Role of Research in Railways of Developing Countries

By

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INTRODUCTION

'Research' is a broad term and is now being used to designate a wide variety of activities, sometimes to the point of being overworked or abused. The dictionary meaning of research is "A studious enquiry or examination ; critical and exhaustive investigation or experimentation having for its aim the discovery of new facts and their correct interpretation, the revision of accepted conclusions, theories or laws in the light of newly discovered facts, or the practical application of such new or revised conclusions, theories or laws. This in simple terms means the acquisition of new knowledge and application of old knowledge to new situations.

Engineering research is of two main types, fundamental research and applied research. Basic research, the pursuit of scientific knowledge in advance of a need for specific applications, rightly continues to be the concern of the universities, technical colleges and science academies. Scientific curiosity is the motivation for this new knowledge. Applied research is putting technology to work and it seeks to apply the results of the basic knowledge to a particular problem and bring it to a successful realisation. The bulk of applied research is carried out by industry in order to retain its competitive advantage, to expand its economic horizons and, in fact, for its very survival at a time when technology is marching fast. It is competition that forces technological change—competition in science, like competition in politics, sports, marketing, etc. make things happen.

There is yet a third type of research activity which is of great importance to us who belong to developing nations. For want of a better word I will call this 'adaptation research'. It is fortunate that the advanced countries of the world have spent millions in conducting research on problems of our concern, the results of which are well known and the processes for which have been fully established and tested. There is no point in our going through the same expensive drill all over again or to try and discover new and untried processes. What is actually necessary is to undertake an extensive programme of adaptation and modification of the known techniques and results of research

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to suit conditions in Pakistan. It is this type of research which has primarily enabled Japan to catch up, and in some instances to overtake, the advanced countries in streamlining and modernising their industries and their economies.

Appreciating the value of 'adaptation research' in the present state of development of our country, the President has been pleased to issue the following directive in July 1965 :—

> In the Cabinet meeting the President was pleased to emphasise the urgent need for obtaining scientific literature and other papers containing information regarding the results of research in every branch of science and technology including optics and electronics in advanced countries from research organisations through our Embassies, Scientific Liaison Officers in USA, Russia, U.K., Germany, Japan, France, etc. He further emphasised that Pakistan could not afford the funds and time to conduct all types of research in every field and obtain results. Moreover, the advanced countries enjoyed better facilities for research. There were numerous instances of different countries having fruitfully utilised the results of research conducted in other countries. Countries like China and Russia had reaped large benefits in this manner.

THE FUNCTION OF RESEARCH IN DEVELOPING COUNTRIES

This section will briefly consider the role of research in a developing nation and its important purposes.

At the outset, it has to be realised that in many of the developing countries, there is often no long tradition of research other than that of an academic type confined to old-established universities and devoted mostly to linguistic, historical, cultural and sociological studies. Very little was done to pursue subjective lines of research likely to be of practical significance in the fields of industry, engineering, utilisation of indigenous resources etc. Even a huge public sector undertaking like the Indo-Pakistan Railways, which prior to independence had an investment of more than eight hundred crores rupees, did not have a properly organised research establishment. In various branches of engineering there was no research activity at all worth the name, the only notable exception being hydraulic research that was being done in Punjab which has and continues to make significant contribution to knowledge on irrigation engineering.

The second important point to appreciate is that research in an expensive undertaking. The investment in scientific research and development in advanced countries ranges from 2 to 3% of the Gross National Product.

Britain is said to have spent $1775 million on research and development in 1961-62 which comes to thirty-one dollars per head. It is understood that the entire scientific effort in our country does not exceed twenty million dollars which is just about a quarter per cent of our G.N.P. and works out to one-fifth of a dollar per head.

Not only is the cost of research, in monetary terms, high, but its demands in skilled personnel are great. In many of the developing countries the number of scientifically or technically, trained personnel is still very small, and even fewer are the scientists capable of undertaking really useful research on their own initiative. Training a research worker is a costly and time-consuming process. The limitations brought out above do not imply that research cannot be undertaken, on the contrary they serve as a sound basis for establishing some of the ground rules for the proper functioning of research in developing countries. They may be spelt out as follows.

Till a proper climate for an exhilarating growth in research is attained, it is imperative that the available resources of equipment and scientific man-power be used to the best and most immediate advantage. This in essence means that we have to be "most thoughtful and deliberate in the allocation of scientific effort and in the selection of areas of scientific opportunity". It is important to ensure that financial assistance is effectively used only for purposes that are likely to benefit a developing country, to expand its economic horizons, to explore and intensify the utilisation of its indigenous resources and to tackle and overcome its specific problems—in short, research to be effective, must be down-to-earth. It also means elimination of such negative functions as the so-called research which, in fact, might be a reproduction, under slightly different conditions, of work done in more scientifically advanced countries ; temptations to undertake research in areas that are currently fashionable ; tendency to select research programme primarily with the objective of producing a paper and gaining publicity.

Another factor equally important is the need to achieve effective co-ordination of national research work, ensuring that the available finance and talent are used to the best advantage for the country as a whole. Of late, it has become fashionable to start research centres, for considerations of prestige as well as just to climb aboard the bandwagon. Confusion is worsened by certain testing laboratories claiming themselves as research establishment. A massive effort is needed to channelise the activities of the various research organisations and to give directions to their effort. An extension of this theme will encompass maintenance of liaison with research establishments in more advanced countries, interpretation of the results obtained abroad and introduction of such news techniques as may be well suited to local needs.

Regarding the function of research in a developing nation or industry,

Mr. Goldman, Director of the Scientific Laboratory of Ford Motor Company in his paper on 'Economic Growth through Research' observes that there are at least four significant and independent 'foundations' to justify expenditure on research. One is purely defensive ; stagnation means death and we have to keep pace with the present advancement in technology for our very survival. Research is a necessary ingredient for industrial as well as national security and growth. The second reason Mr. Goldman mentions is that 'competent personnel active at the very frontiers of science help maximise the probability of internal corporate innovation'. The third reason mentioned is that 'research is an excellent means, for the achievement of diversification'. A good research programme will invariably create and lead into new fields. The fourth and probably the most important factor is that research is increasingly an important source of management personnel. Top management today needs technically oriented people and one of the best means of finding them and keeping them is through the research establishments.

ROLE OF RESEARCH ON RAILWAYS

The philosophy of research in the context of rapidly developing economies in countries that have yet to develop scientific effort to match the pace of progress, has been briefly touched upon in the preceding paragraphs. Narrowing down the field, the specific role research plays in the railways of these countries and its organisation to ensure optimum results are now to be looked into.

The railways are a large industry ; they are, of course, not a manufacturing industry but an industry that provides a service. Its products are passenger-miles and ton-miles. The railway transportation system is the most vital of infrastructures essential for the development of national economy and, in fact, the pace of development of transport sets the pace for development in other sectors. The public have a vital stake in the healthy state of the railways, as a large amount of public money is invested in them ; the capital at charge of the Pakistan Western Railway is now as much as Rs. 165 crores. Thus the railway have a dual role to play. As a public transport undertaking it is under statutory obligation to provide services which the community needs, at a cost strictly controlled by the Government. As a commercial undertaking it has to ensure a fair return on the capital invested.

The facts brought out above serve as a basis for determining the motivation for planning and operating railway research programmes. The central objective of research on railways could be specified as the application of advanced practices in technological as well as organisational fields to help make them a progressive and expanding industry ever sensitive to the needs of the customer.

Organised research on most of the railways on the national as well as on the international scales came into being only after the end of the Second World War. Prior to this, the railways, basking in general prosperity, were more concerned with development rather than research for which they did not have the necessary environmental incentive. For instance, the state of affairs in Britain, the home of railways, was summed up by General Sir Brian Robertson, Chairman of the British Transport Commission as :

> In the days gone by, when many very good things were done on the railways, there was certainly not, it seems to me, built up a very strong research organisation by the former groups, or by the companies that made up these groups originally. Certainly what was inherited in 1947 did not represent a great deal in the way of tangible research assets. The Midland Railway, it is fair to say, was alone in having a real comprehensive laboratory organisation at Derby. Elsewhere there were a certain number of research establishments of a modest character, and they were particularly concerned with chemical analysis—for example, with the analysis of the water that was used in locomotives and dining cars, and various matters of that sort. That was the kind of set-up that was taken over. In saying that I am not in the least criticising, and I dare say that that is what was fairly required in those days. But at all events the visible assets in the research field were pretty modest.

The situation was totally different after the Second World War. In Europe, the railways had been completely destroyed and in the rest of the countries they were in a run down condition. The railways were therefore placed high in the priority list for post-war investment and at the same time opportunity was taken to modernise them. As the railways did not have a sound research base there was a heavy time lag in drawing up and implementing modernisation programmes and in introducing new methods, services and equipment. In Britain, modernisation was not started until 1955. Another important change that occurred was that the railways started losing their predominant position in the transportation field due to intense competition from road, waterways and air.

The struggle for survival, the need to retrieve the railways from their declining trend and poor financial health, compelled the administrations to make imaginative use of research of all kinds in order to convert a drab and inefficient system, into a truly modern one, shaped to existing and future needs. Railway research, however, falls into two main classes : Technical and non-technical.

Technical Research

It is generally held that there is no such thing as research, in the true sense of the word, in railways, *i.e.*, 'finding of new ways of influencing processes, application or creation of new materials and procedures, etc.' However, immediately after the war, railway administrations in advanced countries started expanding their laboratories and testing equipment, and also whatever little research facilities they had. It was soon found that no railway administration individually could afford to put in all the research effort required of its own. This led to the need to co-ordinate research work internationally and to use the laboratory and testing facilities in various countries to common purpose, the more so as the railways do not compete against each other and contrary to the situation in manufacturing industry any result obtained from research cannot be used by one railway to obtain an advantage over the others. For this purpose an organisation,—Office for Research and Experiments (ORE)—was set up in 1949 under the aegis of the International Union of Railways (U.I.C.)

It will be necessary here to digress a little and see briefly how ORE is organised and how it functions, because it shows the way how research effort in developing countries, especially those in the ECAFE region whose railways face similar problems, could be co-ordinated and pooled for common benefit. ORE now represents in all 36 railway administrations, but it is directed by a control committee of delegates from 13 member railways of U.I.C. Its research work is controlled by a bureau of 12 or more engineers, with suitable technical and administrative staff, who come from railways that are members of the U.I.C. These engineers when attached to ORE are not considered representatives of their respective administrations, but as international servants working in the general interest of all U.I.C. members without national bias. Any member administration can propose a problem or subject for study, as can the control committee or the technical committee or the board of U.I.C., but the subjects to be investigated have to be approved by the board of U.I.C. After a question has been approved for study, the control committee appoints an expert committee of engineers, normally from six to eight in number, from member administrations who are acquainted with the subject.

During work for ORE, these engineers are expected to work on a strictly objective basis and not necessarily to adopt the views officially held by their own administrations on the matter. The expert committee begins its task by an enquiry of all railway administrations as to the work they have already carried out on this subject and the data that may already exist. Next, a working programme is drafted with an indication of the research facilities that may be required and the likely costs, which must be approved by the control committee before work can begin. Both progress reports and a final

report are issued, which are subject to discussion and approval by the control committee. After the final report has been approved it is distributed and the question is regarded as closed. Since its inception, ORE has worked on 91 problems on subjects falling under the following main groups :—

(*a*) Electrical questions (electric traction, signalling, telecommunications).
(*b*) Rolling Stock.
(*c*) Interaction of vehicle and track.
(*d*) Permanent Way.
(*e*) Materials.

Another task for ORE is the standardisation of railway equipment not only to facilitate international operation but to reduce production costs. Such studies cover all fields of railway technology ; rolling stock, track, signalling and other installations, electrifications, etc. ORE also supplies technical documentation to member administrations at request.

A special mention has to be made of the fact that ORE works in close contact with industry, with laboratories of universities in several countries, with governmental or private research organisations and particularly with railway research centres elsewhere, such as the Japanese National Railway Research Institute, the Research Department of the Association of American Railroads and the Technical Railway Research Institute in Moscow.

The position of technical research could then be summed up as follows :—

(*i*) Research as carried out by railways is 'rather a probing of way to apply findings in other industrial fields to railway technique'.
(*ii*) Research effort needed, in the context of present technological advancement, is so massive that organisation on international lines is essential to achieve effective and worthwhile results.
(*iii*) It will be extremely useful if an organisation on the lines of ORE is set up under the aegis of ECAFE so that a proper climate of co-operation and participation is established among the railways in this region.
(*iv*) Every railway must have its own technical research cell whose functions should be :—
  (*a*) to maintain with other national and international research organisations,
  (*b*) to serve as a receiving and clearing house for information,
  (*c*) to keep the railway abreast of the latest technical developments, and to appraise such developments for possible economic applications on the system,
  (*d*) to provide a technical consulting service to all departments,
  (*e*) to provide inspection and quality control of equipment and

materials purchased by the railway, and

(*f*) to ensure full exploitation of indigenous materials and products.

Non-Technical Research

In this category fall a varied range of research activities arising from the commercial needs of the railway as an industry. As already observed, the products of the railway industry. As already observed, the products of the railway industry are passenger-miles and ton-miles. They are, however, different from other industrial products because they cannot be stored or preserved—they are lost immediately when not consumed at the moment they are being produced. This important factor demands a very careful planning of production. But, apart from this, the railways have to maintain their effective competitive position with respect to other modes of transport and have to be continuously on the look out for measures to expand the scope of their business and to increase their output.

Thus the objective of general or non-technical research should be to increase the efficiency of the whole transport process : the turn-round of cars, the optimum use of capacity of yards and lines, time-tables, shunting schemes, storage etc. It should also aim at moving trains faster and at less expense, and most important of all, to attract new business and retain old business. To achieve these ends a continuous study is demanded of the general economic situation, production trends, market conditions, traffic pattern, etc. as well as a continuous critical examination of railway's performance. The motivation all the time is to have a truly modern railway shaped to existing and future needs, so that it continues to function as a powerful, efficient and worthy instrument in the service of the community.

Railway organisations in advanced countries are keeping themselves abreast of developments in scientific fields such as cybernatics and computor technology, and also latest trends in the fields of development economics, business administration and industrial organisation and adopting them promptly to railway needs to realise the objectives referred to above. The principal type of research activities employed are operational research, market and customer research, general economics and forecasting studies, development planning, work study and O&M. In an excellent article on 'Future Railway Research : Some Objectives', Mr. S. R. Wise of the British Railways Research Department, has observed that the urgent need of the railways is for a research organisation which would facilitate the flow of ideas through the various stages, *viz.*, Commercial Policy—Market Research—Operational Research—Technical Research—Development—Production and that if railways are to persist in any substantial form, research should be brought into closer contact with commercial

policy and traffic problems and, in fact, it should be integrated into top management policy.

A very good example of what has been achieved through an intelligent use of the above techniques is the high degree of efficiency and vigour attained by the French Railways (SNCF). A few figures which enable an assessment to be made of the ground covered are reproduced below from an article by Mr. J. Antonini, General Secretary of the SNCF :—

> From more than 500,000 employees in 1938, the staff strength had fallen to 362,000 employees at the end of 1964. Over the same period, passenger traffic increased by 71 per cent and good traffic by 146 per cent. Staff productivity, measured by the number of kilometric units corresponding to one hour of work by one employee, thus rose to the coefficient of 177 in relation to the pre-war index.....
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> The productivity of rolling stock also developed considerably bu virtue of its more intensive utilisation. Thus it was that goods traffic in 1964, although very much increased, was in fact handled by a fleet of only 345,000 wagons as against 472,000 in 1938. The productivity of tractive stock more than tripled. Power consumption, expressed in a coal equivalent, decreased by more than 40 per cent. In 1964, goods traffic reached a figure of 65.5 billion tonne-kilometres, whilst 38 billion kilometric units were recorded for passenger traffic.

We may now briefly examine how the railways in advanced countries are making use of various types of research activities mentioned above. The following is mainly based on the articles which have appeared from time to time in the monthly bulletins of the International Railway Congress Association and Mr. Wise's article referred to above, supplemented by information collected from other sources.

Market Research

The objective of market research is to make commercial activities of the railways increasingly dynamic in order to effectively compete with other modes of transport and to attract for the railway a sizeable share of the overall increase in the national traffic. The extent to which this is achieved depends on the effectiveness of the sales organisation in offering the best service on the most favourable terms. The only satisfactory initial approach to the problem is to organise and set up market research teams to investigate and plan marketing strategies. Such studies must begin with the basic commercial problem of what traffics are available, and in what sort of quantities etc., and continuously review the extent and quality of services provided, as well as the pricing policy

and competitive conditions.

It is said that pilot surveys by market research consultants carried out on the British Railways some time back brought to light the amazing fact that because of the quality of service many traders would not send their produce by rail even if it was carried free.

An important wing of market research is the customer research service, whose main function is to provide the freight sales department and the customers with technical assistance through co-ordination of the skills available within the organisation. It is this wing that has initiated new practices in freight transportation like piggy-backing, container services, door to door delivery service, etc., and pays constant attention for improving methods of handling material, packaging goods, etc. On the passenger side, they strive to work out ways and means to make the railway journeys as easy and as pleasant as possible.

General Economics Branch

The main concern of the general economics branch is to keep a continuous watch on the pulse of the national economy and its relationship to the railway. It is the function of this branch to keep abreast of current economic conditions and to prepare reports on changes in existing and prospective business conditions with particular emphasis on how these changes will affect the railway.

Another important function of this Branch is to prepare long and short term traffic and revenue forecasts. Accurate and informed economic forecasts are prime tools for shaping strategy. They are particularly useful for the railway in view of the time required and heavy costs involved in constructing large new works and the long life of the fixed installations and rolling stock. Based on these forecasts, the railway work out the investment plans which enable them to provide those transport services for which they are best fitted, from the point of view of both cost and quality. They also enable the railways to avoid over-capacity which may lead to costly operation and under-capacity which would slow down economic progress.

Operational Research

This is a comparatively new science, but is fast becoming the most important of all research activities on the railways. It aims at helping general management and other levels of management in their pursuit of the best possible decisions regarding complex managerial problems. It does not, however, claim to make the decisions which remain a privilege of management, but to "prepare these decisions by scientific methods". Its function is "to apply modern methods of scientific analysis to railroad activities and by so doing to develop plans and procedures which improve the overall performance of the railway". Thus, this

Branch acts as a consultant to management in the areas of business analysis, management science, operational problems, inventory control, electronic computor systems and other phases of business and operational activities requiring mathematical and scientific skills and insight. It is staffed by talented engineers, economists and mathematicians trained in operational research (O.R.) methods.

Railway Administrations in many of the advanced countries have gone in for O.R. in a big way. Even though this science is still in the process of development, specially in reference to application to railway problems, many of the Administrations consider that "operational research is capable of providing an excellent tool to promote the effort which is required to bring about the earliest possible improvement in the economic efficiency of railways through reducing production costs and improving the quality of services in order to attain increased productivity". Thus, the application of O.R. methods to railway working will help to ensure that the railways remain competitive with the most modern systems of transport.

A few examples of how this new science is helping the railways in realising the above-mentioned goals are given below :

(*i*) A railway system where there are many alternative routes can be considered as equivalent to an electrical resistance capacity network. Here the freight depots would be represented by electrical capacitors and the running lines by resistances so that use could be made of electrical network theory and mathematical analysis to select routes between different terminals that would ensure that the resistance in the running lines (*i.e.*, the number of trains which can pass in a day) is matched to the full potential capacity in wagons per day of the freight depots and *vice versa*.

(*ii*) On the Canadian National Railway, a computer is programmed to include all the factors involved in the operation of a train under any condition or combination of conditions. The 'output' of the computer prints statistical and graphical information from which conclusions can be drawn, and on which managerial decisions can be made with the assurance that the information entering into those decisions is as up-to-date and accurate as modern technology can make it.

(*iii*) An OR technique known as the Critical Path Method (CPM) is playing a vital role in programming execution of projects and in cutting down their duration. In any project there are one or more chains of jobs that control the time needed to complete the whole project. These jobs are 'critical' because there is no spare time associated with them and a delay in any one of them will affect all the jobs that follow. A chain of such critical jobs is called

a critical path. Thus, CPM is used to calculate the project duration and identify the critical chain of activities, and these help the project manager to select the best work schedule and to avoid bottlenecks.

(*iv*) Other spheres of railway working in which OR methods are being used are in the optimum distribution of empty wagons, determining optimum maintenance cycles, programming the distribution of diesel and electric locomotives, research on the saturation limits of the means of transport and their installations (lines, stations, marshalling yards, railway junctions, etc.), market analysis and its correlation with passenger and goods traffic.

(*v*) OR methods are also used for framing stores policies with a view to optimising the purchase, storage and distribution of materials, for the quality control of purchases, for the automatic renewal of stocks and for the associated accounting operations of all transactions. As far as financial policy is concerned, operational research is capable of suggesting the optimum choice for the best utilisation of a given amount within the total programme of scheduled works and investment.

It would thus be seen that in every sphere of railway working OR methods are being applied to evolve the most practical operating procedures in order to attain the maximum efficiency in the economic end results.

Work Study and O & M

Work Study is nothing more, or less than the study of work—physical and—mental in all its forms. It uses a set of techniques to bring about actual changes in methods and procedures in order to improve the productivity of people, of machines and of facilities.

Work Study or industrial engineering is an effective tool in the hands of manager or supervisor for increasing efficiency and lowering the costs of operations. Like any other tool, its full potential is dependent on the user's ingenuity ; all the same, it has to function at every level from the highest level of management to the lowest grades of worker. All must bring to the job a questioning, analytical mind. They must recognize that, in most cases, there is a better way of doing a particular task. Having cultivated this basic attitude of mind and approach to problems, Work Study supplies specific tools and techniques to work with.

By use of work measurement techniques, the accurate determination of performance is possible. Most cases of low performance are due, not to idle workmen but to ineffective management. Work Study does not aim at

getting the utmost from the individual worker, but rather to obtain a high level of productivity of ensuring effective and efficient management.

O&M techniques have also made effective contribution for streamlining office organisation, and for simplifying and reducing paper work. It is said that O&M has played an impressive part in controlling the "Paper explosion" in office working.

The benefits which can be derived from the use of Work Study are many but the main ones as applied to the railways are listed below :—

(*i*) Increased output at lower unit cost.
(*ii*) Reduction in labour costs.
(*iii*) Improved utilization of capital, materials and equipment.
(*iv*) Greatly improved planning, design and layout.
(*v*) Reduction in overheads and administrative costs.
(*vi*) Provision, through work measurement, of reliable labour cost control and, if required, incentive bonus schemes.

ORGANISATION OF RESEARCH EFFORT

Viewed against the background of the facts brought out above, it would be seen that the first essential step is to organise research effort on sound lines, so that it could become a dynamic instrument of progress. Of equal importance is another problem, *viz.* that of integration of research into general railway organisation.

The role and function of the Research and Development Wing in railways is best defined as in the Canadian National Railways' write-up, *viz.* :—

> Research and Development is a staff department, the personnel of which can be considered as a specialised staff force designed to cope with both the day-to-day and the long-range economic and technical problems that arise in the operation of the railway ; partly as a reconnaissance group that applies the general principles of science and the scientific method to the assessment of future events ; and partly as a foraging party in search of quantitative and qualitative data on which executive decisions can be based. The skills employed are those of the economist, engineer, mathematician, physicist, chemist, metallurgist, as well as those of the experienced railroader. Their efforts are directed towards the systematic application of common-sense, supported by factual data.

The question that arises is, considering the particular circumstances and local conditions, on what lines should research and development effort on the Pakistan Western Railway be organised. In working out the outlines, it is only natural and proper to draw inspiration from the way in which research

establishments are organised and are functioning in advanced railways. It may, however, be pointed out that each railway system has evolved its own set-up to suit its genius—thus research establishments in United Kingdom, Germany, France and other industrial countries have extensive laboratory facilities which are mostly used to evolve and test new products and techniques in order to sustain and expand their industries in a highly competitive world market. In Germany most of the basic research on railway problems are carried out in the Universities. Japanese National Railways have the most extensive and modern research establishment in the world employing a staff of over 900 out of which about 650 are research workers and technicians. Soon after independence, Indian Railways started developing their research effort and in their Research, Designs and Standards Organisation at Lucknow, the working strength of staff as in March, 1962 was 1226, out of which 760 were officers and technical staff. The railroads in the States have formed the Association of American Railroads to centralize and expand their research activities.

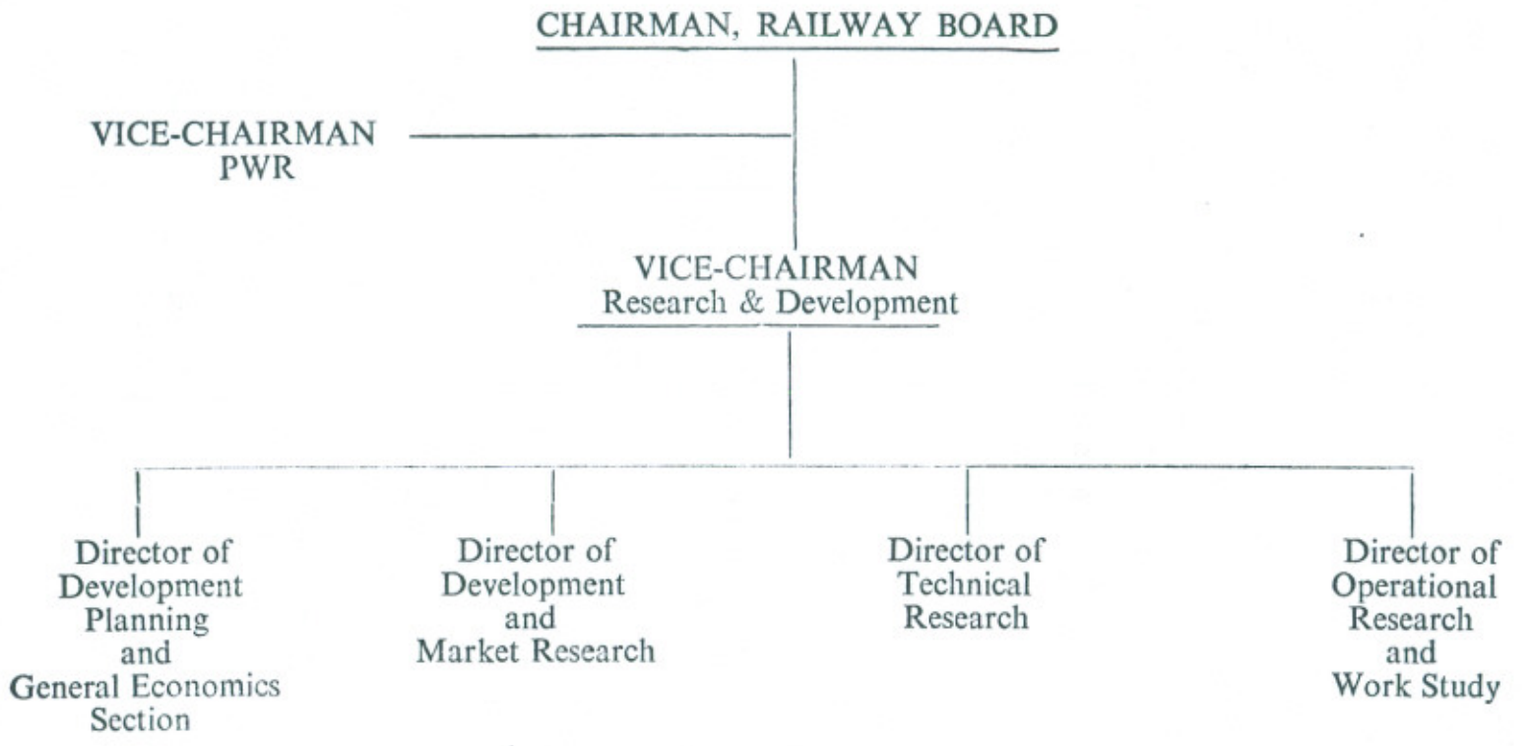
All the systems mentioned above are distinguished by their extensive networks sub-divided into a number of administrative regions. Hence, the extent and nature of their problems are entirely different from those pertaining to smaller systems like Pakistan Western Railway. The need on this Railway is obviously to build a compact set-up to handle the whole range of technical and non-technical research activities briefly touched upon in previous sections.

Based on a comparative study of research organisations in most of the railway systems of the world, it is considered that the pattern that would suit the Pakistan Western Railway best is the lines on which Research and Development is organised on the Canadian National Railways. The Research and Development department of the railway consists of a number of branches under the direction of the Vice-President and the Assistant Vice-President, Research and Development. The branches are :—

(*i*) Development Planning Branch.
(*ii*) Development Branch.
(*iii*) General Economic Branch.
(*iv*) Operational Research Branch.
(*v*) Technical Research Branch.
(*vi*) Work Study Group.
(*vii*) Customer Research Services, and
(*viii*) Real Estate Department.

Considering the importance of Research and Development in the context of modern railway working it would only be proper to establish a compact and self-contained organisation under a separate Vice-Chairman for the Pakistan Western Railway also. The Research Wing should have the necessary prestige and the benefit of mature views of experienced and talented officers if it is to play its role effectively. Suggested lines for the proposed set-up are shown in the attached Organisational Chart.

RESEARCH & DEVELOPMENT ORGANISATIONAL CHART



Note.—Further sub-division of sections is not shown in this chart and will have to be worked out after a a detailed study of the quantum of work involved.