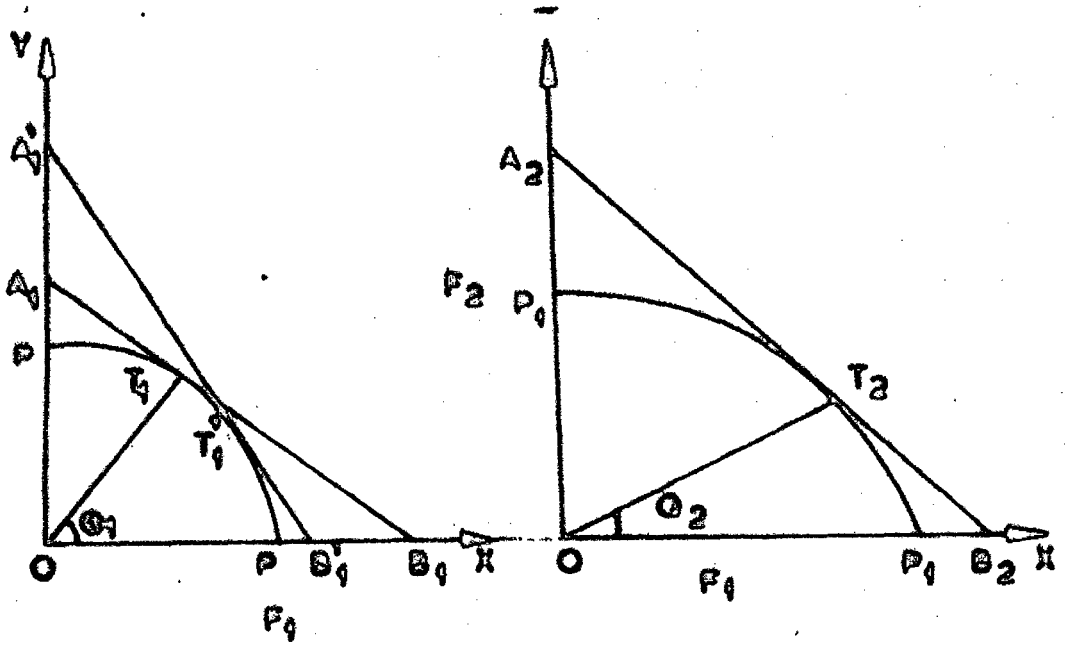
I N T R O D U C T I O N

I.1 Need for a Wider Meaning of Manpower Planning

Manpower is a critical resource in any economy. Its development and proper utilisation becomes one of the important policy objectives of economic planning itself. Very often, manpower planning process is carried on the 'static' framework, where technology is assumed to be given. Moreover, it assumes the ratios of inputs remain fixed. This implies unchanging relative prices.

In technical terms, manpower planning in the 'Static' sense, chooses not only a particular production possibility curve but also a particular point on it. The planning process becomes less flexible whenever it assumes a particular production possibility curve. It becomes still more rigid when it assumes a particular point on it. In Otherwords, manpower planning within the reach of a single point assumes too much fixity which need not necessarily be true in the real world situations.

Let us examine this with the help of a conventional diagram.



These two figures represent conventional production possibility curves (PPC), PP and P_1P_1. A_1B_1 and $A_1'B_1'$ show different relative prices on the same PPC. In the 'static' sense manpower planning assumes a particular point, say T_1, on a particular PPC, say PP and this is applied at a global level for the economy to make projections. When we fix a point on a PPC, relative prices are not allowed to change. More precisely $L\theta$ is assumed to be the same under all circumstances. But in real situations, the production possibilities in the economy need not be concentrated on the single point, say T_1, that we have already chosen. Any change in the relative prices makes different point on the PPC. Within the given technology, this may be possible. In otherwords, even within the given technology, if relative prices are not constant it is possible to move from one point to another on the same PPC, say from T_1 to T_1'. Therefore, the contention is that

in the first stage of improvement in the manpower planning process a movement along the PPC should be allowed.

A movement along the same PPC assumes that technology remains the same. Therefore, the next stage is to allow a shift from one PPC to another, say from PP to $P_1 P_1$. This may not be possible within the existing technological framework. In the planning process we should try to evolve a new strategy so as to facilitate this shift. This leads to the planning for a different technology - an appropriate technology. Such a technology need not necessarily be existent in under-developed countries. Therefore, the planners have to either design for a new technology or reformulate the existing one. Thus, in the second stage of improvement in the manpower planning process, it should be allowed to shift from one PPC to another, say from PP to $P_1 P_1$, as shown in the diagram.

In its still advanced level, manpower planning has to take into account various other factors also. Generally, manpower planning is carried on the basis of plan targets; i.e. manpower planning is very often used as an instrument to reach the planned output target. Here the objective of manpower planning is for an increment of GNP and therefore, this can be termed as manpower planning for target GNP (MPGNP). P Manpower is not like other physical inputs. Here the output need not necessarily be quantifiable nor homogeneous. We cannot assume a high degree of quality control especially

in the case of High Quality Manpower (HQM). In this case the objectives of manpower planning cannot be restricted to the increment of GNP alone. The objectives are a wider concept - a target vector of social objectives which includes GNP also. This can be termed as Manpower Planning for a target Vector of Social Objectives (MPVSO). Since it is a wider concept than GNP, GNP is not a reliable surrogate of it. In otherwords, manpower planning at this stage faces a dilemma regarding MPGNP Vs a wider vector MPVSO. Therefore, our objective in this thesis would be to widen the existing concept of manpower planning as far as practicable along the lines indicated above.

I.2 Categories of Manpower Projections

The term manpower denotes selected categories of personnel who require several years of education or training. Planning of manpower includes the development, maintenance and the optimum utilisation of labour force. Development of manpower is the process of acquiring skills, maintenance is the process of preservation of the existing skills and utilisation is the process of matching the needs of the economy and the supply of personnel depending upon the level of economic development.

Manpower planning, in general, consists of three processes:

(a) projecting demand and supply;

(b) integrating manpower planning with economic planning, and

(c) proper employment of the produced manpower.

These three processes are not distinct and separate, but interlinked. Projections of manpower automatically takes into account the other two aspects. Therefore, in our further discussions we give priority to projections, though the other two aspects will be discussed side by side.

A distinction between projection and forecasting is in order at this stage.[1] A projector acts within the framework provided by the planning authorities. His model is based on a number of assumptions and the past trend. His success depends on the number of variables he accounted for and on the validity of the assumptions he made. His projections are successful to the extent that the economic planning process and thereby the framework provided them are valid. Therefore, his statements will be conditional to this extent. In the case of a forecaster, he has the institutional freedom to choose any framework and he can make unconditional statements. Since Indian manpower planning process is carried on the projection lines, in our discussions we use the concept of projections and not forecasting. However, in the theoretical discussions, we argue for a change in this attitude.

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1. Magnum (Garth) and Nemore (Arnold): "Nature and Functions of Manpower Projections." Manpower Journal, October-December 1967, page 77.

Projections are usually carried on at micro and macro levels. At micro-level, firms make their manpower demand projections where as at the macro-level, planning authorities make projections for demand and supply of manpower. Firms consider supply as given and therefore, no projections of supply are made. Very often firm-level projections are for the promotion possibilities of the already employed labour-force. Therefore, these projections have very little to do with the unemployment situations whereas macro-level projections directly affect the unemployed labour-force. Moreover, macro-level projections incorporate the demands of firms, at one stage or the other. Therefore, the scope of this study is limited to macro-level projections.

A projection has three aspects - demand, supply and a balance between the two. The third aspect is the resultant of the first two. Again, demand and supply projections are inter-related. Supply projections depend on the requirements of the economy and these requirements are the projected demand. But for practical purpose, these may be discussed separately.

Manpower demand at any particular point of time represents the requirements of skill mix against certain specific levels of technology and productivity. Technology and productivity are important because the development of a particular technology affects the structure of demand and the quantity demanded of a particular manpower category.

Therefore, it may not be correct to assume fixed technology or fixed relationship between technology and manpower, which is very often done in our planning process. Moreover, there is substitution possibilities between different factors which affect the demand for manpower. Generally there are three kinds of substitution possibilities:
(a) between labour and capital, (b) between occupations, and (c) between certificates and experience. As far as engineering manpower is concerned the last point is very important. Mostly, demand projections are based on the educational qualifications like degree and diploma whereas employment is very often experience based. Though the earlier projections did not give due emphasis to this aspect the later projections considered it and termed them as 'practicals.'

The second aspect is the supply projections. It is the projections for the development of training facilities so as to facilitate the availability of projected demand at the proper time. The main source of supply is the educational institutions. Therefore, planning for manpower supply indirectly implies planning for educational institutions.

To sum up, demand and supply projections are two sides of the same coin. Demand projections directly aim at the achievement of the planned output targets whereas supply projections prepares the ground work for it by making available the trained manpower at the proper time.

The rest of this chapter gives the plan of different chapters in the thesis.

I.3 A Preview

Chapter II presents the dimensions of manpower planning. It starts with different definitions of manpower planning and a discussion on them. It is followed by a discussion on the 'static' and dynamic aspects of manpower planning where we emphasise the need for a search for an appropriate technology. Then the classical view of labour market and its relevance to manpower is considered. In the last section of the same chapter we concentrate on the High Quality Manpower (HQM) planning with special reference to engineers.

Chapter III is devoted to discuss the problems and dilemmas for developing economies. Followed by a discussion on the problems in the development process in its manpower aspects, we consider four dilemmas - the dilemma of GNP Vs other elements of the 'target Vector,' the dilemma of point of time Vs the period of time, the dilemma regarding over production and finally the dilemma regarding expectations. The main theme running through the discussions is that manpower planning should be based on a wider concept - a target vector of social objectives - and not on GNP alone. Since no reliable surrogate is avialable it is difficult to get optimal solutions. Therefore, very often manpower planners are forced to resort to sub-optimal solutions. These solutions are to be evaluated against the

time element involved and this time element is important in questions regarding the capacity and capability of the system.

Chapter IV is on projections on Engineering Manpower in India. Here we come from the theoretical plan to the practice of engineering manpower projections. The first part of this chapter deals with the necessity of projections. Then we tried to classify projections depending on its purpose.. We classified projections into three (a) market based demand projections, (b) plan based market projections and (c) need based social demand projections. The last part is devoted to a review of Indian projections on engineering manpower. Projections are broadly categorised into global and sectoral. Within this broad category, each particular projection is discussed separately depending on the basis they used. We have tried to cover all important projections in this field.

Chapter V presents the conflicting facts in Indian projections. First we discuss the discrepancies regarding various projections. Within the comparable projections, it is obvious that projections by different authorities for the same period varied. The last part deals with the projections and reality. Here we considered the fact that though we started projection very early, unemployment still remains as an unsolved problem.

Chapter VI gives the summary and conclusions. Here we summarise the theoretical discussions and put forward the emerging concept of manpower planning in developing economies. In the succeeding section we tried to see the difects of engineering manpower projections. We end with some suggestions on further studies.

CHAPTER - II

THE DIMENSIONS OF MANPOWER PLANNING

II.1 Definitions

If we wish to define manpower planning, then we find, we can take positions anywhere between two extremes. At one end will be what may be called the deterministic position.

"Manpower planning is the integration of manpower policies and practices and procedures so as to achieve the right numbers of right people in the right jobs at the right time."[1]

At the other end will be the pragmatist position yielding only a working definition of manpower planning as: "the process of developing and determining objective policies and programmes that will develop utilise and distribute manpower so as to achieve economic and other goals. It includes developing the necessary organisations and institutions required to execute manpower programmes."[2]

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1. Lynch J.James; Making Manpower Effective, Part I, page-12.
2. Government of India, Ministry of Home Affairs - "A Manpower Programme for Economic Development" 1960, quoted in Batra V.P., Economy and Human Resources, p.3, 1978.

The first definition brings to light the main features of manpower planning. But it is too rigid, technical and mechanical. It gives us the feeling that manpower planning is like deliberations on a chess problem, attempting at precise and unique solutions.

The second definition is obviously less rigid, more realistic and more extensive. While it is certainly more flexible, it is also somewhat vague. It emphasises the two aspects of manpower planning;

(a) making blue prints for the development and the utilisation of human resources in the best possible way: this is the traditional planning aspect; and

(b) the institutional process of the development and utilisation of human resources itself: this is the traditional implementation or execution aspect.

Manpower planning is here defined as a whole, combining both these aspects in an interacting feed-back system. Particularly, it is difficult to fasten the responsibility of precise qualifications on the manpower planner, if we use this definition, which the first definition would insist upon. In our study we would like to take a position somewhere between the two extremes while we opt for a holistic view, we shall try to use some qualifications, at the same time emphasising their usefulness and limitations in a given context.

Manpower planning cannot be considered in isolation. It is only a part - an integral part - of our national

planning goals. In other words, manpower planning cannot be divorced from other economic and non-economic policy formulations. This inter-relationship is very important because planning helps the government to determine policies and policies adopted by the government are essential factors of planning.[3] Therefore, the central objective of manpower planning is to construct a strategy of human resource development which is consistent with a country's broader aims of social and economic development.

To begin with, the projection of these objectives creates the problem of choice at least on two dimensions. In the first place, some objectives can be pursued only at the expense of others. Secondly, the objectives have to be stated for a time horizon which has to be more or less arbitrarily chosen. If these objectives are not in line with other policy formulations, then we may be aiming at a wrongmix or producing the rightmen at the wrong time.

The objectives are very important in evaluating our planning. But only very few organisations make their objectives explicit. And in some cases the pattern of objectives can be seen only as a hierarchy which is not stable or lacking in perspective overtime. In both these cases evaluation becomes very difficult.

The projections will form an important aspect of manpower planning. There can be and in two senses - as

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3. Smith, A.R.; An Introduction to Manpower Research in Manpower Research, N.A.B.Wilson (Ed.), 1967

positive projections or as normative projections. Positive projections would show 'what will happen' in the future and normative 'what ought to happen.' The distinction is very basic in the planning process because the latter is the result of a deliberate and conscious value judgement exercised by the planning authrity while the former is the expected result of an uninterfered growth of the economy. Positive projections are merely an expected matter of fact and here the success depends on the techniques employed rather than on the planning process. In the normative projections first we plan for future situation and then try to achieve the planned objectives. Though these aspects will be discussed in detail in the succeeding chapters, it is to be clear at this stage that in the planning process we are concerned about the normative projections.

In projections, the final demand for different categories of manpower for particular occupations is expressed in terms of educational qualifications such as degree, diploma etc. Here, the underlying assumption is that education is the criterion for job selection. The validity of this assumption itself is often questioned. According to George Skorov "empirical studies reveal that in no country is there a rigid relationship between occupations and the levels of types of education."[4] This challenges the validity

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4. Georgi Skorov; Highlights of the Symposium from Manpower Aspects of Educational Planning; UNESCO, International Institute of Educational Planning, 1967.

of education-based manpower planning and manpower-based educational planning. But it is to be remembered that, it questions only the rigid relationship and not the relationship as such. Moreover the positive association of education with employment is likely to be higher in the case of high level manpower.

II.2 The 'Static' and the 'Dynamic'[5] Elements of Manpower Planning Fixed Vs Variable Technology.

Manpower is a critical resource in any economy. For a developing economy, it assumes even greater importance because:

(a) if a part of the manpower remains unused on account of structural imbalances of resources then the economy must find a way through the adoption of appropriate technology to ending this mis-match, and

(b) if the structure of skill formation is inadequate for matching the available manpower through appropriate technology to other resources then again manpower planning becomes a crucial instrument for economic planning itself.

Let us now proceed to examine the two aspects of manpower planning referred to above. Manpower planning is very often used in a 'Static' sense where we do not necessarily recognise the search for an appropriate technology. In the 'static' sense, we assume that the technology is given and the planning process is carried accordingly, within

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5. The terms 'Static' and 'Dynamic' are used here in a restricted sense. They are used only in relation to technology only.

the framework provided by the existing technology.

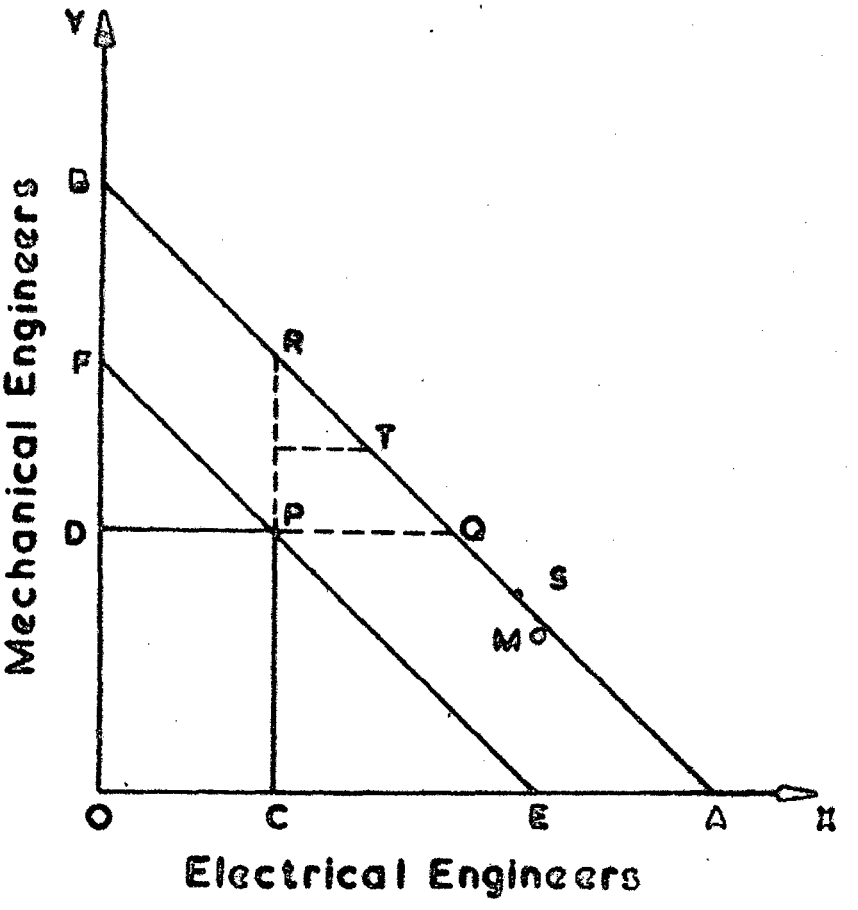
'Dynamic' manpower planning searches for an appropriate technology and the planning process is carried accordingly. Very often, such an appropriate technology does not exist, especially in developing countries. Therefore, it becomes the responsibility of the manpower planners either to design new technology or to reformulate the existing technology. The 'dynamic' aspect of manpower planning envisages the emergence of new technology and the productions of the system to this technology. This is not an easy task in an under-developed country.

Any manpower planning based on the existing technology will be a failure in an under-developed economy because of the mis-match of capital and labour. Its failure will be demonstrated by the existence of the unemployment of human resources. In developing economies, capital is scarce in relation to the abundant supply of labour. Moreover, since the capital is scarce there is a possibility that it will be fully employed before the whole labour-force is absorbed. This unabsorbed labour-force in the form of unemployed persons with little or no capital, forms one of the important problems to be solved by the manpower planners. In the'Static' planning framework, the manpower planning can have only marginal success. At the most, they may maintain an equitable distribution of unemployment between different sectors. In other words, even if they reduce the unemployment in one category of labour force, it may increase or at the most remain unaltered in other categories. That is, in 'static' planning

framework, we may be able to transfer the burden of unemployment from one shoulder to the other, but the level of unemployment in toto will remain without substantial change. This is because of the nature of existing capital structure and technology which determine the limits of employment and production in the economy. Given a particular capital structure and technology, the possibility of the system to change according to the pressures of the supply of labour is very limited.

With the help of a diagram we can drive home the idea of 'static' and'dynamic' manpower planning. For the simplicity of explanation, let us assume that there are only two categories of manpower mechanical and electrical engineers. The figure is given below.

AB is a choice line. P is the actual manpower demand with the existing technology. S is the actual supply. The present demand with the existing technology, i.e. P, is an inferior point. When the demand is at P and supply at S, there is an excess supply of electrical engineers and a shortage of mechanical engineers. In otherwords at this stage there is a demand - supply disequilibrium; one category is highly employed and the other category relatively unemployed. Moreover, with the existing level of demand it is very difficult to reach the point S; i.e. within the 'static' planning process it is difficult to attain the point S. However, the attempt is to bring the demand to S or close to S and to attain a balance between demand and



P = Actual manpower demand with existing technology

T = Static planned supply

S = Actual supply

M = Potential demand with another technology.

supply. But the choice line, with the existing technology is reduced to the segment RQ on the choice line AB. This is because, it is the only segment by which P can be attained. Choosing any point outside the segment would mean, the demand is less than P. Therefore the 'static' planners will try to bring the supply within this segment RQ. They are left with three options; to bring the supply to R or to Q or to any other point between these two extreme points. If they choose R, mechanical engineers are highly employed; if we choose Q just the reverse is the case. Therefore, the planners will try their best within the static framework to bring the supply to somewhere between R and Q. Let it be at T. The society may choose point T, because of two reasons; (a) equity justification; and (b) best skill formation.

In the first aspect - equity - it may not be desirable for the society to keep one category of human resource completely unemployed and the other completely employed. Therefore, the planners will try to reduce the severity of unemployment though it may create some degree of unemployment in the other category. In other words, from societal point of view an equitable distribution of unemployment or employment is desirable rather than keeping a high disparity.

In its second aspect - best skill formation - when there is excess demand for a particular factor our chances of choosing the best are limited, and therefore, we may be forced to select the second rate skills. When there is unemployment, our choice universe is expanded and hence we can choose the best available. It may seem paradoxical, but it

is inherent in the very nature of human skill formation. This again is an important aspect of the necessity of overproduction in manpower planning, which will be elaborated in the next chapter.

The actual supply is S. But our system can move only within the segment RQ. Therefore, the system cannot reach S in the 'Static' planning process. In other words, in the 'static' sense the system becomes more rigid and the mis-match between demand and supply will continue to exist. This rigidity of the system is because of two reasons:

(a) in the 'static' manpower planning the capital structure is rigid or flexible depending on the time element; and

(b) the output structure is rigid or flexible depending on the technology.

And in 'static' manpower planning process technology and capital structure are assumed to be given. Therefore the rigidity of the system is also because of the rigidity of our assumptions.

In the 'dynamic' planning process, it is possible to find an appropriate technology. Any technology which can take the demand to the right of line EF can reduce unemployment. This technology should absorb the actual supply S, which implies more electrical engineers and less mechanical engineers are needed for the economy. Our aim is to reach choice line AB; but any point to the right of EF is superior to P and is preferable. Let such a point be M. The supply

was at S. But 'static' planning process shifted it to T. Now the system is working at T. Now the problem is to shift from T to M and not from S to M. A shift from S to M was easy. But we did not forsee it in our 'static' planning process. A shift from T to M is very difficult, for it needs structural changes in the economy. Moreover it is quite probable that a sudden shift from T to M, may result in a large degree of unemployment in a particular category of manpower, at least in the short run. This will be a short run affair which can be remedied easily with the new technology. But the question is whether the political and other pressures will allow to face this initial difficulty. Even when the economy is at M, it need not necessarily be completely employing its human resources. But no doubt it will be a good improvement on the previous system.

A movement from S to M is not difficult, a movement from S to T is also not difficult. But a movement from T to M is really difficult. This shows that the short run remedies made by the short sighted 'static' planning process really becomes harmful for a long term 'dynamic' planning process. This may seem to be a criticism against the sub-optimisation process which we are forced to adopt sometimes.

The second aspect of the problem is the capability of the system to produce the required category of manpower. A change to a different type of technology needs a sudden increase in the supply of some categories of manpower. This direct association between technology and manpower ca

for a planning link between technological development and educational system. The main source of supply of manpower resource is our educational system. But very often the educational system is not in line with the technological requirements. This necessitates a restructuring of the existing educational system. Therefore, our second aspect is concerned with (i) deciding the numbers, so as to make available the required supply at the required time; and (ii) restructuring the educational system by giving a different orientation.

II.3 Classical View of Labour Market

According to the classical theorists, the manpower maladjustments in the labour market are not problems of great concern. To them there cannot be any imbalances in demand and supply of manpower. The shortages and surpluses are only a temporary phenomena and the market mechanism can be fully relied on to set the system to equilibrium. This theory is based on two assumptions:[6]

(a) the labour market produces right signals at times of disequilibrium;

(b) the easy substitutability of one category of manpower for another.

If this theory is reliable manpower planning is irrelevant. Here the labour market finds its automatic

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6. B.Ahmed, M.Blaug, etc.; The Practice of Manpower Forecasting: A Collection of Case Studies, 1973, New York.

adjustments by the mechanisms of demand and supply in relation to wage rates. No labour market is so flexible as to facilitate these automatic adjustments. Therefore, labour market cannot produce signals at right times and whatever signal it produces need not be reliable. This first assumption is a logical extension of another assumption - the existence of perfect competition in the factor market - which again is questionable.

The substitution possibility given by the second assumption is also not reliable. The very basis of manpower analysis and its relation to educational planning "rests on the assumption that there is little or no substitutability between skills,"[7] says McMeekin. Substitutability gives a way out of manpower mal-adjustments in the short run. In technical terms, if elasticity of substitution is greater than one, then it is not really a problem even if manpower is produced at a later period. On the other hand if it is less than one and near to zero, it creates skill bottlenecks. All these amounts to the unreliability of classical labour-market mechanism and the need for a proper manpower planning machinery.

Manpower planning is a process for providing a frequently updated framework of information for decision making with the object of improving the utilization of resources.[8] It tries to avoid or minimise the mis-matches

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7. Robert W.McMeekin,Jr.; Educational Planning and Expenditure Decisions in Developing Countries with Malayasian Case-study, 1975.
8. Smith,A.R.; The Philosophy of Manpower Planning from Manpower Planning, D.J.Barthalourea (ed.), Penguin, 1976

between demand and supply by a clear analysis and understanding of the interdependence of education, manpower planning and economic growth. The primary goals of such a policy should be:

(a) appropriate job creation by avoiding or minimising the possible wastages; and

(b) to provide training facilities so as to match the educational system with employment markets and manpower needs of the economy.

The success of these goals depends on the analytical superiority of the 'trinity aspects of manpower planning'[9] namely demand analysis, supply analysis and an interaction between the two. These three aspects form the core of the manpower planning irrespective of its level of economic development.

II.4 HQM Planning

In our discussion we shall concentrate only on the problems of High Quality Manpower (HQM). This is not because lower skills are unimportant; but because of the importance of high level manpower. There is a practical problem attached to it. Predictions or projections regarding demand and supply of mediocre manpower is practically impossible because of the large numbers involved and the non-availability of informations about them. Moreover, they are more substitutable which reduces the task of the planners.

9. Smith, A.R.; Ibid.

The other reason for high level manpower planning is the strategic position enjoyed by this category. This strategic position is because of various factors which will be mentioned below.

II.4.1 High Cost of Production

HQM needs far more specialised production which involves high costs in monetary and non-monetary terms. Direct monetary costs consist of direct payments whereas non-monetary costs include training facilities such as training institutions, teachers, equipments etc. The opportunity cost of the resources involved in the production is always very high. Therefore, in the process of resource allocations this forms an important aspect. Highly skilled personnels can be viewed as a sort of produced capabilities that can be used for further production like heavy machineries in firms.

II.4.2 The Problem of Non-comparability

The products of these personnel are more visual. At the same time, the products are not uniform. Some of them are in the form of services which are not even quantifiable and hence it is difficult to compare one with the other. Therefore, there is a need for a proper planning so as to use the resources in the most economic way possible thereby to ensure that they are neither overproduced nor underutilised.

II.4.3 The Problem of Brain Drain

Highly qualified personnel are a form of national capital - human capital. The accumulation process is different from that of physical capital especially in economies where there are high subsidies for education. It is at the cost of the society. At the same time, as the accumulated capital itself is inseparable from the individuals concerned, it is more susceptible to problems like drainage and erosion - commonly known as brain drain. Their loss is to the society and not to the individuals concerned. Since they have taken resources from the social stream, it is our responsibility to see that they are repaid. In other words, the acquired capabilities should be used within our system.

Dissatisfaction with the jobs because of monetary and non-monetary reasons, high expectations about their capabilities are some of the main reasons for this disease. Therefore, a proper planning so as to utilise them in the appropriate positions, becomes essential and crucial.

Engineering manpower, which is no doubt a high level manpower, has certain special features, in addition to the above mentioned, which makes proper planning unavoidable.

Engineering manpower is directly linked with the growth of the economy. The growth of the economy to a great extent depends on the productivity of its labour-force. Productivity is a relative term related to the level of

technology. The development and utilisation of technology depend on the quality and quantity of the engineering manpower. Therefore, its planning should be a part - important part - of the overall economic planning. This is technology based planning. Technology is fast changing, especially at the stage of technological transformations. Therefore, switchability and adaptability become important aspects to this category of manpower. Because of the overemphasis on the narrow fields of specialisation followed in our engineering education, this becomes very difficult. The possibility of substitution within the same category like mechanical to electrical etc. becomes almost an impossibility. Our engineers are like finished products - readymade for a particular job. This increases the possibility of wastage and underutilisation. Therefore, a proper rearrangement of our engineering education in tune with the changing technology becomes essential.

The complementarity aspect of engineering manpower is to be considered properly in the planning process. The efficiency of an engineer is related to his subordinates like technicians and draftsmen. Therefore it is necessary to keep a reasonable ratio between these two categories. In other words, engineering manpower planning should be followed by the planning for technicians etc.

Doctors etc. constitute a service rendering category whereas engineers mainly build assets or ensure a proper

functioning of the economy.[10] Demand for doctors is a direct community based demand whereas engineering demand is a derived demand, derived from the production possibilities of the economy. Thus it is a technology based demand depending on the rate of growth of the economy.

Engineering manpower is consumed by the industrial and technologically advanced sectors of the economy. As a result the traditional agricultural sector and rural population do not come under its purview. Here the need and demand are negligibly small whereas in the case of doctors, the need is more or less uniform, though the demand for their services may be high in urban areas.

With these preliminary discussions on manpower planning we come to its process and problems in the next chapter.

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10. Aggarwal, S.P.; Manpower Demand:Concepts and Methodology, Meerut, 1970, pp.260-61.

CHAPTER - III

PROBLEMS AND DILEMMAS FOR DEVELOPING ECONOMIES

III.1 Manpower Problems in the Development Process

Manpower planning got currency in developing countries only very recently. Still it is very difficult to have a homogeneous structure for all countries on this aspect. The objectives, goals and even the process are different among countries, depending on their special problems.

Most of the developing countries are in the second stage of demographic transition resulting in a high rate of growth of population. The net additions to the labour force every year is beyond the absorption capacity of the economy causing unemployment at a high rate. Though there is an abundant supply of labour force, people with critical skills are again a scarce resource. As a result there exists on the one hand an excess supply and on the other unfulfilled demand from employers. In other words, the 'qualitative shortage'[1] of manpower, side by side with the abundance of 'physical manpower' is a special problem faced by under developed countries.

To add to this, is the problem of choice of technology. Developing countries are in a stage of transfer of

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1. IAMR Report No.2-1965. Second report on engineering manpower survey. Demand and Supply of Engineering Manpower 1961-75. December, 1965.

technology.' This transfer of technology has two aspects:[2]

(a) import of technology from foreign countries; and

(b) transfer of technology from long transitional companies within the country.

In both cases, transfer aims at an advanced level of technology which is quite unfit for the environments in developing countries. It is unfit in two senses: (i) advanced technology is highly labour saving which will cause conflict with the social goals; (ii) the proper management of this technology is difficult because of the lack of personnel with appropriate skills.

In general, manpower planning in developing economies concentrate on the following human resource problems:[3]

(a) rapidly growing population;

(b) mounting unemployment in the modern sectors of the economy as well as underemployment in transitional agricultural sector with special reference to the utilisation rates;

(c) shortages of persons with critical skills and knowledge required for effective national development;

(d) inadequate organisations and institutions for mobilising human effort.

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2. Technological Choice in the Indian Environment, Report of the Seminar held by Indian Institute of Management, Bangalore, Social Scientist, November 1977.

3. Frederick Harbison: A System Analysis Approach to Human Resource Development Planning from Manpower Aspect of Educational Planning, UNESCO, International Institute of Educational Planning.

There are two basic features to a developing economy, in its manpower aspects. (i) An enormous initial expansion of high quality manpower is essential in developing economies, while in developed countries only marginal additions to the existing stock is sufficient. This initial 'big push' is crucial in economies which follow a path of high technology. Here again, distinction should be made among the developing countries. In countries like India, manpower shortage of the high order is not a disturbing factor. We have a large amount of scientific and technical personnel. Though in aggregate we are not in shortage of adequate skilled personnel, sectorwise analysis shows that our expansion in this field is not properly balanced. But in African countries the case is different. They do not have persons with critical skills. India's example shows that an economy can be under-developed even with large number of skilled personnel.

Another aspect of the same problem is the over-concentration of the available skills in the industrially advanced sectors in urban areas. This problem of over-concentration has two dimensions: (i) regional equity, (ii) unemployment. Certain areas or regions are highly concentrated with industries. The metropolitan cities of our country experience this phenomenon. Therefore, the available skills are over concentrated in certain regions,

leaving the rest in backwaters. This is a problem that is to be considered alongwith the industrial policies. Since most of the technical institutes are concentrated near the industrial areas, unemployment is also concentrated there. Again, unemployment is felt more in particular categories of manpower.

The second feature regarding manpower planning is the set up of the planning machinery. Our planning machinery is in the form of a hierarchy. This hierarchical order is partially because of the federal and democratic structure of the nation.

In this hierarchy of planning process, manpower planning forms an integral part of the overall economic planning. Again manpower planning forms a basis for educational planning. This hierarchy becomes a difficult process when it comes to the question of production of manpower. We have to consider all independent and autonomous institutions in the decision making and implementation process. For particular categories of manpower we have to consult particular institutions which are the implementing authorities. The establishment of a proper link between the two is really difficult, but a lack of the link is more harmful. All these amounts to saying that a basic change in the curriculum according to the changing needs of the economy is very difficult.

The hierarchy of the planning process reduces the role of manpower planners in making substantial changes

in manpower policies. The planners are forced to work under a given framework. Again in the process of evaluation this becomes crucial. The success or failure of manpower planning depends on the fate of the overall economic planning. The implementation of the policies depends on the enthusiasm of the autonomous institutions.

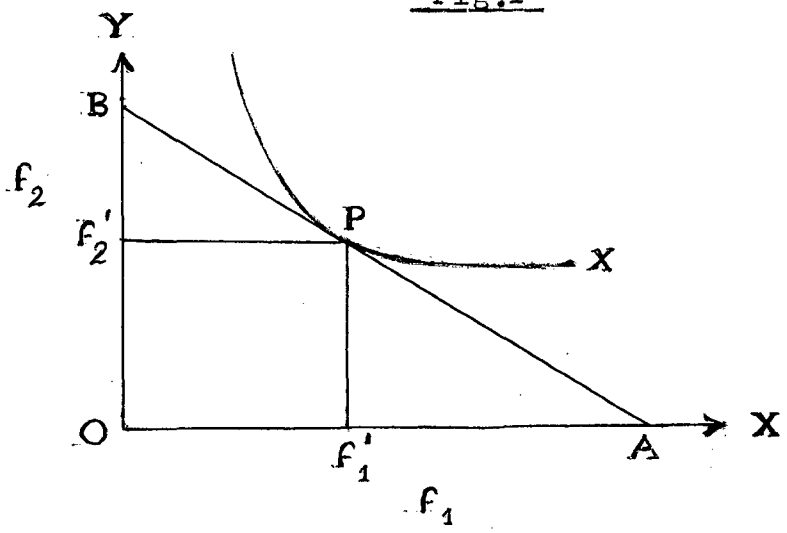
III.2 Some Dilemmas in HQM Planning

Manpower projections can go wrong because of two reasons - firstly because of the wrong methods and shaky assumptions used and secondly because of the in-buit difficulties involved in it. Planning authorities are responsible for the first aspect. No one can be blamed for the second aspect. It is inherent in the planning process, because of the structure and institutional fabric of our economy. So far as the structure remains the same, however efficient the planning process be, there is no way out but to reconcile with the dilemmas mentioned below.

III.2.1 The Dilemma of GNP Vs Other Elements of the 'Target Vector'

Suppose we have a basic capital structure which includes human capital. We are given the budget resource and the possibility of its deployment. Our attempt is to produce the maximum possible output, X. This may be represented in a diagram.

Fig.I



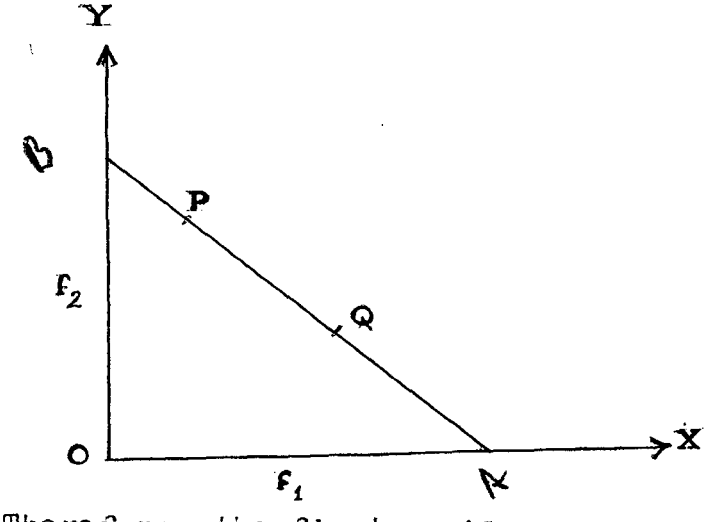
AB represents the budget resource. X represents the output; f_1 and f_2 are two goods. Our basic capital structure is capable of producing f_1 and f_2. If the resources are utilised completely for one good, say f_2, it can produce OB of f_2; alternatively, if it is used for f_1, the total production can be OA of f_1. In other words, there are three possibilities of production, either f_1 only or f_2 only or a combination of both.

In the conventional text book analysis the problem is very simple. Using the technique of isoquents we can select a point of AB. Let P be such a point, where the isoquent is tangent to AB showing the maximum output for the given resources. At P we can have f_1' of f_1 and f_2' of f_2.

Now consider f_1 and f_2 to be two factors of production; let it be two categories of human resources. The basic assumption in using isoquent is that, the output

should be unidimensional, homogeneous and quantifiable. But in manpower planning, the output is neither unidimentional nor homogeneous. Moreover, it may be quantifiable or may not be. The 'output' or the 'target' in this case will be a vector consisting of various elements like health, education, social security, national income, etc. Firstly, these outputs are not measurable nor comparable. Each element represents a different variety which has no similarity with the other. Secondly, national income, as it is used very often, cannot be used as a proxy for this 'target.' It is a wider concept than national income. Moreover, national income forms only one element of the target vector. Since the elements of 'target vector' are heterogeneous and non-comparable and a reliable proxy cannot be used, isoquent analysis cannot be applied here.

Fig.II



Therefore, the first problem in manpower planning at this stage is the problem of choosing a point on AB.

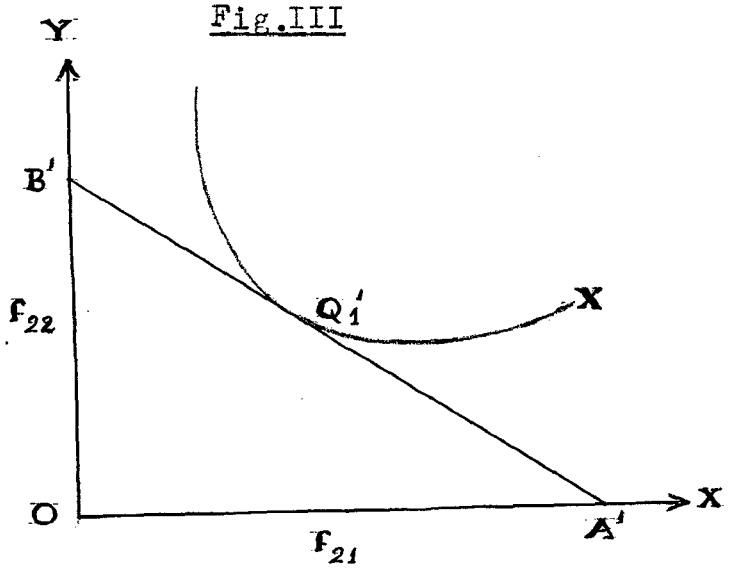
Choosing any point on AB is at the expense of others. Even if we choose one point we cannot say at present, whether we have chosen the best one or the wisest one because of the non-comparability of the elements indicated by the different points. P and Q are on the same line AB. These two points refer to two entirely different targets whose impacts on the economy will be quite different. These two points are not comparable since there is no single identifiable and quantifiable output which is common in both points. For example, consider f_1 to be doctors and f_2 to be engineers. Selection of a point, say P, denotes larger number of engineers and less number of doctors. Larger number of engineers implies high productivity, technology utilisation and larger output. But less doctors means poor health, medical care and so on. Point Q denotes the reverse case. Which point is to be chosen cannot be determined by mere text book analysis. It should include the needs of the living economy. The isoquent analysis can give no answer. Here there can be no unique optimal solution. So we have to depend on the sub-optional solutions.

In choosing between P and Q, we are in a dilemma such as growth versus health, GNP versus education, technology versus social security and so on. Which point we choose depends on our analysis of the current economic situations and needs. In this process we cannot rule out the element of arbitrariness involved. Sometimes this is not purely an economic question, it depends on the political authority also.

With all these considerations, let us assume that, we opted for Q. Now we come to the sub-optional solution; let us see whether isoquent analysis can be applied here.

Recollecting our earlier example, point Q is the combination of two factors f_1 and f_2 or doctors and engineers. Now in the proceeding analysis we can split this point Q into two - these part which contains engineers only and the other with doctors only.

Fig.III



The point Q of our earlier diagram is split into two. The above figure shows one part of it, Q_1 which contains engineers only. This segment contains engineers only but of different categories. They are more or less homogeneous in nature, i.e. though they may differ in specialisation they can be considered homogeneous with respect to their profession. Since they are of a homogeneous category, to find an optimum number of solution we can depend on the

technique of isoquents. The output of engineers can be categorised in a broad spectrum of similar products - therefore isoquents can provide a reasonable answer. But it is to be noted here that isoquents can give answers only to questions like how much electrical engineers we need, how many mechanical engineers we need, etc.

Same is the analysis for the other part of the Q namely Q_2 which contains doctors only which can be represented similarly. There also, isoquent analysis can be used which will provide answer for how much surgeons we need or how many physicians we need, etc.

To sum up, Q in our earlier diagram had two constituents, engineers and doctors. Since isoquent analysis could not be used in the first instance we split the point into two - Q_1 representing engineers and Q_2 representing doctors only. Any point on AB such as P, Q, etc. represents an optimal point whereas any point on A' B' such as Q_1', Q_2', etc. represents a sub-optimal point. In choosing a point on AB we are not in a paradoxical situation but only in a dilemma. The way out is a qualified solution namely sub-optimisation.

Sub-optimisation can be applied only after choosing a point on AB. Choosing of any point on AB involves an element of arbitrariness. But it is chosen on the basis of the following two considerations:

(a) choose a point and do as well as possible; and

(b) choose that point which enables us to shift from one point to the other without much difficulty.

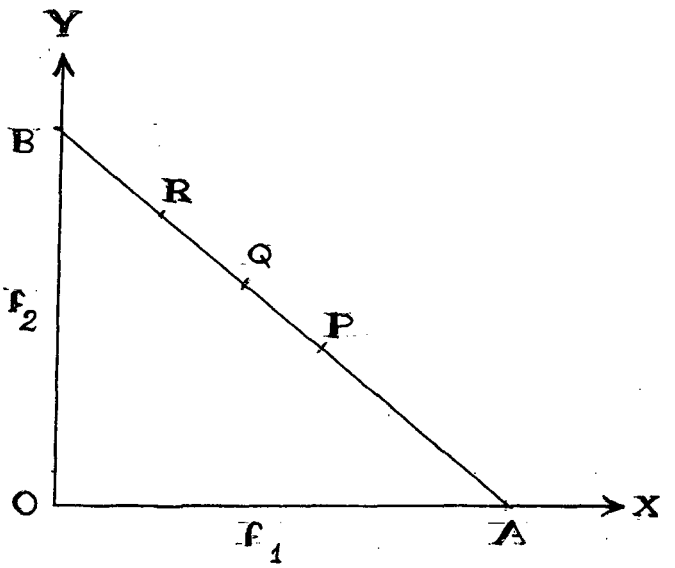
The shiftability or switchability from one point to another leads us to the concepts of capacity and capability of the system. Capacity is a long-run concept and it is fixed in the short-run. Any point on AB is the capacity of the system. Therefore, once we choose a point, we have chosen the capacity also. The possibility of shifting or switching from one point to another on AB with the accompanying capacity is known as the capability of the system. Therefore, larger the number of points on AB, greater the possibility of shifting and higher the capability of the system. This point will be elaborated in the next section.

III.2.2 The Dilemma of Point of Time Vs. the Period of Time.

If we think of manpower planning as a process of capacity creation, then we have to consider the time element. In the planning process itself, it should be made clear whether we are planning for a point of time or for a period of time. We can be more specific and precise for a point of time but not over a period of time.

This element of time becomes very crucial when we have to consider the capacity and capability of the system. Capacity is a long-run concept and is 'given' for the short period. The flexibility of the existing capacity depends on the capability of the system. We can illustrate this with the help of a diagram.

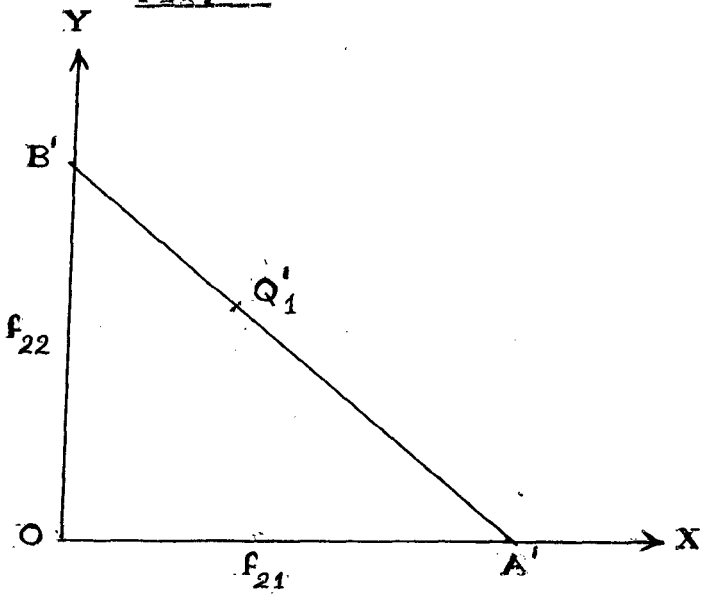
Fig.IV



This is our initial diagram. If we choose any one of the points, say Q, the capacity is also chosen because there is a particular capacity that accompanies to each point. This will be the capacity for a reasonably long period. That is, in the short-run we do not expect a change in capacity. Same is the case with other points like P or R. In other words, P,Q and R are three different points showing three different capacities. If the system can shift from P to Q, or Q to R or R to P, it is known as the capability of the system. In the long run, we may have to shift from the existing capacity Q to another capacity P, depending upon the capability of the system. Once we choose P, again capacity is fixed in the short-run sense.

This means, though capacity is shiftable, it cannot be done at every now and then.

Fig. V



This figure again is a repetition of the sub-optional point. Here we choose a point Q_1' which is sub-optimum. Then the question is whether this optimum is for a point of time or over a period of time. If it is for a point of time this optimal solution can be considered as precise. If it is over a period of time then the question is whether it is for a long period or for a very long period. If it is for a very long period, then the capacity also is not fixed.

Side by side with the 'capacity' comes the concept of utilisation. Utilisation of the capacity is a short run continuous concept which will change depending on the short-run demands of the economy. If the short-run demand of the economy is strictly linear, then utilisation coincides with the capacity. But the changes of such a coincidence are very rare. This is because of the cyclical

nature of the demand. So the capacity should be able to meet the oscillating demand. Planning for capacity in this sense is similar to the system of electric power generation, "a system of human skill generation, should be designed to carry varying loads, it must be adequate in size and above all its components must be properly balanced."[4] For instance, when we plan for any manpower training institute, it should be able to accommodate the maximum probable number of students for a reasonably long period. This is its utilisable capacity. But the yearly admission, that is the utilised capacity may be less. There is only very low probability that the utilisable capacity will be always equal to the utilised capacity. This means, under-utilisation of the existing capacity in the short run is not at all a symptom of defective planning. This under-utilisation becomes a problem only when it is considerable, regular and continuous at all times in the long run. Then it is an indication of defective planning.

III.2.2 The Dilemma Regarding Overproduction

In the production of high quality industrial output we can assume almost cent per cent precision regarding the desired quality. This is not possible in human beings.

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4. Harbison Frederick: A System Analysis Approach to Human Resource Development from Manpower Aspects of Educational Planning, UNESCO

With the same initial endowment and the same treatment, every one thus turned out need not be of the same quality. The quality of the manpower is probabilistic and less than one. This is a problem when we try to produce first rate highly qualified personnels. The problem of over production stems from two factors:

(a) to begin with we do not know who is best or who will be the best; and

(b) even if we know who is best competition is necessary to develop them completely.

Suppose we need 3,000 first rate engineers. We have to start with a number for above it. Let us consider, we take 5,000 students for training. At the end of the training period labour market can provide employment only for 3,000. This involves an element of 'waste.' But is it really a waste? In strict economic terms it is not. This excess number was necessary to get the required first rate personnels. In other words an element of over production which at the first instance may seem to be waste, is inherent in the planning process; i.e., no matter what manpower planning does, it will never be able to avoid manpower over production.

Another aspect of the same problem is that, in a period of rapid technological change, the output of the unchanged curriculum may be thrown out of employment possibilities. This is mainly because of the improper coordination between educational and developmental planning. Switchability and quick adaptability should be developed in each individual during their education. In other words, our educational system should teach skills to pick up skills.

Now we can agree that over-production is an inherent necessity. The question then is what to do with this excess number. The way out of this impasse is 'complementary planning,' i.e. in the planning process itself we should be able to understand the gravity of this problem and we should plan for different avenues for them. In other words, at the planning stage itself we have to plan for this excess number. Therefore, it is not a 'waste' if the first rate engineer comes to the industrial sector and the second rate goes for administrative jobs. If the contrary happens, it is really a waste.

III.2.4 The Dilemma Regarding Expectations

This is a special problem faced by capitalist countries in general and some of the developing countries in particular. There is produced manpower; though employment avenues are open, some of them are not ready to take up the jobs at the going wage rates. The wages are not to their expectations. This very often leads to brain drain in developing countries which we have already mentioned.

The problem of expectations and disillusionment need not be always because of planning factors alone. Job satisfaction, social recognition, location of jobs etc. can be equally important factors.

No planner can fully foresee this aspect and they may not be blamed for it. This again is inherent in the system. The system produces whatever it needs, but it is

not getting a feed back. As long as the income earnings differential between countries continue to exist, the problem of draining out will continue. In underdeveloped countries the Government should not allow them to go out. But in economics like ours, where the system fails to provide them with jobs, how far the government can be strict?

CHAPTER - IV

PROJECTIONS ON ENGINEERING MANPOWER IN INDIA

IV.1 The Necessity of Projections

Projections form an important aspect of manpower planning. It is the result of the analysis of the past and present situations and tells us of the future developments. It gives us the guidelines for an integrated development of the concerned sectors.

Even in economics where manpower planning process is not developed, projections become necessary. In these economies, projections may be based on certain crude norms or personal experiences rather than on analytical and logical methods. Even then, it may provide a broad framework or guideline for the educational and technological expansion.

Projections become crucial in economies where manpower planning is developed, because further developments in the manpower and allied sectors mainly depend on it. In a country like India, where the development of different sectors are not balanced or correlated, projections give more precise guidelines.

The HRM planning and their projections, especially of engineering manpower, is important in India for various reasons. In our plannings we follow a policy of rapid industrialisation. Development of key industries like

Iron and Steel, Coal etc. is essential in achieving this objective. These key sectors consume a large amount of engineering manpower. Therefore, availability of engineers at the proper time is important, which can be ensured through projections.

Our economy lacks proper link between educational institutions, which form the main source of supply of manpower, and development of industries. Moreover supply cannot be generated all on a sudden. Therefore, it is the responsibility of the planners to see that supply will be made available whenever it is demanded. Here projections become the guideline for the expansion of educational institutions.

Unemployment is a necessary evil associated with the uneven growth of any economy. It is an indicator of mal-adjustments of manpower in the economy. Minimising the maladjustments becomes a policy tool. Anyway this does not imply that we should give undue importance to the numbers and it should be taken for granted. On the otherhand, even if it is not precise, projections become fruitful if it can provide a correct guideline.

Projections vary from one to another depending on the purpose and basis. These projections may be true in its own framework but may not enjoy general applicability. In otherwords projections made for one purpose cannot be reliably applied to another purpose in a different situation. Depending on the purpose we can classify three different projections.

IV.2 Classifications of Projections

IV.2.1 Market Based Demand Projections.

Market based demand projections are short-run projections based on trends in the market. This is more reliable in advanced capitalist countries where market signals can be relied upon. But in developing countries it will only help to misguide at the macro-level. So far as free play of demand and supply mechanism fail to work, market projections have only limited success.

The information provided by the market need not be always complete. It need not always represent the trend in the economy. Therefore, it cannot be relied on for macro-policy decisions. In matters of capacity and capability determinations market projections are of little use, for it need not always necessarily show the need of the economy.

Market projections are very often used by private individuals as their guide-line. Individuals fix their expansion plans depending on the market trends. These projections need not be the outcome of the factual analysis of the situations; but depends on the personal experience etc. It may also be helpful for individuals to select their future career. From the macro-policy level this cannot be taken as a guideline. In our country the projections made by certain firms come under the category of market projections.

IV.2.2A Plan Based Market Projections

The difference between market based demand projections and plan based market projections is only on the matter of intervention. In the latter case markets are not considered as given. On the contrary,we are planning for the market. We anticipate the future market conditions assuming that the economic policies are persued properly. Here,first we plan for market, then we try to see what will be the nature of demand for manpower. In otherwords the intervention from the part of the authorities is substantial and dominant in plan based market projections.

The planned demands will be always different from the demands signalled by the market. The planned demands are a means to achieve a pre-planned end - plan targets. For market demand there is no fixed and pre-planned targets. The market demand will be always at a price, a price determined by the market. In planned demands, the demand is always at socially planned prices. The projections made by planning authorities and other recognised bodies come under this category. Since manpower planning is an integral part of the overall economic planning, we are concerned with these projections only in our discussion.

IV.2.3 Need Based Social Demand Projections

These projections purely depend on the social needs and not on demands. Social projections are important

because, social needs are not always translated in the plan targets. Therefore, demand projections by the planning authorities cannot be taken as identical with social needs.

Even when market demands are cleared and planned targets achieved, social needs may not be fulfilled. So far as the market is not perfect, equilibrium in the market does not imply equilibrium in the society. Welfare depends on the social needs.

Planned demand is at a planned price, but at an acceptable price; social needs are at a price which the society is capable of paying. It need not be at a reasonably acceptable price. This valuation will be less than the planned valuations and far less than the market prices. The social needs will be much higher than the planned needs. But it is very often difficult to use this as a guide for our plans. And in our country need based social demand projections are yet to be started.

With these discussions, let us come to actual projections made in India. All the projections under our considerations are plan based market projections.

IV.3 Indian Projections - A Review

Starting from 1947 India made various studies by different authorities on engineering manpower. A review show- that we can broadly divide all studies into two -

global studies and sectoral studies. In global studies a relationship is established between employment of engineers and other parameters such as national income, investment, workforce etc. Then these relationship is applied to known or assumed development targets for the next 5-10 years and from there the requirements of engineers are estimated. Sectoral approach demands an indepth analysis of factors affecting the requirements for engineering personnel in each segment of the national economy.[1] From there the demand for engineers by each segment will be estimated. The availability of data is a major problem for sectoral studies. Data pertaining to industry group product mix, technology etc. should be available. This is one of the reasons why our earlier studies were global in nature.

Even within the broad category we can distinguish between studies depending upon their bases. We will first discuss the global studies and their bases.

IV.3.1 Study Based on Production Personnel Ratios

The first serious attempt in manpower planning started in India with the establishment of a scientific manpower committee. The Committee was established in 1947, with the primary objective of assessing the requirements for different grades of scientific and technical manpower in the succeeding 5-10 years which could be used as a guideline for educational expansion.

1. IAMR Report No.1-1974

Since this was a pioneer study,[2] no data were available. The Committee resorted to the questionnaire method for its basic information. Questionnaires were sent to different branches of industry, government departments and educational institutions to collect information regarding employment, production, annual intake, expansion plans of firms and wastage of scientific and technical manpower. Out of the 3,000 questionnaires sent, the Committee received only 1,019 replies. The Committee sent another set of questionnaires to individuals to measure the extent of wastage in terms of unemployment. The Committee received 8,000 replies and came to the conclusion that wastage is at the rate of 10%.

From the information collected the Committee estimated production; personnel ratios for different industries and government organisations. It was assumed that these ratios will remain constant over time and this assumption was applied to output targets to get additional requirements of engineers in each industry. These requirement figures were then compared with the possible out-run of engineers in the supply. The estimates of the Committee are given in table IV.1.* The Committee concluded that there was wide gap between demand and supply of engineering manpower. When the engineering requirements between 1947-52 were compared with the out-turn for coming ten years, it

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2. Ministry of Education, Government of India - Scientific Manpower Committee, Basic Report on Survey and Assessment.

* See Appendix-A.

was found that engineers are in acute shortage. Therefore the Committee recommended a marked expansion in engineering industry.

It is to be noted that the assumption of constancy of production personnel ratios cannot hold good. And the Committee had no claims that the estimates were precise. On the otherhand, the Committee's view is that the projections indicate 'the broad magnitude of demand over the next five or ten years.'

IV.3.2 Study Based on the Fixed Relationship Between New Investment and Employment of Engineers

The next important study was by the Engineering personnel Committee which submitted its report in 1956[3]. The earlier study and the questionnaires sent by the Committee were the sources of information. The primary aim of the Committee was to estimate the probable requirements of engineers for the second plan and to make recommendations to ensure an adequate supply of engineers in time. From the discussions with the Ministries and other concerned authorities they came to some standard norms for projection. These norms assumed a fixed relationship between new investment and employment of engineers. This relationship was applied to the official targets to get the required number of engineers.

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3. Planning Commission, Govt. of India - Report of the Engineering Personnel Committee.

The projections were region-wise and speciality-wise. No attempt was made to estimate sector-wise engineering manpower requirements because they felt that "the fact that sector-wise demand has no particular relevance to the organisation of additional training facilities, the Committee thought it best not to attempt such break-up".[4]

The estimates for private sector were based on the assumption that employers would employ proportionally more graduate engineers. In their own words, "Our demand estimates for the private sector are based on the 'changing end'[5] and not on the existing pattern of graduate employment."[6] The estimates of the Committee are given in tables IV.2*, IV.3* and IV.4*.

The Committee concluded that there were 22,000 graduate and 29,000 diploma holders in the working pool and also by "the year 1960-61 we will be in short supply of engineering personnel to the extent of about 1,800 graduates and 8,000 diploma holders"[7] and it recommended

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4. Report of the Engineering Personnel Committee Planning Commission 1956, page 12.

5. The Committee found that the allegation that private employers prefer less qualified engineer was not true. And it expected a change in trend to employ more graduate engineers.

6. Report of the Engineering Personnel Committee Planning Commission 1956, page 10.

* See Appendix A.

7. Report of the Engineering Personnel Committee Planning Commission 1956, page 21.

for an expansion in the engineering manpower. It also recommended that "the object that we have in mind could best be served by setting up a technical manpower committee of the cabinet, because this is a field where policy and coordination affect almost all Ministries and decisions have to be taken at the highest level."[8]

According to the recommendations of the Engineering Personnel Committee, the Planning Commission created a manpower division which carried out a number of studies. Its first attempt was to estimate the stock of engineers by analysing the number of engineers employed. In its subsequent studies it calculated the ratio between employment of engineers to total employment. The ratio of engineers varied from 1 per cent in some industries to 10 per cent in machine tools and hydro-electric undertakings. The overall ratio calculated for graduates and diploma holders was 1:1. This was used for projecting the additional requirements of engineers during the second plan under the assumption that the number of engineers employed would increase in direct proportion to the total output in each industry. These recommendations were further considered by the Planning Commission and they appointed a small implementation Committee known as "Ghosh-Chandrakant Committee" consisting of two members only. This Committee submitted its report on 17th January, 1957. The actual expansion of engineering education in the second plan took place on the basis of this report.

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8. Report of the Engineering Personnel Committee, Planning Commission 1956, page 37.

The manpower studies No.5[9] estimated the total number of engineers as 72,000 consisting of 31,000 graduates and 41,000 diploma holders. The unemployment was 1,300 i.e. only 2 per cent. It considered public and private sector separately and came to the conclusion that public sector absorbs 75 per cent of the total engineers and private sector the remaining 25 per cent. In the category-wise distribution, it was found that private sector employs less than $\frac{1}{10}$ of civil engineers, less than $\frac{1}{3}$ of electrical and more than half of the mechanical and nearly $\frac{3}{4}$ of other types.

IV.3.3 Study Based on Rate of Growth, Employment Potential and Employment Ratio

The working group on technical education and vocational training was appointed in February 1959, with M.S. Thacker as its Chairman. The working group submitted its report in April 1960. The primary task of the Committee was to recommend measures for the full utilisation of available technical manpower and also to estimate the requirements of engineering manpower and recommend provisions for its expansion in the coming 15 years. The Committee made forecasts for III and IV Plan. The third plan estimates were based on the following assumptions:

(a) 50 per cent increase in investment during the III Plan over the II Plan or at a rate of development of 5 per cent per annum; and

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9. Engineers in India: Number and Distribution, 1955, Planning Commission, Government of India.

(b) on the basis of additional employment potential during the III Plan. On the basis of certain norms and targets of capacity DGR & E and labour employment division of Planning Commission indicated that a net investment of Rs.10,000 crores in the III Plan would generate an additional employment for 1.01 crores of persons. This was further confirmed by the perspective planning division of the Planning Commission. And they came to the conclusion that the requirements of additional engineering personnel would be about 1 per cent of the total additional employment. The Committee on the basis of these factors concluded that, the total demand for engineering manpower in all categories by 1966 will be 45,540 graduates and 80,100 diploma holders. On the supply side it estimated that there will be 51,740 graduates and 76,000 diploma holders, i.e. an excess supply of 6,200 graduates and a short supply of 4,100 diploma holders. The estimates are given in table IV.5*. The working group recommended for an expansion in the engineering education which was accepted by the Planning Commission.

The Fourth Plan estimates were based on the following assumptions:

(a) According to the model of economic growth indicated in the II Plan, investment in the third plan would be of the order of Rs.14,800 crores and the ratio worked out for previous Plans, 1.1 to 1.3 lakhs of engineers for Rs.10,000 crores was assumed to the same.

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* See Appendix A.

(b) On the basis of the employment potential of the fourth Plan obtained from the information of the Planning Commission. The estimates of the Committee are given in table IV.6*. The working group estimated that the total demand for engineering degree holders by the end of the fourth plan to be 75,000 and its supply 57,375 showing a deficit of 17,625. And for diploma holders, the demand would be 1,20,000 and the supply 94,250, thus showing a deficit of 25,750.

The Committee arrived at the conclusion that;

(a) the number of engineering personnel per million population has been increasing rapidly. The percentage increase in 1965-66 over 1955-56 is 186.

(b) the percentage of requirements for additional engineering personnel to the additional employment generated in non-agricultural sector during the first three plans has been increasing. The percentage at the end of second plan would be 0.91 and that by the end of third plan would be 1.2.

Institute of Applied Manpower Research (IAMR) was established in 1962 to carry out manpower studies and to advise Government on manpower policies. Its first study was the stock taking of engineers in 1963. In 1963 itself it brought out another study[10] which re-examined the demand supply position in the light of new developments. It was the period after the Chinese aggression, internal emergency was still in existence. Because of these unforeseen calamities development

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*See Appendix A.

10. IAMR working paper No.7-1963, Part I and II.

programmes did not proceed the way it was proposed to and even the development process took a new turn. The growth of national income was reduced to 2.5 per cent as against the target growth of 5 per cent. From the analysis of the newly emerged situation IAMR concluded that the demand for engineering personnel would be 20 per cent less than the working group estimates. But the high demand by defence will compensate it partially. Even then the possibility of surplus was obvious. Therefore it recommended for an 'expansion pause.' for engineering. In their own words "in order to avoid the unhappy situation in the near future it is imperative at this juncture that the intake capacity at the degree level should be checked."[11] Thus for the first time recommendations were made to halt the expansion process. Despite this recommendation enrolment continued to increase.

In 1965 IAMR published a report[12] on the demand and supply of engineering manpower. The projections of demand were based on the following:

(i) The rate of growth of national stock of engineering manpower must be more rapid than the rate of growth of net non-farm product.

(ii) It would not be more rapid than the rate of growth of net product of that part of non-farm sector which can be expected to grow fastest and whose growth can be measured with some confidence.

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11. IAMR working paper No. 7-1963, Part II, page 30.

12. IAMR Report No.2-1965. Demand and Supply of Engineering Manpower 1961-75.

(iii) Engineers are in short supply by the beginning of III Plan but the shortage will be reduced year by year and a reasonable balance will be attained by the end of third plan.

(iv) Employment in the organised sector will grow at the same rate as annual net non-farm product.

The estimates are given in tables IV.7* and IV.8*. The total requirements come to 240,000 degree and3321,000 diploma holders showing an excess of 24,000 graduates and 117,000 diploma holders by the end of Fifth Plan.

IV.3.4 Study on the Basis of Engineering - National Income Relationship

The next global study[13] was by IAMR in 1969 - 'Employment outlook for Engineers.' The study first established relationship between engineering manpower, employment and economic development by fitting the regression equations to the available time series data. A series of manpower projections have been made on the basis of different relationships and the variations in the estimations were ascertained. Because of the lack of data in the further analysis, the study adopted a single approach using the relationship between engineering employment and total national income.

In the period between 1956 and 1965, we experienced a movement from shortage of engineers to a surplus. This period was taken as the basis to get reasonably fair relationships between effective demand of the economy and actual

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* See Appendix A.
13. IAMR Working Paper No.11-1969.

employment. To validate the hypothesis six separate regressions were made.

(a) From 1950-60

(b) From 1950-64

(c) From 1955-60

(d) From 1955-64

(e) From 1960-64

(f) From 1960-68.

A comparison of the results indicated that:

(a) There was a good relationship between growth of national income and the employment of engineers.

(b) The curve fitted for the data 1956-64 was below than others and so it was taken as the base.

A comparison of different sets of demand estimates for engineers for the year 1973 shows:

Basis	Demand for Graduates and Diploma
(a) Total National Income	3,84,000
(b) Non-Agricultural National Income	3,62,000
(c) National Income in Engineering Intensive Sectors	3,01,000
(d) Investment	3,25,000

that the estimates based on investment shows the lowest.

For the projections of demand for engineers in 1973-74 and 1978-79 three assumptions were made about national income.

(a) Low rate of growth which represents 4.8 per cent per annum from 1969-78.

(b) Medium. An annual rate of 5.5 per cent in the fourth plan and 6 per cent in the fifth plan.

(c) High Rate of Growth. The high rate of growth is 7 per cent annual growth from 1969-79. The estimates also differ on this basis. The estimates are given in table IV.9.*

IV.3.5 Sectoral Studies: Based on Fixed Engineer-output Ratio

The next important study was carried out by the joint effort by London School of Economics, Perspective Planning Division of Planning Commission and Indian Statistical Institute. It is in short known as LSE-ISI-PPD Study.[14] It was the memorandum submitted to the education Commission "to advise Government on national pattern of education and on the general principles and policies of development of education at all stages in all aspects."[15]

There is a marked difference between this study and the earlier studies. All the earlier studies were global in nature, whereas this is the first sectoral study.

Method: From the targets of economic development put forward by the Perspective Planning Division of the Planning Commission they derived estimates of educated man power required and thereby the out-run required from the

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* See Appendix A.

14. Burgess, Layard and Pant. Manpower and Educational Development in India 1961-86. The Memorandum submitted to the Education Commission 1964-66.

15. Burgess, Layard and Pant. Manpower and Educational Development in India 1961-86. The Memorandum submitted to the Education Commission 1964-66. From the preface.

educational system. For projection purposes they divided the economy into two sectors:

(a) Other services excluding trade and transport

(b) Other sectors of the economy.

It assumed that, as net output in each sector and in each branch of manufacturing increases, so proportionally will be the employment of educated manpower. The proposed target growth of national income is 6.6 per cent a year between 1960-61 and 1975-76 and an average of 6.8 per cent a year over the whole period from 1960-61 to 1985-86. The sectoral targets were 10 per cent for organised manufacturing construction, banking and insurance, less than 10 per cent for mining and transport, 6 or 7 per cent in small enterprises, commerce and services and 4 per cent in agriculture.

The first step was to project the total number of workers required. The following assumptions were used:

(a) Population will grow on the central assumptions proposed by the Registrar General's expert committee.

(b) Urban population will grow 4 per cent a year and sex balance in cities will remain as in 1961 as also the age-sex participation rates. The estimate is given in table IV.10.* The next step was to suggest how the total number of workers would be divided among the various sectors of the economy. This was done by providing for a rate of change in output per worker in each sector and for engineers, fixed engineer-output ratio was assumed. Tables IV.11* and IV.12* give these estimates.

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* See Appendix A

In making estimates they considered the changing structure of the manufacturing industry. They did not give speciality-wise break-up of engineering manpower.

The study came to the following conclusions. In engineering the long term rate of growth should be roughly 12 per cent a year so that by 1986 there will be 875,000 graduates and 13,00,000 diploma holders compared with 58,000 and 75,000 graduates and diploma holders in 1961.

IV.3.6 Sectoral Study Based on the Three Factors Simultaneously

One of the drawbacks of all the studies till this time was that it was related to one factor only, namely output or investment. The present study[16] considered three factors i.e. output, investment and workforce simultaneously. In the working group estimates (1960) they considered more than one factor, but not simultaneously. This study was sectoral and adopted a three factor relationship.

The sectors were chosen on the basis of the division of standard industrial classification, but with slight modifications. The service sector was sub-divided in terms of three sectors namely educational services, government administration and the sector other than these two. The study pooled the industrial classifications of mining, quarrying, manufacturing electricity, gas and sanitary services into one, and it was named as mining, manufacturing and utilities.

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16. IAMR Report No.1-1967

The next step was to establish the relationship between engineering manpower and output, investment and workforce. Three relationships were used:

(a) Output - Engineer Relationship Engineers employed in a sector were considered as the dependent variable and output from that sector was the independent variable. Then by using the technique of regression the follwing results were obtained which is shown in Table IV.13. *

(b) Investment - Engineer Relationship The engineers employed in a sector were considered as dependent variable and investment in that sector as the independent variable. Regression method was employed on the following assumptions.

(i) The use of net additional investment implies that replacement equipment is excluded.

(ii) All engineers employed at the time of completion of a plant continue to be employed when the plant comes on regular production. The results obtained are shown in table IV.14.*

(c) Work-force-Engineer Relationship This is very often used in Western countries where data are available with all the necessary particulars. Here with the help of the regression method a relationship is established between these two variables and estimations are made on that basis. The results are given in table IV.15.*

A comparison of these three estimates shows how far estimations differ because of its differences in assumptions. The total demand for engineers in 1970-71 would be

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*See Appendix A.

4,56,000, 4,64,000 and 4,09,000 depending on calculations based on output, investment and workforce respectively and that for 1975-76 were 7,66,000, 7,39,000 and 5,84,000. In both cases the estimates based on workforce were far below.

The main advantage of the three factor approach over the one factor approach is that it ensures consistency in important ratios. In the three factor approach there will be a set of six ratios.

(a) Output-engineer ratio.

(b) Investiment engineer ratio.

(c) Engineer workforce ratio.

(d) Output per worker.

(e) Investment per worker.

(f) Investment output ratio.

These ratios are interdependent and each can be expressed as a multiplication or division of the other e.g.:

$$\frac{\text{Output per worker}}{\text{Engineer: Worker}} = \text{Output engineer ratio}$$

IAMR in the subsequent years brought out various studies - employment outlook for engineers in 1969 which we have already discussed; a study on metallurgists in 1971, an individual study on civil engineers in 1971, a review of the methodology of forecasting manpower in 1972 and a study on the attrition rate of engineering graduates in 1973. Since these studies were individual in nature, we will not discuss it in detail. The next important study of engineers was brought out in 1974.

IV.3.7 Sectoral Study Based on the Employment-output Relationship

1974 report[17] is a sectoral study taking each individual sectors and its manpower needs. Though it is very difficult, it has been undertaken with considerable success. Another important aspect of the study is that, it treats engineers as an occupation group and does not equate them with degrees. The study is based on the following assumptions:

(a) A linear relationship between employment in engineering occupation and output measured in terms of gross value added.

(b) There will be no fundamental changes in technology during the fifth plan period.

The economy was divided into 23 segments and engineering speciality-wise employment was estimated for each particular sector. Since it is diffult to put here the demand for engineering categories from each sector, the total demand for each category is compiled and is given in the table IV.16*.

It estimated the stock of engineers both for degree and diploma holders for years 1974 end and 1978 end is shown in table IV.17*. The additional requirements of degree and diploma holders are given in table IV.18.* The total unemployment in 1978 end was 60,297, consisting of 23,297 degree and 43,000 diploma holders. The projected employment

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17. IAMR Report No.1-1974 Engineering Occupations in the V Plan.

* See Appendix A.

was compared with the projected stock and it was found that there will be a more or less balance between these two by 1978-79. The projected employment was 650,365 (for all categories) and the stock was 644,105. This shows that supply is less than the employment opportunities.

The next study on engineers was IAMR Report No.1/1975. It was concerned with the characteristics of unemployed engineers in Delhi employment exchange only. Therefore, it is not discussed here.

These were the important studies in India on engineering manpower. Here it is only a review, a comparison and the success of these projections are dealt in the succeeding chapter.

CHAPTER - V

THE CONFLICTING FACTS IN INDIAN PROJECTIONS

V.1 The Problem of Non-comparability and the Discrepancy.

In the preceding chapter we discussed the projections made by different authorities on engineering manpower. Here we will compare and contrast these projections and see how far they succeeded in their goals.

A close analysis of these projections shows that, they are non-comparable because of various reasons:

(a) Assumptions and bases of the projections were different, which resulted in the differences among projections. Since we had discussed the assumptions in the last chapter there is no scope for a further discussion here again.

(b) The nature of the estimated numbers were different. The earlier studies were global in nature, some giving the speciality-wise breakup and others region-wise breakup. The later studies were sectoral giving total number of engineers demanded in each sector without speciality breakup, in some cases even without diploma-degree classifications.

(c) Even in those cases which are similar in the above two cases, mentioned, they do not belong to the same period. This point we will discuss below.

The projections of Scientific Manpower Committee were for the years 1947-52. Engineering personnel Committee projected for the year 1960-61, i.e. till the end of second Five Year Plan. The working group on technical education and vocational training projected for 1966 and 1970-71. The second report on engineering manpower survey's projections were for the years 1970-71 and 1975-76. The LSE-ISI-PPO Projections were for the years 1975-76 and 1985-86. The sectoral study based on output, investment and workforce estimated the demand for 1970-71 and 1975-76. IAMR Study No.1-1974 projected for the years 1973-79. The IAMR Report No. 11-1969 projected for 1973 and 1978. Many of the studies which projected for years 1970-71 and 1975 were made under the assumption that the Fourth Plan will be a continuation of the third. But the discontinuity in the plans and the revision of plan targets affected the estimated numbers substantially.

Now let us consider the above estimations which belonged to the same period. For 1970-71, we get three projections by different authorities. Among these, the working group estimates are speciality-wise, the second report gives only employment possibilities and the sectoral study gives only sector-wise estimations without reference to engineering classifications. The only possibility we are left with is to compare the totals. According to the working group estimates, the total demand for the years 1970-71 was 195,000, consisting of 120,000 diploma holders and 75,000 graduates. The sectoral study gave three estimates

based on three factors. The totals given are 4,03,000 based on output, 4,11,000 based on investment, 3,56,000 based on total workforce. The totals including practicals come to 4,56,000, 4,64,000 and 4,09,000 respectively. The difference is quite substantial.

The other studies which belong to the same period 1975-76, are the second report, LSE-ISI-PPD and the sectoral study. The second report is on employment. The other two are sectoral studies and carried out without much timelag (LSE-ISI-PPD Study was carried out by 1965 and the sectoral study by 1967). Therefore, we can expect a close similarity in the projected numbers. However, the LSE-ISI-PPD study gives 604,000 engineers in total consisting of 269,000 degrees and 335,000 diploma holders whereas the sectoral study gives a total demand of 766,000 based on output, 739,000 based on investment, 584,000 based on workforce. The totals excluding practicals are 703,000, 674,000 and 521,000 respectively. The range of the differences varies from 20,000 to 62,000, which is quite substantial.

From whatever is comparable, the difference among projections for the same period is obvious and substantial. Tables V.1*and V.2* shows these differences considering some more projections. Table V.1* shows the studies conducted by the same authorities for the same year. But the basis is different, and hence shows a substantial difference of five figures which again is substantial. It again tells us that

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*See Appendix B.

demand projections on the sectoral basis have higher values than global. Table V.2*compares the projections made by different authorities which again tells us the same story.

The differences may be mainly due to the differences in the bases and assumptions used. This point needs explanation. All studies assume that technology remains the same. This assumption of the constancy of technology gives us production possibility curves. The choice of a particular PPC and a point on it depends on two factors:

(a) The Scale of Operation;and

(b) The Relative Prices.

The scale of operation is determined by the stock of capital. Since most of our projections were based on investment or output or workforce or on all.

In a 'static' situation, if the stock of capital and relative prices are given, investment, employment and output will have a specific and stable relationship where we can find out the two factors if we are provided with any one of them. In such a situation it is immaterial whether our projections are based on investment, output or workforce. All of them should give the same result. The more important question here is, how far this situation holds good in reality. In a dynamic economy, there is least scope for this hope.

On the other hand, even with the same technology, it is possible to have unstable relationships between these factors. The stable relationship implicitly assumes full

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*See Appendix B.

capacity utilisation of capital and labour at all times. The relationship can be stable even under conditions of under-utilisation provided its rate is same in all firms. Both these cases cannot again be considered to be true for our analysis.

Now consider the difference basis - output, investment and workforce - separately. Let the workforce be divided into two - $L=L_1 + L_2$, L_2 representing HQM which in our case will be engineers, L_1 representing all others. The stable relationship assumes that relative prices remain the same. When the price of any one of these factors changes, the relative prices and thereby the relationships also change.

Suppose there is a change in the price of capital goods. When its price goes down it becomes cheaper, and with the same amount of capital and workforce we can produce more of output or the same output can be produced with less investment. Further, in the process of expansion there will be a substitution in favour of capital goods. Here the whole structure of relationship changes and no stable relationship is plausible.

When there is a change in wages, then the relationship also changes. When wages go up, we cannot throw out the labourers, because of the trade unions and their collective strength. In wage structure itself there is a difference - L_1 wages will stick more where trade union effects are high. A change in the wage of either L_1 or L_2 affects the relationship. If L_1 wages are changed, it first affects the relative

positions of L_1 and L_2, then L_2 and capital and investment. Here again stable relationship cannot hold good.

When there is a change in the output in the goods market, output will be changed depending on the demand. When output is reduced, it is not possible to reduce the workforce. Similarly, when we increase output we are not increasing the workforce all of a sudden. In any case, the stable relationship cannot hold good. Therefore, any estimate based on this assumption cannot be true.

Now the question is which one can be nearer to reality. It is really difficult to make a choice. As far as the figures show, estimates based on output and investment come nearer than that of investment and workforce or output and workforce. Therefore it may be better to choose either of them. Whatever the base chosen, when we estimate future demand, stable relationship cannot be relied completely. Even if it is relied on, due emphasis should be given to the other economic factors and forces which disturb the relationship.

Another reason for the difference in the estimates may be the nature of our plan targets. Many of our plan targets were revised from time to time and therefore, the estimates based on certain targets differed from those which were based on revised targets, though both of them were for the same period. For instance, the LSE-ISI-PPD estimates were based on the target growth of output given by PPD which assured a target of Rs.3,69,000 million total output by

1975-76. When IAMR made its study in 1967, the Planning Commission had revised the output to Rs.2,31,000 million because of the recession that our economy experienced. Therefore, it is natural that the estimates also differed. In this case the manpower planners are helpless. They are working in a given framework, provided by the overall economic planners. Here the framework itself was changed, but projections are based on the earlier framework.

This tells us only one side of the story, i.e. demand side. The other side which is equally important is the supply side. Here again we are not in a better position. Atleast in the case of stock taking of engineers, we can expect uniformity. When we considered the stock takings of different authorities - CSIR, IAMR, DGE&T, it was found that they differed substantially. Tables V.3,* V.4* and V.5* show the stock takings by different agencies. In the speciality-wise distribution of engineers the IAMR and DGE&T estimations show a difference of 85,000 engineers. This is substantially large number. The difference in other two agencies, stock-takings is also quite substantial. The total stock of engineers in 1968 according to IAMR calculations is 332,000 and that of CSIR is 326,100 giving a difference of only 5,900Q But the differences in speciality-wise, diploma-degree-wise are quite high.

The differences in stock taking may be partly because of the differences in the definition of manpower by various authorities. For example, CSIR uses educational qualification

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*See Appendix B

as the basis for definition of manpower, DGE&T uses occupational criterion and IAMR uses both. Not only in the definition but also in the process of collection the authorities differ very much.

V.2 The Projections Vs Reality

The above mentioned part forms only one aspect of the problem - the differences among the projections of demand and supply of engineers. The discussions will be complete only by considering how far these projections differed from the actual demand and supply. For this the actual intake or absorption of engineers is to be considered. Unfortunately, data regarding absorption of engineers are not available. If unemployment can be considered as a reasonable indicator of demand and supply maladjustments, we can draw some conclusions. Here again there is a problem, the estimations of unemployment by different authorities show a considerable difference. This is explicit in Table V.6* where we consider the unemployment calculations by DGE&T, IAMR and CSIR. DGE&T shows a total unemployment of 345,000, CSIR 375,000 and IAMR 40,000 for the year 1968. But these are not substantial when compared with the differences in the demand estimations.

IAMR in their study in 1969[1] projected the demand and supply of engineering manpower till 1978 and came to the

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*See Appendix B.

1. IAMR Working Paper No.11-1969.

conclusion that the demand and supply will balance by 1978 and hence there will be no unemployment. In the study[2] conducted in 1974 they came to the same conclusion, though it was not mentioned explicitly. When the projected employment was compared against the projected supply, employment will be more than the supply of manpower by the end of 1978. These conclusions were compared against the actual data available. The results were different.

The procedure that was adopted to get the actual demand and supply, is as follows. The data regarding the stock of engineers were collected from IAMR. The unemployment figures were collected from DGE&T. The stock was considered as the supply. To get the demand, the unemployment figures were substracted from the stock. In other words, the difference between demand and supply was considered as unemployment. Then these figures were plotted on a graph sheet. The data used for plotting the points are given in the table V.7*. This was compared against the chart that the IAMR had given in their study.[3] This showed substantial difference. In IAMR chart, the demand and supply coincides by 1978, where-as in our chart, demand and supply diverges showing an increasing level of unemployment.

This procedure has a number of limitations. Data from DGE&T regarding unemployment are not completely reliable.

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2. IAMR Report No.1-1974.

*See Appendix B

3. IAMR Working Paper No.11-1969, page 55.

In their own study in 1972[4] showed that out of the total registrants of engineering graduates, 43.5 per cent are employed and 1.8 per cent are students and for diploma holders, these figures are 41.4 per cent and 1.8 per cent respectively. The figures were not deflated before plotting the graph because we have considered the unemployment figures from 1962 and this type of calculations are not available for all years. Moreover, there is a considerable number of unemployed engineers who do not register.

Again, it is not always a correct practice to take the unemployment figures from one authority and stock from the others to find out the supply and demand. This is basically because, the stock takings of different authorities vary which we have already discussed. But IAMR has not estimated the recent unemployment figures and DGE&T has not estimated the total stock of engineers. CSIR etc. has estimated neither of the figures. Therefore, we resorted to this procedure.

Because of the above mentioned limitations, no precision can be claimed. However after giving allowance for all these, the fact remains that, the trend in unemployment is increasing. Moreover the trend shown by the two graphs differs; IAMR gives a balancing demand and supply trend by 1978, whereas the other gives a widening trend. This serves our purpose. Therefore, if unemployment can be considered as a reliable indicator of imbalance between demand and supply, then our projections are far from satisfactory.

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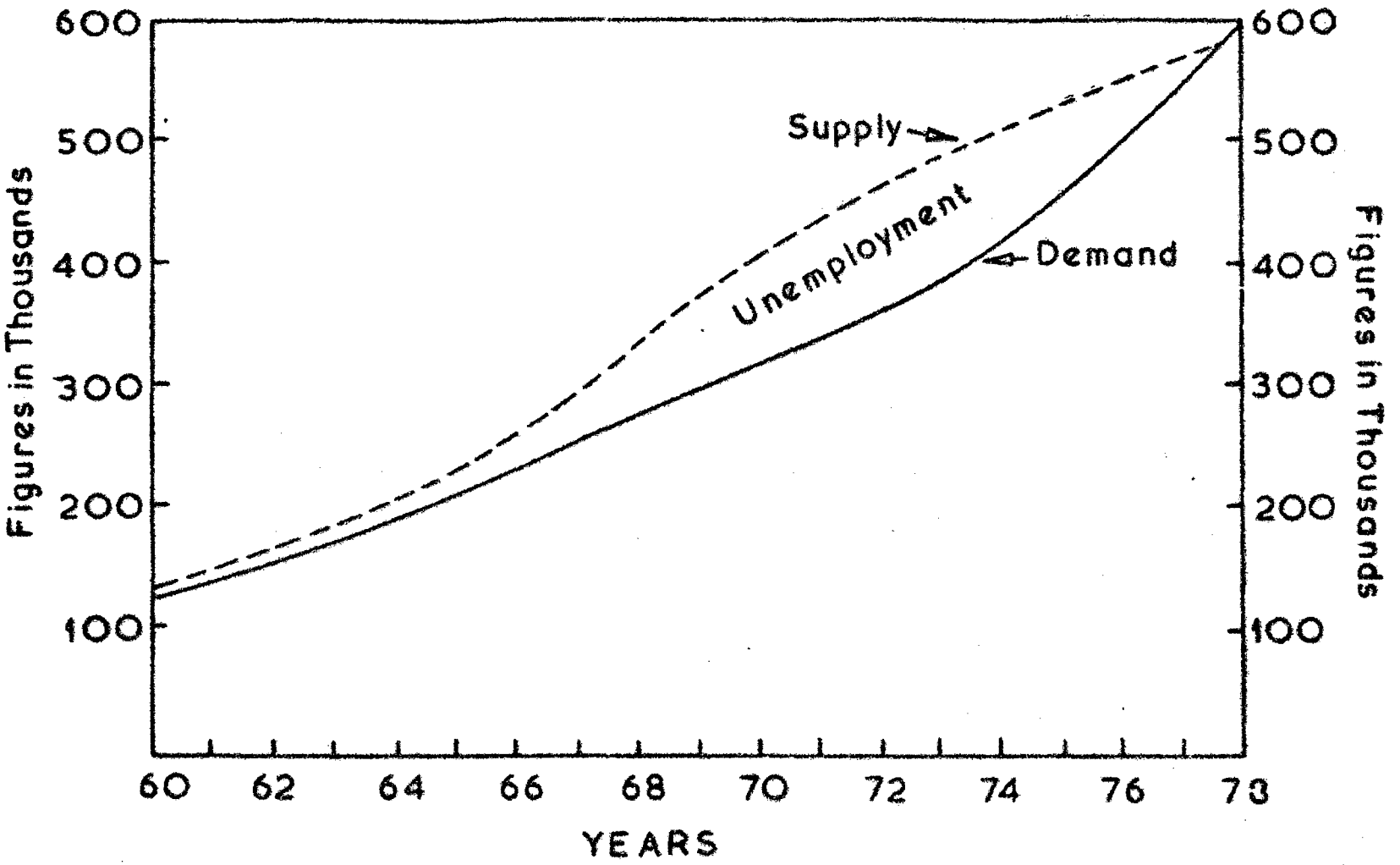
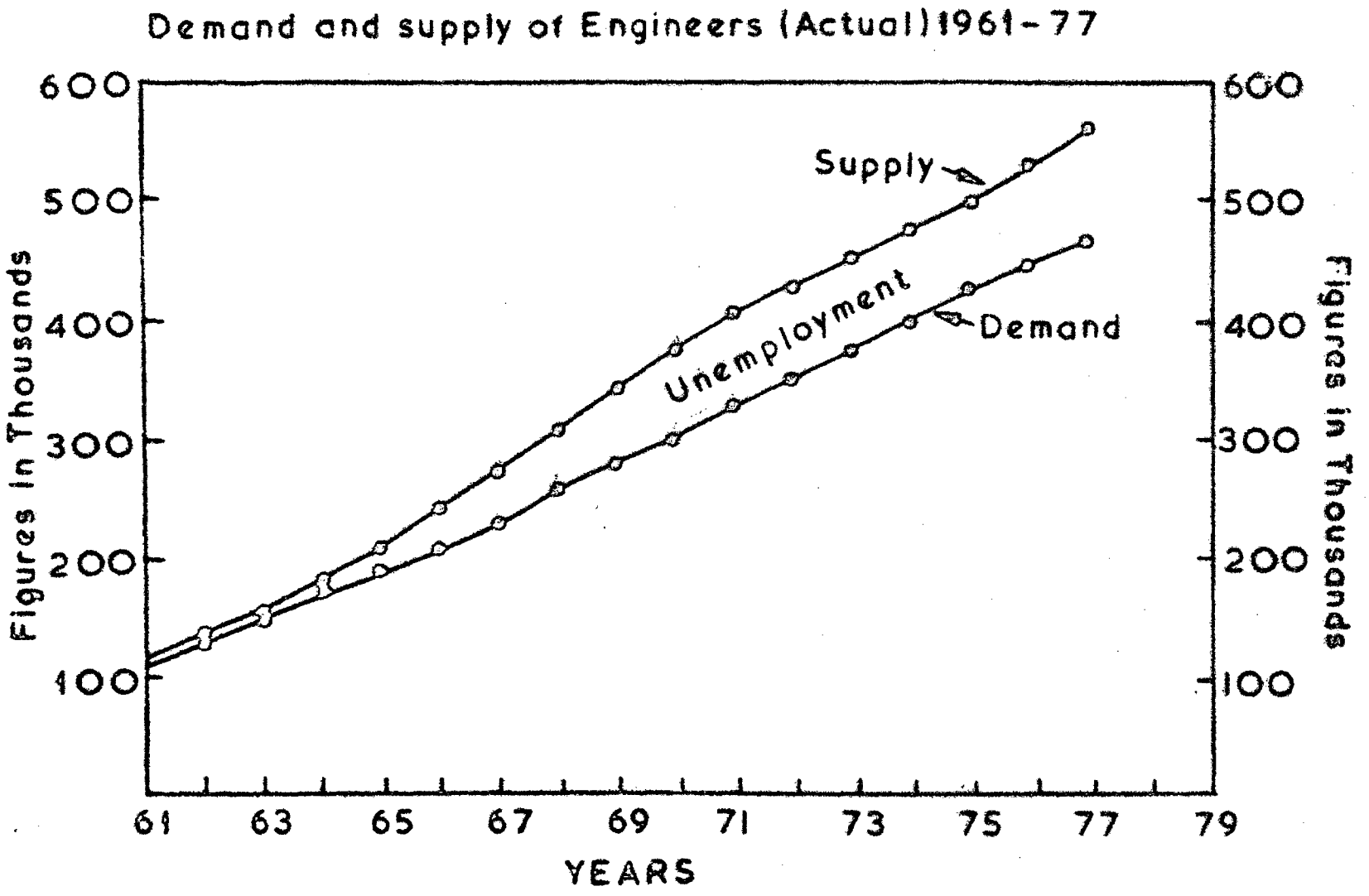
4. Report on the Survey of Employed Persons Among the Employment Exchange Registrants, DGE&T, 1972.

Demand and supply of Engineers 1960 to 1978 (Projected)



Source: IAMR working paper No 11/1969 p. 55


Demand and supply of Engineers (Actual) 1961-77
600
500
400
300
200
100
Figures in Thousands
Supply
Unemployment
Demand
61
63
65
67
69
71
73
75
77
79
YEARS

The question here is, can we blame the planning authorities for this mistake? IAMR Report 1969 gives some reasons for this unemployment. By 1968 the unemployment of Engineers was 17.1 per cent of the total stock. Moreover the report says that considering underemployment there is an underutilisation of 37,000 engineers. The reasons according to them are - the current unemployment is mostly due to the economic set-backing of 1965-66, the increase in the annual admissions to technical institutions, over and above this, the rigid targets in the third plan also contributed to this. Out of the total unemployment in 1968, 53 per cent is attributable to the effects of recession and 47 per cent to the increase in student admissions. Anyway they optimistically hoped that by 1978, there will be no unemployment. Another reason for the unemployment is the uncontrolled admission policies.

As far as the student admissions are concerned, it points to the distinct aspects of the same process. In our economy, there is a dichotomy between Planning authorities and implementing authorities. Therefore, all the recommendations are not implemented. IAMR in 1963 rightly detected the danger of increasing admissions and recommended for a halt in the expansion of engineering education; but the enrolment figures given in table V.8* show that it continued to increase.

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* See Appendix B

Again Education Commission (1964-66) recommended for a reduction in enrolment in the higher education. But it was not implemented. This was because:

(a) a shortage was considered to be more dangerous than a surplus;

(b) the parliamentary Committee which discussed the report proposed that higher education is a legitimate right of every individual who fulfills the eligibility criterion for higher education; and

(c) the enormous expansion and unemployment of the educated at the lower levels pressurised for an expansion of the education at the higher level.

Here, the planning authorities diagonised the symptom in time. But the implementing authority failed to do justice. It was felt that, it is difficult to control supply of manpower in countries like India where the substantial proportion of the demand for education comes from private individuals.

The first reason - the recession - points to a different aspect of manpower planning. Manpower planning is only a part of the overall economic planning. Moreover its projections are the translations of plan targets. When our planned targets are revised frequently and they fail to achieve even the revised targets, we cannot expect a part of it i.e. manpower planning can be successful. This is reasonable but not a complete excuse.

As regards the responsibility of planning authorities to this aspect is concerned, we have to distinguish two aspects in the planning process - forseeable changes in the economy and unforseeable changes. If the changes were forseeable, and the authorities failed to take it into account then the responsibility is with the planning authorities. For instance, every planner has to expect an inflation at a low rate atleast. If our plan targets are upset because of mild inflationary process, then the responsibility lies with the planners. On the otherhand if the changes were not forseeable, then they are helpless. For instance, we fought three wars within a decade starting from 1961-62. No planner can forsee this calamity; when a war is fought, all the earlier plan targets will be upset, the orientation of investment will be changed, even after the war, it will take a long time for the economy to reconstruct it. 1962 war overturned all targets of III Plan. The projection of manpower for III Plan period was based on the assumption that there will be a growth rate of 5 per cent per annum in the economy. But the growth rate came down to 2.5 per cent, defence expenditure increased enormously and all our projections went wrong. Similarly by 1966-67, our economy faced a recession partly because of 1965 war. Our Fourth Plan targets were forced to be revised and the manpower projections based on earlier targets went wrong.

CHAPTER - VI

SUMMARY AND CONCLUSIONS

This chapter summarises the discussions that were made in the previous chapters. The discussions in the earlier part can be divided into two - (a) theoretical considerations; and (b) the practice of engineering manpower projections in India. In the last part it tries to provide some suggestions on further studies.

VI.1 The Emerging Concept of Manpower Planning for Developing Economies

We have already argued that manpower planning in under-developed countries, as currently practised, is of little success. This has a number of built-in factors of failure:

(a) its inability to take into account the relative price changes;

(b) its inability to take into account the switchability of factors from one occupation to another which a proper education and training system should ensure upto a point;

(c) its inability to take into account the switchability of functions within each occupation (like foreman doing the work of an executive engineer or vice versa); and

(d) finally the essential problem in manpower planning in a developing economy is the problem of searching for appropriate technologies, i.e. not only moving along one PPC (say from a more capital intensive to a more labour intensive method of production) but also shifting from one curve (say, relatively capital favouring) to another (say, relatively labour saving). This needs explanation.

Manpower planning in the under-developed countries is carried on the 'static' framework which very often assumes constant technology and unchanging relative prices. In other-words it assumes a particular point on a particular PPC. First we questioned the validity of choosing a single input or a unique input combinations which prevents a movement along the same PPC.

In the second stage we argued for a shift from one PPC to another. This can be brought about only by a change in the dominant technology. Therefore, searching for an appropriate technology becomes an essential consideration for a successful manpower planning process in a developing economy.

To make the basis of manpower planning more refined and even more extensive we argued to take into account a vector of social objectives. In the discussions it was felt that mostly manpower planning is the manpower implications of planned output targets. This GNP-base narrows down the scope of manpower planning. Manpower cannot be treated as other

physical inputs. The outputs in the case of manpower planning incorporates a wider concept than GNP. The objectives mostly consist of a number of social welfare objectives which may not always necessarily be quantifiable. In this sense we argued for a 'target vector' to be the basis for manpower planning. This target vector includes several social objectives other than GNP. Though this may cause some difficulties at the planning level, it is essential. The 'target vector' - base of manpower planning casts out the possibilities of using GNP as a reliable surrogate of the outputs. Lack of a reliable surrogate casts doubt about using conventional economic tools to get optimum solutions in manpower planning. In other words optimal solutions become very difficult in manpower planning at this stage. Therefore, we are forced to carry out manpower planning at a still different level, where it is possible to obtain qualified solutions. This is why we resorted to the method of sub-optimal solutions.

VI.2 The Purpose and Limitations of Manpower Studies in India.

Engineering manpower projections in India were single valued predictions rather than a range of estimates. These single valued numbers were mostly derived from planned output targets. This creates problems atleast in two respects:

(a) Since they were signle valued projections it can be contradicted very easily. If we evaluate on its

numerical basis, there is a good possibility that it can be falsified very easily; and

(b) since they were derived from planned output targets, an evaluation of manpower planning in isolation is difficult. The success of manpower planning depends on the achievement of plan targets.

Many of the plan targets were not attained. GNP targets or its constituent targets were not achieved for one reason or the other. Therefore, manpower planning based on this GNP targets cannot be expected to be accurate. Very often it becomes difficult to evaluate how far our manpower planning process is successful or not. Therefore, a proper evaluation becomes difficult in the first place.

Many of the projections were for a considerably long period. The procedure adopted for these projections was to project the GNP for these periods and based on this projected GNP or its constituents, the engineering manpower demand was projected. In this process it was difficult to obtain sector-wise breakup of GNP precisely. The engineering manpower demand was estimated sector-wise, in many of the cases. This resulted in crude approximations and further assumptions. Here again, projections of demand and supply were less specific.

The conceptual difficulties also created problems of a different nature. The important conceptual difference was between classifications by occupation and classification by educational qualifications. Mostly, projections, atleast in the earlier stages were carried on the basis of educational

qualifications or certificates like degree, diploma etc. The recruitment in the labour market was on the basis of experience or the capability of an individual to perform a particular function. When we consider supply and demand projections as related categories, this creates difficulties. When the projections were carried on the basis of educational qualifications, the underlying assumption was that certain types of general and vocational education develop patterns of skill that are essential to perform corresponding occupational functions. This, in otherwords, specify the educational inputs that are required to produce a worker for a particular occupation. But such a rigid relationship is rare in many of the economies. As a result, when the projected supply targets were fulfilled, a considerable number of engineers in India is unemployed. In the engineering field 'practicals' form a good amount. In the earlier studies 'practicals' were not accounted for. However, in the latter periods the authorities realised its importance and were taken into account.

Coming to the assumptions of the studies, we are not in a better position. Different authorities in India made projections on engineering manpower. The assumptions used by them were different which we had already discussed. However, the recurring assumptions in many studies were constant output - engineer ratio and constant investment-engineer ratio or some of its constituents. These ratios

which they have used can be reliable accepted only after further testing. But data regarding these aspects are not available. Therefore, it is difficult to see how far these assumptions are valid in the real situations. However, there are indications that the productivity of engineers has decreased[1] which casts doubts on the validity of these assumptions.

Another problem which is still confusing is the engineer - technician ratio. The engineer-technician ratio is a concept based on the occupational structure rather than on educational qualifications. The question regarding what should be the optimum ratio is still not yet solved. However, it was hoped that the ratio should change according to the availability of supply of personnel. Diploma holders were produced in large numbers. But the absorption did not take place in the same line. This was basically because of the inadequate learning, training facilities provided to them. The employers are not ready to absorb them because their technical experience is too low. Even under these conditions, the supply of diploma holders continued to increase. As a result, there is substantial unemployment among diploma holders.

Another important drawback of our manpower projections is that in none of the projections utilisation rate of engineers is not considered. But underutilisation is a

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1. 'The output per engineer would continue to fall to Rs.5,70,000 in 1970 and Rs.4,60,000 in 1975'. Ahmad B, Blang M; The Practice of Manpower Forecasting, page 199.

recurring phenomenon in our country. The unemployment figures will become very high once we consider this aspect. Since the data regarding unemployment are not available nobody can be blamed for it. Atleast, at this stage the time is too late to have a data system for it also.

We have seen that there is considerable level of unemployment among engineers. The earlier predictions of the IAMR, stating that there will be a balance between supply and demand by 1978 has proved to be false. We have tried to estimate the trend and the extent of unemployment with the available information from different authorities. This is shown in the graph in the preceding last chapter and when it is compared against the IAMR prediction it again show a different trend. If unemployment can be considered as a reliable indicator of demand and supply maladjustments, then it is to be admitted that our engineering manpower projections failed to achieve its goals satisfactorily.

This unemployment problem is again partly because of the fact that in our projections the supply targets were fulfilled whereas demand targets were not. Demand targets were not fulfilled partly because the economy did not progress in the way as it was envisaged. The supply targets were fulfilled because whenever the studies recommended for an expansion in education it was implemented; but whenever the study asked for an 'expansion halt' or reduction in enrolment it was not strictly implemented. IAMR in 1963 and Education Commission (1964-66) recommended for an 'expansion

hault' and a reduction in enrolment. But the parliamentary Committee which considered these recommendations was of the opinion that higher education in India should be a legitimate right of each individual if he satisfies the eligibility criteria. Moreover, undue expansion at the lower levels and widespread unemployment pressurised for an expansion in higher education also. This points to another aspect. When substantial amount of demand for education comes from the private individuals, it is very difficult to control. Its implication being manpower planning can be successful when the planning authorities have a control over demand and supply of manpower.

To conclude, our engineering manpower projections, for one reason or the other, failed to provide us with a blue print for the future. In some cases, it provided broad guidelines which were not completely satisfactory.

VI.3 Some Suggestions on Further Study.

Till now we discussed the nature and fate of manpower planning process at its theoretical and practical plains. In the analysis it was clear that substantial changes at the theoretical level itself is necessary. Therefore, we argued for a new strategy which incorporates the search for an appropriate technology and a 'target vector'-base for manpower planning. But how far these can be put into practice is not yet tested and it is beyond the scope of the present study. Moreover, we did not consider the techniques that can be used to make it successful. Therefore, for further studies in this

field, we have to take into account all these aspects in detail and to find out a suitable technique which will not be limited to the mechanical process of projections with fixed ratios like output-engineer ratio, investment-engineer ratio etc.

APPENDIX-A

Table IV.1
Estimates of the Manpower Committee

Category	Number required for next five years 1947-52	Out-turn during next five years 1947-52	Balance (1-2)	Out-turn during next ten years 1947-57	Balance (1-4)
	(1)	(2)	(3)	(4)	(5)
Civil	8,170	2,240	5,930	5,240	2,930
Architects	320	40	280	90	230
Mechanical	5,610	1,020	4,590	2,050	3,560
Electrical	4,520	1,210	3,310	2,660	1,860
Chemical	600	460	140	1,020	420
Electrical and Communication	1,060	160	900	410	650
Aeronoutical	700	80	620	60	540
Minining	360	170	190	340	20
Automobile	270	-	270	-	270
General Electrical and Mechanical	2,840	1,390	1,450	4,410	1,570
Marine and Naval Architects	1,120	-	1,120	-	1,120
Metrallugists and Metrallugical Engineers	1,060	290	770	580	480

Source: Report of the Scientific Manpower Committee 1947 from IAMR Report No.7-1963 Part.II, page 39.

Table IV.2

Engineering Personnel Requirements for the Second Five Year Plan - Demand and Supply

Branch of Engineering	1956-57 Demand	1956-57 Supply	1957-58 Demand	1957-58 Supply	1958-59 Demand	1958-59 Supply	1956-60 Demand	1956-60 Supply	1960-61 Demand	1960-61 Suppl
Civil	1,814	1,371	2,000	1,532	2,200	1,522	2,400	1,744	2,700	1,864
Mechanical	851	759	923	787	1,003	796	1,138	900	1,251	960
Electrical	952	791	1,022	826	1,089	803	1,171	912	1,239	912
Tele-Com.	200	57	220	60	250	82	300	80	350	80
Mining	52	41	87	47	92	44	108	48	132	48
Metallurgical	150	58	180	59	199	55	84	56	80	56
Chemical including Chemical Techno.	311	444	312	440	469	463	528	474	636	490
Aeronautical	30	4	30	24	40	10	60	16	70	16

Source: Report of the Engineering Personnel Committee 1956, Govt. of India, Planning Commission, page 67.

Table IV.3

Engineering Personnel Requirements for Second Five Year Plan - Demand and Supply

Branch of Engineering	1956-57 Demand	1956-57 Supply	1957-58 Demand	1957-58 Supply	1958-59 Demand	1958-59 Supply	1959-60 Demand	1959-60 Supply	1960-61 Demand	1960-61 Supply
Civil	3,005	2,318	4,000	2,868	5,000	3,300	6,200	3,300	7,500	3,488
Mechanical	1,612	1,209	1,859	1,364	2,167	1,402	2,744	1,402	3,639	1,488
Electrical	1,503+ 10	1,128	1,700+ 26	1,070	2,002+ 35	1,110	2,414	1,110	2,809	1,204
Tele-Comm.	90	80	100	74	110	75	120	75	142	75
Mining	69	16	110	16	136	19	173	19	204	19
Metallurgical	31	19	36	21	41	19	46	19	50	19
Chemical	181+ 12	177	129+ 15	150	147+ 22	130	181	110	199	110

Figures added represent probable vacancies caused by promotion of overseers to officers

Source: Report of the Engineering Personnel Committee, 1956, Govt. of India, Planning Commission, page 68.

Table-IV.4

Additional Engineering Requirements for II Plan

Regional Department	Total Graduates	Total Diplomas
Northern Region	3,395	10,580
Eastern Region	4,892	13,218
Western Region	4,248	8,833
Southern Region	4,850	7,935
Ministry of Production	1,314	1,413
Ministry of Railways	800	3,550
Ministry of Iron & Steel	1,608	582
Ministry of NR and SR	249	136
Ministry of Food and Agriculture	164	258
Ministry of Communications	586	411
Ministry of Transport	680	920
Ministry of I & B	885	21
Ministry of Finance	28	32
Ministry of Defence	2,197	1,173
Ministry of Irrigation and Power	400	2,000
C.P.W.D.	332	1,368
Total	26,628	59,430

Source: Report of the Engineering Personnel Committee, Planning Commission, 1956, pages 48-63.

Table - IV.5

Position Regarding Demand and Supply of Engineering Personnel Requirements (1961-66)

Category	Degree Holders			Diploma Holders		
	Demand	Supply	Surplus (+) Deficit (-)	Demand	Supply	Surplus (+) Deficit (-)
Civil	12,500	16,700	+4,200	40,000	40,000	-
Mechanical	11,500	13,000	+1,500	17,500	16,500	-1,000
Electrical	11,000	12,700	+1,700	14,000	12,500	-1,500
Tele-Comm.	2,500	2,100	- 400	500	400	-100
Chemical	2,300	2,300				
Metallurgical	1,100	1,000	-100	800	100	-700
Mining	1,800	1,500	-300	4,000	2,500	-1,500
Others	2,840	2,440	-400	3,300	4,000	+ 700
Total	45,540	51,740	+6,200	80,100	76,000	-4,100

The figures are rounded to the nearest whole number. Supply under degree holders included 2,000 AMIE's foreign trained engineers.

Source: Report of the Working Group on Technical Education and Vocational Training 1960, April, page 38.

Table - IV.6

Estimated Requirements of Category-wise Additional Degrees and Diploma Holders During IV Plan 1970-71

Category	Degree Holders			Diploma Holders		
	Demand	Outrun	Surplus(+) Deficit(-)	Demand	Outrun	Surplus(+) Deficit(-)
Civil	18750-20250	18360	(-)390-(-)1890	57600-60000	46180	(-)11420-(-)13820
Mechanical	20250-18750	14345	(-)5905-(-)4405	26400-24000	19700	(-)16700-(-) 4300
Electrical	18000-18750	13770	(-)4230-(-)4980	24000-21600	15075	(-) 8925-(-) 6525
Telecom.	4500-3750	2870	(-)1630-(-) 880	1200-2400	95	(-) 1105-(-) 2305
Chemical	3750-4500	1150	(-)2600-(-)3350	4800-3600	945	(-) 3855-(-) 2655
Metallurgical	2250-3000	1720	(-) 530-(-)1280	1200-2400	1885	(+) 685-(-) 515
Mining	3000-3750	2295	(-) 705-(-)1455	2400-1200	945	(-) 1455-(-) 255
Others	4500-2250	2865	(-)1635-(+) 615	2400-4800	9925	(-) 7025-(+) 4625
Total	75000	57375	(-)17625	120000	94250	(-)25750

Source: Report of the Working Group on Technical Education and Vocational Training April 1960, page 40.

Table - IV.7

Estimated Requirements for Employment of National Stock of Engineering Degree and Diploma Holders

Plan Period and End Year	Graduates			Diploma Holders			Grand Total (4 +7)
	Employment in organised industries	Employment in services	Total	Employment in organised industries	Employment in services	Total	
1	2	3	4	5	6	7	8
			(figures in thousand)				
II Plan Period 1960-61	30	30	60	33	56	89	149
III Plan Period 1965-66	56	38	94	62	72	134	228
IV Plan period 1970-71	99	51	150	109	96	205	355
V Plan period 1975-76	170	70	240	188	133	321	561

Source: Compiled from IAMR Report No. 2-1965. Second Report on Engineering Manpower Survey. Demand and Supply of Engineering Manpower (1961-75) December 1965.

Table - IV.8

National Stock of Engineering Manpower

Plan Period		Degree Holder	Diploma	Total
			(figures in thousand)	
	Opening Stock	39	51	90
II Plan period	Growth	19	24	43
	Clossing Stock	58	75	133
III Plan period	Growth	36	59	95
	Clossing Stock	94	134	228
IV Plan period	Growth	73	146	219
	Clossing Stock	167	280	447
V Plan period	Growth	97	158	256
	Clossing Stock	264	438	702

Source: IAMR Report No.2-1965. Second Report on Engineering Manpower Survey. Demand and Supply of Engineering Manpower (1961-75) December 1965.

Table-IV.9

Demand and Supply of Engineers

Assumption	1973 Demand	1973 Supply	1973 Surplus	1978 Demand	1978 Supply	1978 Surplus
Total in thousand						
Low	357	485	+128	513	584	+71
Medium	384		+101	593		- 9
High	439		+46	710		-126
Graduates						
Low	143	209	+66	205	258	+53
Medium	154		+55	237		+21
High	176		+33	284		-26
Diploma						
Low	214	276	+62	308	326	+18
Medium	230		+46	356		-30
High	263		+13	426		-100

Source: IAMR Report No.11-1969. Employment outlook for engineers, page 53.

Table IV.10

Matriculates and Above Required by Industiry India 1960-86

Industry group	1960-61			1975-76			1985-86		
	Matric	Inter	Graduate	Matric	Inter	Graduate	Matric	Inter	Graduate
	(Figures in thousand)								
Agriculture	381	46	67	681	83	120	984	120	174
Mining	67	5	6	282	20	527	632	45	61
Manufacturing	436	90	103	2880	584	707	6681	1355	1642
Construction	99	30	19	503	150	97	1131	337	218
Trade & Commerce	452	100	92	1181	262	240	2565	570	522
Transport & Communication	318	80	94	1200	301	354	2608	654	769
Services (Others)	1509	404	765	4147	1040	1754	6677	1653	3156
Public Administration	723	245	296	1299	441	533	1923	652	789
Education	407	102	290	2112	463	877	3041	668	1723
Medical & Health	124	27	47	379	82	175	1139	248	360
Miscellaneous Services	195	30	132	357	54	169	574	85	279
Total	3262	755	1146	10874	2440	3299	21278	4734	6542

Source: Manpower and Educational Development in India,1961-86.
Tyrrell Burgess, Richard Layard, Pitambar Pant, page 14.

Table IV.11

Engineers Required by Industry India 1961-86

Industry Group	Graduates			Diploma Holders		
	1960-61	1975-76	1985-86	1960-61	1975-76	1985-86
	(figures in thousand)					
Agriculture	-	-	-	-	-	-
Mining	1	4	9	1	4	9
Household Industry	-	-	-	-	-	-
Other Manufacturing	18	97	240	18	97	240
Construction	10	50	110	9	45	99
Trade & Commerce	1	2	6	3	7	17
Services excluding teaching	16	67	148	39	163	361
Teaching	8	34	74	-	-	-
Transport & Communication	4	15	33	5	19	41
Total	58	269	620	75	335	767

Source: Manpower & Educational Development in India 1961-86. Burgess, Layand and Pant, 1968. page 22.

Table IV.12

Output and Engineers Required in Manufacturing Using the 1955 Ratios

Industry	Value				Engineers required			
	1955-56	1960-61	1975-76	1985-86	1955-56	1960-61	1975-76	1985-86
Food and Kindred Products	829	1235	2991	5911	438	653	1581	3123
Teatile Products and apparel	2068	2750	4250	15465	447	594	916	3344
Chemical & Allied Products	399	986	13115	29062	762	1883	2505	5550
Petroleum & Extraction	145	223	1850	3833	66	102	841	1744
Stone clay and glass products	177	305	1922	3935	268	462	2910	5958
Primary Metal Industries	237	533	7567	16453	490	1102	15646	34010
Fabricated Metal Products & machinery	298	1067	12204	29926	2826	10118	115725	283787
Transport & Equipment	390	879	3486	7888	645	1454	5766	13048
Other Industry	118	513	2254	5575	502	2182	9588	23714
Total	4661	8491	49639	118048	6444	18550	155478	374278

Source: Manpower and Educational Development in India. Burgess, Layend and Pant 1968, page 23.

Table IV.13

An Estimate of Net Output and Engineers Required by Sectors for the Years 1970-71 and 1975-76.
(output in ₹ of Rs. at 60-61 prices)
Estimate of Engineers on the Basis of Estimated Output.

Sector	Net output during 1970-71	Net output during 1975-76	Estimated Total recruitment of engineers (in thousand) 1970-71	Estimated Total recruitment of engineers (in thousand) 1975-76
Mining, Manufacturing and utility	49.5	80.3	193	365
Construction	6.1	9.1	45	70
Trade and Commerce	24.7	36.1	14	23
Transport and Communications	15.4	24.4	32	54
Educational Services	4.2	6.4	33	55
Govt.Administration	17.2	26.0	52	74
Other Services	23.3	35.3	31	55
Agriculture	90.6	108.7	3	4
Total	231.0	326.3	403	703
Total including practicals	-	-	456	766

Source: IAMR Report No.1-1967. Engineering Manpower. A sectoral study of Engineering Manpower Requirements upto 1976 based on output investment and workforce. (Compiled from page 10 and 16).

Table IV.14

An Investment by Sectors and the Requiremnt of Engineers based on it for the Years 1965-66 to 1970-72 and 1971-72 to 1975-76

Sectors	Investment during (in crores) 1965-66 to 1970-71	1971-72 to 1975-76	Requirement of Engineers (in thousand) 1970-71	1975-76
Mining, Manufacturing and utilities	7929	12708	163	279
Construction	2007	2800	42	63
Transport and Communication	3988	5382	27	44
Educational Services	710	970	52	92
Govt. Administration Trade, Commerce & Other Services	2905	3729	124	193
Agriculture	4095	4411	3	5
Total	23434	30000	411	676
Total including practicals			464	739

Source: IAMR Report No.1-1967.
A Sectoral Study of Engineering Manpower Requirements upto 1976 based on output investment and workforce (computed from pages 11 and 21).

Table IV.15

Estimated Distribution of Workforce and Requirement of Engineers Based on it for the years 1970-71 and 1975-76

Sectors	Workforce during (in lakhs)		Engineering Requirements during (in thousand)	
	1970-71	1975-76	1970-71	1975-76
Mining, Manufacturing and utilities	269.0	320.0	150	239
Construction	33.0	41.0	39	50
Transport and Communication	54.0	72.0	24	34
Educational Services	31.5	43.0	39	60
Govt.Administration, Trade and Commerce and Other Services	385.5	470.0	102	135
Agriculture	1293.0	1346.0	13	13
Total	2069.0	2292.0	356	521
Total including practicals			409	584

Source: IAMR Report No.1-1967 Engineering Manpower. A Sectoral Study of Engineering Manpower Requirements upto 1976 based on output investment and workforce.(Computed from pages 12 and 24).

Table IV.16

Employment from 1962 to 1968 and Projections of Employment for 1973-74 and 1978-79

Category		1962	1963	1964	1965	1966	1967	1968	1973-74	1978-79
Civil (including overseers)		71318	76228	81221	92064	101934	103054	104184	151706	241030
Excluding Agriculture		70951	75864	80877	91639	101410	102544	103694	150958	240746
Mechanical	(a)	26373	33074	40769	41639	51896	63688	75639	131227	253318
	(b)	26301	32952	40587	49428	51689	63456	75381	130745	252395
Electrical	(a)	19357	22150	25013	30556	36319	40064	43912	71938	122200
	(b)	19341	22061	24860	30480	36304	40036	43878	71887	122201
Chemical	(a)	2957	2962	2968	5244	7607	6172	4764	10225	18357
	(b)	2952	2957	2962	5240	7604	6170	4763	10222	18351
Metallurgical	(a)	825	1217	1716	1650	996	990	1190	1514	2906
	(b)	825	1217	1716	1650	996	990	1190	1514	2906
Mining	(a)	2051	2243	2439	2012	1652	2152	2651	4181	5057
	(b)	2051	2243	2439	2012	1652	2152	2651	4181	5057

Source: IAMR Report No.1-1974. Engineering Occupation in the V Plan. Compiled from pages 26,29,31,33,35 and 37.

Table IV.17

Stock of Degree and Diploma Holders in Engineering

Branch	Degree: Based on out run from colleges	Degree: Total incld. professional & foreign qualified	Diploma 1	Diploma 2	Grand Total
	1974 end				
Civil	50725	56024	95493	93534	149558
Mechanical	58774	63752	96123	94122	157874
Electrical	47175	50381	69908	68655	119036
Chemical	12801	12979	1365	1276	14255
Metallurgical	7247	7519	1200	1064	8583
Mining	2336	2341	2566	2564	4905
Electri.-Tele.	5659	8559	2972	1322	10281
Architecture	3956	3975	238	230	4205
Total	209234	226312	295915	289428	515740
	1978 end				
Civil	60213	66208	113115	110750	176958
Mechanical	69633	76103	121741	118964	195067
Electrical	58106	62407	92142	90317	152367
Chemical	16341	16644	2208	2057	18701
Metallurgical	9200	9630	1800	1585	11215
Mining	2552	2557	2917	2915	5472
Electri.-Telecom.	8702	13243	4515	2245	6760
Architecture	5661	5277	652	644	1296
Total	257198	278183	374523	365922	644105

Source: IAMR Report No.1-1974. Engineering Occupation in the V Plan, pages 72 and 73.

Table IV.18

Range of Additional Requirements of Degree and Diploma Holders in Engineering for 1978-79

Category	Proportion of practicals remain the same		All new entrants being qualified	
	Graduates	Diploma	Graduates	Diploma
Civil	26632	54695	32404	70670
Mechanical	47731	37434	60389	74627
Electrical, Electronic)	19332	23503	24666	38474
Chemical	4312	638	5564	4163
Metallurgical	608	150	816	738
Mining	449	153	624	597
Total	99064	116573	126943	189269

Source: IAMR Report No.1-1974, Engineering Occupations in the V Plan, page 71.

APPENDIX-B

Table V.1

Range of Projections of Engineering Requirements 1970-71

Approach	Degree and Diploma holders based on			Total including practicals based on		
	Output	Investment	Work force	Output	Investment	Work force
Sectoral	403	411	456	456	464	409
Two-sector	395	354	341	448	407	394
Global	371	325	333	424	378	386

Source: IAMR 1967 A Sectoral Study of Engineers based on output investment and workforce, page 29.

Table V.2

A Comparison of Estimates of Demand for Engineering Manpower by Different Authorities and their Basis

Approach Organisation	1970-71 Degree & Diploma Output	Invest-ment	Work force	Totals including 0 practicals Output	Invet-ment	Work force
	(figures in thousand)					
Sectoral						
IAMR	403	411	356	456	464	409
Two Sector Approach						
IAMR	395	354	341	448	407	391
Global						
IAMR	371	325	333	424	378	386
Planning Commission, Directorate of Manpower, Ministry of Education	420	422	NA	434	436	NA
Working Group on Technical Education and Vocational Training	Not worked out	440	450	NA	NA	NA
	1975-76					
Sectoral						
IAMR	703	676	521	766	739	584
ISI-LSC-PPD	878	NA	NA	NA	NA	NA
Two Sector Approach						
IAMR	694	650	486	757	713	549
Planning Commission, Directorate of Manpower, Ministry of Education	720	NA	NA	732	NA	NA

Source: IAMR Report No.1-1967. A Sectoral Study of Engineering Manpower Requirements upto 1976 based on output, investment and workforce, page 29.

Table V.3

Distribution of Engineers and Engineering Technicians by Speciality 1966

Engineers by Speciality	DGE&T Total	DGE&T % of the Total	IAMR Total	IAMR % of the Total
Civil	73017	49.89	96700	42.8
Mechanical	40123	27.42	67200	20.1
Electrical	25577	17.48	52600	18.3
Chemical	5357	3.66	6600	3.3
Metallurgical	1016	0.69	3500	1.7
Mining	1219	0.86	4300	1.4
Grand Total	146349	100.00	230900	87.6[1]

1. Total is less than 100% because of the exclusion of unclassified engineers

Source: Occupational Educational Pattern in India Public Sector 1966 DGE&T, Govt.of India 1966, page 7.

Table V.4

Stock of Engineering Personnel at the End of (figures in thousand)

	IAMR Degree				IAMR Diploma			
	1955	1960	1965	1968	1955	1960	1965	1968
Civil	109	195	298	393	211	371	594	775
Mechanical	72	125	234	346	85	141	322	568
Electrical	62	102	183	279	79	125	265	421
Telecommunications	5	9	19	29	3	6	11	18
Metal	11	19	28	40	3	4	4	6
Mining	5	9	19	25	6	10	21	26
Chemical	27	40	56	77	4	4	4	4
Others	55	81	118	147	55	90	117	158
Total	346	580	955	1336	446	751	1338	1984

Source: Fact Book on Manpower Part III, Scientific and Technical Personnel IAMR Report no.5-1967, page 11.

Table V.5

Stock of Engineering Personnel at the End of

Speciality	CSIR Graduates				CSIR Diplomas			
	1955	1960	1965	1968	1955	1960	1965	1968
	(Figures in thousand)							
Civil	125	213	342	463	243	384	624	796
Mechanical	76	128	257	391	90	145	338	510
Electrical	63	106	208	356	66	108	260	414
Telecommunications	7	13	24	48	5	9	15	19
Metallurgical	8	13	24	35	3	3	4	4
Mining	5	9	20	29	4	8	19	25
Chemical	30	44	59	73	2	3	4	5
Others	8	19	36	48	17	37	38	45
Total	332	545	970	1443	430	690	1302	1818

Source: Fact book on Manpower Part III, Scientific and Technical Personnel. IAMR Report No.5-1969, page 11.

Table V.6

Estimates of Unemployment Among Degree and Diploma Holders in India According to Different Sources 1968.

Source	Date	Degree	Diploma	Total
		(figures in thousand)		
DGE & T Employment exchanges and register	December 1967	6.2	28.3	34.5
CSIR estimates	July 1968	7.5	30.3	37.5
IAMR estimates	December 1967	6.5	33.5	40.0
	December 1968	10.0	46.7	56.7

Source: IAMR Report No.5-1969, page 91.

Table V.7

Demand and Supply of Engineers

Year	Unemployment	Supply	Demand
1962	13019	146050	133031
1963	14828	165826	150998
1964	12981	188047	175066
1965	17033	210274	193241
1966	26474	245474	219000
1967	46538	278258	237720
1968	55715	313225	257510
1969	62927	346119	283192
1970	66098	375426	309328
1971	74057	410444	336387
1972	83474	436136	352662
1973	78991	459922	380931
1974	74227	482668	408454
1975	74211	508333	434122
1976	82267	537198	454931
1977	94979	565641	470667

Source: Unemployment Data are from Live Registers of DGE&T
Supply (stock) data re from IAMR (unpublished)

Table V.8

Enrolment Figures

Year	Degree Holders		Diploma Holders	
	Sanctioned intake	Actual intake	Sanctioned intake	Actual intake
1961	15850	15850	27701	27701
1962	16882	16882	30826	30826
1963	20798	20744	39712	39712
1964	23480	22214	45853	41645
1965	24353	23315	47648	43984
1966	24462	24934	48087	48087
1967	24706	24571	46600	42600
1968	23051	18445	46372	27254
1969	20986	17853	42886	26585
1970	20734	17907	42363	27862
1971	21044	18197	42977	33151
1972	21198	19997	43294	36675
1973	21198	21199	43294	41333
1974	21198	21870	43294	43984
1975	22492	22454	44769	44961

Source: Survey of Facilities for Technical Education in India, Ministry of Education and Social Welfare, Govt. of India.

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