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Conceptual model for manpower planning for the construction industry in developing countries

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Developing countries are characterized by growing populations. Because of this and the initial low level of development, there is a need for infrastructures to support these populations. The industry that is most important in the development of the infrastructure (highways, utilities, industrial plants, etc.) is the construction industry. The construction industry in developing countries is characterized by a large pool of untrained, unskilled labour, and is unable to access its manpower needs. Therefore, a diagnostic manpower planning model for the construction industry has been developed. A diagnostic model was used because it considers both the environment and the factors that affect the demand for, and the supply of, regional labour. The types of data required for forecasting the demand and supply of regional labour, possible sources of data and possible manpower programmes are presented.

Keywords: Manpower planning, diagnostic model, construction industry, conceptual model, labour demand, labour supply.

Introduction

The employment of craftsmen in construction is characterized by instability. Contractors normally hire workers to work on a specific project that has a finite duration. Thus, a construction worker is hired on a project with the objective of working him or herself out of a job by completing the project. When the project is completed, the worker is normally laid off. As a consequence of this instability, the construction industry in most countries is characterized by an area pool of labour. This allows for the movement of workers among contractors, different branches of the industry (industrial, residential, non-residential and heavy construction) and jobs that are being completed and others that have increasing manpower needs. Contractors in need of workers hire from the area pool of labour and return workers to the pool when they are no longer needed.

In the absence of manpower planning, the area pool of labour fluctuates from shortages to surpluses. Because of the nature of the industry, small shortages and surpluses will occur for brief periods of time. The real concern is when the situation becomes grossly out of balance for extended periods of time. Shortages result in the hiring of unqualified workers, the use of overtime to maintain schedules and increased wages to attract workers. Surpluses are costly in human terms because unemployed workers are unable to provide for their families. To foster equilibrium between the supply of, and demand for, the various crafts, it is necessary to develop a manpower planning model that will facilitate the development of programmes designed to maintain relative equilibrium between supply and demand. Despite the labour-intensive nature of the construction industry, manpower planning has been the subject of little investigation.

Contractors typically pay little attention to the availability of manpower during construction planning. For the most part, they assume that sufficient numbers of qualified workers will be available when needed. As a result, there may be problems recruiting enough qualified craftsmen to complete projects. This is particularly true for the construction of industrial projects in developing countries. These countries are characterized by large populations and, therefore, surplus labour. When construction shifts from residential and highway construction to oil refineries, the mix of skills required changes significantly. If a country wants to develop industrially, it must develop programmes to ensure that sufficient numbers of qualified indigenous workers are available through training. There is a definite need for manpower planning and a framework within which to conduct the planning.

Literature review

A review of the literature relating to manpower planning and, in particular, the literature on construction manpower planning, revealed that there has been little research in construction manpower planning. The major research effort in the area was undertaken by the US Bureau of Labor Statistics (BLS) in developing its construction labour demand system (CLDS) (US Department of Labor, 1977, 1978).

The CLDS uses two approaches for forecasting demand. There is an approach for non-energy construction and another for energy construction. The major data used in the CLDS forecasting system include (US Department of Labor, 1979):

1. Data on construction projects under way throughout the country.
2. Data on the duration of construction projects.
3. Data on the labour requirement associated with construction projects.

The CLDS forecasts construction labour demand in manhours by crafts, for specific types (energy and non-energy) of construction in the local labour market area. The main strengths of the CLDS are that it is project-based and uses existing project data in its forecasting procedure. However, some of the weaknesses of the CLDS are that it requires considerable effort and expense to regularly update the database. In its present form, the forecasting model contains 185 variables.

Because of the lack of reported work in construction manpower planning, it is necessary to consider work in other industries. The methods of forecasting manpower in other industries that were identified in the literature review can be classified as supply (Greer and Armstrong, 1980; Hooper, 1981), demand (US Department of Labor, 1970; Walker, 1980) and diagnostic (Fyfe, 1981) models. The supply models are concerned with the planning of the availability of labour in the industry. Some of the commonly used supply models are Markov flow models, linear programming and personnel inventories.

Demand models are used in the determination of the manpower required by the industry at some point in the future. Some of the factors used in demand models are the level of national economy and changes in technology. The following are commonly used to develop demand models: regression analysis, the Delphi technique and replacement charts.

Diagnostic models are manpower planning models that include both supply and demand factors. These models identify the variables that affect manpower in the industry. The models consider such factors as labour market conditions, nature of the industry and the level of economic activity in the economy. The diagnostic models reviewed are not well developed because the nature of the relationships between variables are not fully understood. The models, in fact, provoke speculation and varying interpretations.

A common drawback in the use of the supply and demand models is that they depend heavily on past data. The models tend to be concerned largely with generating some numerical statement about an industry's labour requirements at a point in, or over, time. The diagnostic models have potential, but are not well developed in their present form. What is needed is a detailed diagnostic model that incorporates the factors that influence both the supply and demand for labour.

Objective

The primary purpose of this paper is to present a conceptual manpower planning model for the construction industry in developing countries. The model that will be presented will show the variables that impact manpower (both labour supply and labour demand) in the industry. The proposed model will help in uncovering the following:

1. Where and when imbalances are forecasted to occur and the extent of the imbalance between the demand for, and supply of, manpower in the industry.
2. The nature of any factors (restrictions) in the operation of the labour market that give rise to such imbalances and how and why they occur.

The model will help to establish data requirements for construction industry manpower planning in the developing countries.

Construction manpower planning model

Models may be used for organization, industry or economy manpower planning. They may be descriptive, representing current or past patterns, or normative, presenting possible future patterns. They are useful to decision makers in examining the implications of alternative manpower policies and in providing a framework in which all relevant information is sorted and analysed. The model presented in this paper has two major segments. The first is the framework for forecasting construction labour demand, while the second models construction labour supply. The two segments are then integrated and potential manpower programming is explored.

Construction labour demand

Figure 1 presents a framework for forecasting construction labour demand. The figure has three major sections. The first deals with general economic planning, the second with construction product demand and the third with construction labour demand by skill. The sections are separated in the figure by heavy broken lines.

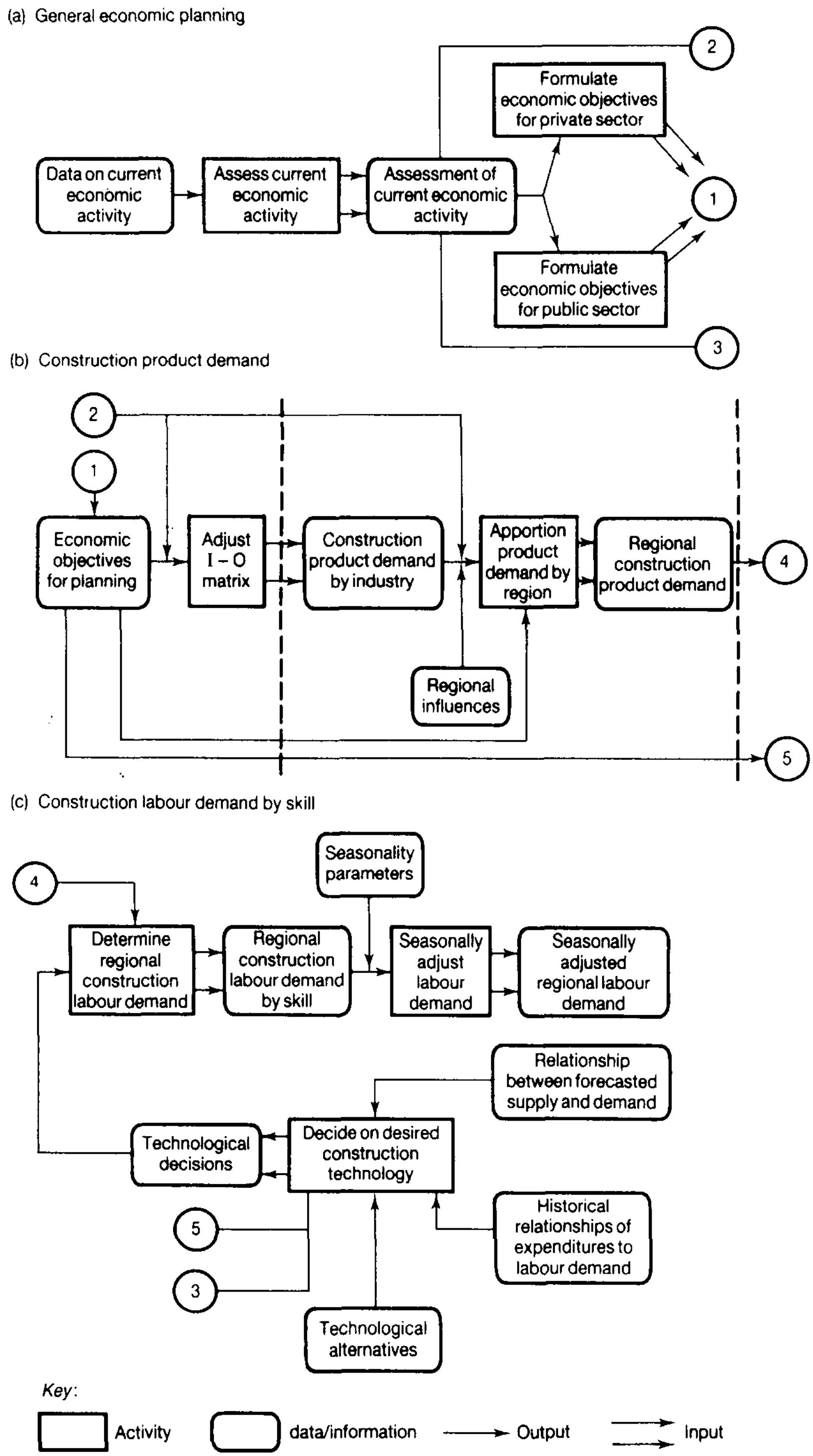

Fig. 1. A conceptual framework for forecasting construction labour demand.

A. GENERAL ECONOMIC PLANNING

1. Assess current economic activity

In assessing the economic activity in a country, it is important that the following be analysed:

(a) *The level of economic activity in the economy.* The Gross National Product (GNP) is a typical measure of the level of economic activity of an economy. It is a measure of the total value of final goods and services produced by the economy. The GNP may be viewed in two ways: as final sales or value-added. As final sales, the GNP would measure the value of final items such as refrigerators and houses sold in the economy. As value-added, the GNP is the sum of the value-added by all industries in the economy. In this model, the former is used.

(b) *The distribution of economic activity within the economy by industry.* The distribution of economic activity between industries can be analysed using an input–output (I-O) matrix for the economy. An I-O matrix indicates the interdependence among industries. Steel mills, for example, will require inputs from the coal and iron industries, and may sell their output to the automobile industries which provide automobiles for private households.

(c) *The distribution of economic activity by geographical region.* Within an economy, there may be variations in regions. For example, a region with abundant crude oil may be a good location for oil refineries. However, it may be necessary to locate such facilities nearer to the port where the oil will be exported from. With this strategy, industries may not be concentrated in a single region, but be located in several regions. This distribution of economic activity among regions may be due to natural resources (agriculture, minerals and location), natural features and/or social factors.

2. Formulate economic objectives of the private and public sectors

From the assessment of current economic activity, private firms may formulate their objectives by considering the nature of the economy and government objectives during the planning horizon. For example, a private firm may set an objective of making a Return on Investment (ROI) of 15% after tax by the end of 2 years (the planning horizon). To meet this objective, its plan may include building modern facilities, operating at capacity and upgrading its skilled labour force during the planning horizon. Typical government objectives may be to provide 500 miles of highway and increase its export of agricultural products by 10% during the planning horizon.

3. Economic objectives for the planning horizon

The planning horizon is the period in which the objectives set by both the private and public sectors will be implemented and evaluated. For example, a planning horizon of 3 years may be more manageable than a 10-year plan. The economic objectives for the planning horizon are generated from the objectives formulated by both the private and public sectors. For example, the government's economic objectives for the planning horizon may be to provide 300 miles of highway and provide utilities such as electricity and water to most regions of the country during the planning horizon. These government objectives will result in new construction contract awards and demand for construction skills such as carpenters, concrete masons and asphalt concrete finishers. The government objective to increase the export of crude oil by 10% may result in the expansion of existing sea ports and the construction of refineries. This will give rise to increased demand for such craftsmen as pipefitters, plumbers and electricians.

Private sector objectives such as increasing return on investment by 20% may result in building new plants, and renovating and modernizing existing plants. The consequent result of the construction needs will result in the award of new constracts, which will lead to a demand for such craftsmen as carpenters, masons, iron workers, plumbers and electricians.

4. Adjusted I-O matrix for the planning horizon

The plan to meet the economic objectives may necessitate a change in the I-O matrix. This will result in a change in the quantitative relationships between industries. For example, if the planning objectives emphasize the development of industrial plants such as manufacturing plants, it may change the historical relationship that exists between manufacturing and the construction industry.

B. CONSTRUCTION PRODUCT DEMAND BY INDUSTRY

The adjusted I-O matrix is one form of arranging the economic data of an economy and it reflects the relationships that exist between industries during the planning horizon. The matrix reveals what each industry sells to every industry in the economy including itself, as well as final demand (government expenditure, consumption and net exports). The matrix also reveals what each industry buys from every industry, including itself, in order to produce its own output. For example, it may be determined that manufacturing and utility industries will buy $500 million and $800 million worth of construction, respectively, during the planning horizon.

5. Regional influences

Regional influences are those which are characteristic of a particular region. Such factors include private sector objectives, available resources, government objectives and the economic activity in the region. For example, those regions where there are oil refineries will buy more industrial construction, whereas those regions where there are manufacturing plants will buy more more building construction. Because of these variations in construction product demand, there is a need to develop a regional factor that will be used to adjust construction production demand by industry.

Regional factors will influence the regional fractions. It is defined as the fraction or percentage of construction product demand by industry in a region. Typical examples of regional factors are the level of economic activity in a region and labour force statistics (unemployment rate, wage rate, etc.). The level of economic activity will influence the volume of construction that may be bought during the planning horizon. For example, in a region where the economy is contracting, there may be fewer new non-residential or residential construction opportunities.

6. Apportion product demand by region

The volume of construction product demand by industry is obtained from the adjusted I-O matrix. This is further apportioned by the use of the regional fraction to obtain regional construction product demand. It reflects the nature of economic activity in the region. Regions experiencing expanding economic activity will have more new construction products in demand than regions where the economic activity is contracting.

Regional construction product demand is the product of construction product demand by industry and regional fraction and may be calculated as follows:

$$RCPD = \Sigma(CPD \times RCF) \tag{1}$$

where RCPD is regional construction product demand, CPD is construction product demand by industry and RCF is the regional construction fraction.

The RCPD generated from equation (1) is the dollar volume of construction product estimated for a region during the planning horizon.

C. CONSTRUCTION LABOUR DEMAND BY SKILL

7. Technological alternatives

Technology refers to the systematic application and utilization of either scientific or organized knowledge to accomplish a task. Hence, it will include hardware (pieces of equipment), software (management practices) and other intellectual tools. Thus, technological alternatives exist in an industry if there is more than one way to perform a certain activity. In the developing countries, technological alternatives may be influenced by the government. For example, government may require contractors to bid for projects using labour-intensive methods even though capital-intensive techniques may increase productivity and lower the cost of production. The government objective (in this case to reduce unemployment) dictates the technology that may be used.

Because the decision of the type of technology to be used may be controlled by external factors (e.g. government) rather than the construction firm, it is important to consider how technological alternatives will influence manpower requirements. For example, concrete slabs may be placed by either cast-in-place techniques or by the use of precast concrete slabs. By using the cast-in-place technique, five carpenters, three masons and five common labourers may have an hourly output of 400 ft^2 of concrete slab. If precast technology is used, however, it may require one carpenter, two masons, three common labourers and one crane operator, and they may have an hourly output of 800 ft^2 of concrete slab.

The effect of the use of different techniques (techological alternatives) is that there may be an increase in demand for a particular skill. Hence, in determining regional construction labour demand, a subjective estimate of the impact of technological alternatives is necessary. This may be estimated by past experience of the technique commonly used by contractors in the region or by surveying engineering, construction and architectural firms in the region.

8. Relationships between forecasted supply and demand

The relationship that exists between forecasting supply and demand for labour will lead to varying technological decisions. For example, in a surplus situation, labour-intensive techniques may be appropriate, whereas in a shortage situation, capital-intensive techniques may be more appropriate.

Data on construction labour forecasts may be available from the Ministry of Labour or it may obtained by a survey of major construction firms in the region.

9. Decide on desired construction technology

The decision on the desired construction technology is influenced by the economic objectives for the planning horizon, the technology available and the relationship between forecasted supply and demand for construction labour. One of the economic objectives of the planning horizon may be to increase labour productivity. Because of this, contractors may be encouraged to use new pieces of equipment in their operations.

The relationship between the forecasted supply and demand of labour in the planning horizon may influence the decisions of contractors as to whether to use labour- or capital-intensive techniques.

10. Historical relationship of expenditures to labour demand

Construction product expenditures by labour demand may be obtained by the use of coefficients that express the manhour requirements by skill for each \$1000 (or any other standard desired) worth of construction product bought.

Determining the expenditures on construction products and skills required over time will provide planners with a manhour estimate of labour demand by skill for a certain dollar value of construction product (by type). For example, the expenditure relationship could be for every \$1000 of industrial construction bought, 0.1 manhours of carpentry will be required.

The data required for the estimation of expenditure to labour demand by skill may be obtained from contractors or architects in the region. The data may also be obtained by analysing major projects in the region.

11. Determining regional construction labour demand by skill type

The regional construction labour demand by skill is the product of regional construction product demand and manhour expenditure. The regional construction product demand is the dollar volume of construction product estimated for the region during the planning horizon. The manhour expenditure is given as the dollar expenditure by skill for a given dollar amount. The regional construction labour demand can be expressed as:

$$\mathrm{RCLD} = \mathrm{RCPD} \times \mathrm{MHE} \tag{2}$$

where RCLD is regional construction labour demand in manhours, RCPD is regional construction product demand in dollars and MHE is manhour expenditure by skills per dollar amount.

The MHE is derived from an analysis of technological decisions and the historical relationship of expenditures to labour demand. The RCPD is obtained from equation (1). As an illustration, suppose RCPD is estimated to be \$1 million of industrial construction, and analysis of MHE revealed that 0.01 manhours of carpentry is required for every \$1000 of industrial construction. Then, the RCLD for carpentry skill for every \$1 million of industrial construction is 100 manhours. From equation (2), the regional construction labour demand for each region is determined. It is the average number of manhours required by skill during the planning horizon. For example, it may be determined that 400 000 manhours of carpenters, 600 000 manhours of masons and 250 000 manhours of electricians will be required in the region during the planning horizon.

12. Seasonality parameters

The construction industry is a seasonal industry. The seasonality may be a result of weather or patterns of contract awards. For example, employment activity follows changes in weather. During the rainy seasons, there may not be any type of highway construction, whereas in the dry season, most highway projects will be underway. Consequently, the skill requirements will vary as a result of changes in weather. However, while highway projects may not be in progress in the rainy season, non-residential and residential building construction may be in progress throughout the year. Because of fluctuations in demand for certain skills due to seasonal changes, it is necessary to develop seasonality parameters.

Typically, seasonality parameters include data on weather, patterns of contract awards and construction permits. Weather bureaux can provide historical weather data and city offices can provide records of the number of construction permits issued in previous years.

13. Seasonally adjusted labour demand

Seasonality may affect demand in the construction labour market. For example, patterns of contract awards may cause an increase in the demand for construction labour at certain times (2 months after the award), but weather factors (such as the approach of winter) may lengthen project durations and reduce construction labour demand.

There may be labour shortages during peak construction periods in the summer months. However, demand decreases for construction labour during the winter months because there are not many active construction projects. Because of seasonal parameters and their effect on labour demand, the regional construction labour demand may be adjusted to reflect the seasonality of demand. Equation (2) is, therefore, further adjusted by a seasonal demand factor and the equation can now be expressed as:

$$\mathrm{RCLD} = \mathrm{RCPD} \times \mathrm{MHE} \times \mathrm{SDF} \tag{3}$$

where RCLD is regional construction labour demand, RCPD is regional construction product demand, MHE is manhour expenditure by skill and SDF is the seasonal demand factor.

As an illustration, suppose from equation (2) that the RCLD for masons was found to be 600 000 manhours during the planning horizon (1 year); then, the RCLD per month is 50 000 manhours. But in the month of August, the demand for masons increased by 50%. Therefore, the SDF equals 1.5. Hence, the RCLD for masons for the month of August is 75 000 manhours.

Construction labour supply

Figure 2 presents a framework for forecasting construction labour supply. The components are presented in the following sections.

14. Population data for a region

Changes in the nature of a population have far-reaching effects on an economy. A nation's population influences the size of the labour supply because future manpower is dependent on the number of persons of working age (usually persons 18 years of age and older). A study of the population is therefore a necessary starting point for forecasting the future manpower supply. Population growth results from the interaction of the number of births, the amount of immigration and emigration, and the number of deaths. An analysis of these factors can generally provide a basis for forecasting the size of future populations.

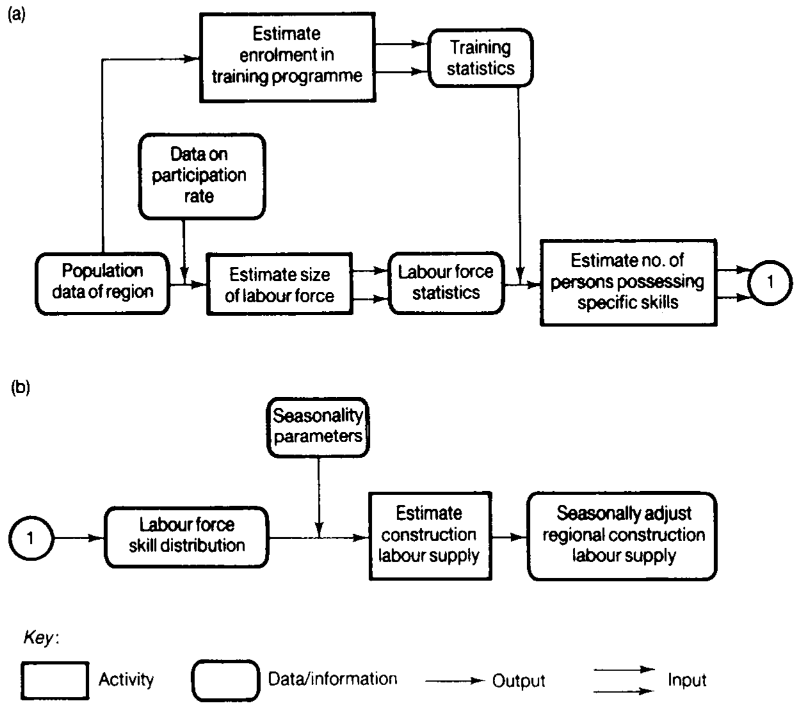

Fig. 2. A conceptual framework for forecasting construction labour supply.

Some of the types of data that are required for forecasting population include the birth rate, annual number of immigrants and emigrants, and the population of the region. These data may be collected by sex, education, skill, etc. The primary source of data is the ministry in charge of the national census.

15. Participation rate and required data

The participation rate is that proportion of the population aged 18 years or more who are active in the labour force, either as workers or actively seeking a job. The participation rate in the labour force is influenced by individuals' decisions to seek work or to withdraw from the labour force. The data required for calculating the participation rate are the number of persons in the labour force, and this may be obtained from the ministry in charge of the national census.

16. Estimate size of the labour force

The regional labour force is defined as those persons from the region over the age of 18 who are employed or are looking for work. The size of this labour force is obtained by multiplying the estimated population (for each age group, sex, skill, etc.) by its estimated participation rate. Thus, the labour force is an aggregate measure of supply for the region.

Labour force statistics are generated from the estimates of the size of the labour force. What is generated is the participation rate of the labour force in the region. The participation rate may be classified according to sex, skill and education.

17. Estimated enrolment in training programmes

A good proportion of the regional population may not possess adequate skills. Because of this lack of skills, training programmes may be necessary for the development of an adequate regional labour force supply. A trained and skilled regional labour force will be of particular benefit to the regional economy because of an increase in labour productivity and a large pool of trained workers. Training programmes may be in the form of full-time or on-the-job training.

Formal types of training, such as apprenticeship training, may lead to the acquisition of particular skills such as carpentry, masonry and electrical skills. In this type of training, the individual is taught how to perform tasks, how to use tools safely and the importance of working in teams. With adequate training, the regional labour force will have a more qualified pool of workers with diversified skills.

The sources of information for the estimation of enrolment in training programmes are the various vocational schools. Resulting from the estimation of enrolment in the training programme is training statistics in the region. The statistics will show, for example, the number of persons (by age, sex, education, etc.) that are in the various training programmes.

18. Estimated number of persons possessing a specific set of skills

The number of persons possessing specific skills is estimated from an analysis of the regional labour force and training statistics. From this, an estimate of the number of persons possessing specific skills available during the planning period can be determined. The estimate will reflect the diversity of skills possessed in the regional labour force for the planning horizon.

In general, because of the multiplicity of skills possessed by individuals, the number of persons with a specific skill, such as electrical, may be larger than the number actually employed in jobs requiring electrical skills. Many such persons may not be employed in jobs which require electrical skills, may not be employed or are no longer in the labour force.

With an estimate of the number of persons possessing specific skills in the labour force, those involved in planning will have adequate information on imbalances in skills such as shortages or surpluses. The number of persons possessing skills can be expressed as:

$$\mathrm{NPS} = (\mathrm{POP} \times \mathrm{PR}) + \mathrm{TE} \tag{4}$$

where NPS is the number of persons possessing specific skills, POP is the regional population, PR is the participation rate (%) and TE is the number of entrants on the training programme. The result of the estimation is labour force skill distribution.

19. Seasonality parameters

The supply of workers in the construction industry varies with the seasons. For example, in the summer months, many students are on vacation and may join the labour force temporarily. At the end of the planting or harvesting months, some farmers who have construction skills may be willing to offer their services to the construction industry. These workers may be classified as secondary construction workers, because they are not always available but only available in regions with seasonal industries such as agriculture.

Because certain construction workers may be classified as secondary workers, it is necessary to develop a factor that will be used in the transformation of the regional construction labour supply. Another factor that may influence the seasonality parameter is when vacations are taken, e.g the summer months. There may be more people willing to work in the industry during these months. As a result, a seasonality factor (SSF) is necessary to help in adjusting the regional construction labour supply.

A probable source of data on seasonality is random sampling of contractors or major project sites in the region. Typical data may include primary source of income, type of skill and times persons are available for employment.

20. Estimated regional construction labour supply

The regional labour supply is defined as those persons who possess a specific set of skills and are willing to offer their services to the construction industry. The regional construction labour supply may change by quantity or quality. It may change by quantity as a result of new additions and withdrawals, whereas it may change by quality as the workers gain more experience in the labour force. The quality of the supply will also improve as the new entrants from the training programmes gain more experience and knowledge.

The regional construction labour supply can thus be expressed as:

$$RCLS = NPS \times MHA \tag{5}$$

where RCLS is the regional construction labour supply, NPS is the number of persons possessing specific skills and MHA is the average number of manhours available for employment.

Converting the regional construction labour supply into manhours available is to ensure comparability with regional construction labour demand, which is expressed as manhours required.

21. Seasonally adjusted regional construction labour supply

The result of equation (5) may be adjusted seasonally. The seasonally adjusted regional construction labour supply is the forecasted number of manhours for the various skills available in any given period in the region. There may be more workers with construction skills at the end of the harvesting or planting seasons. For example, from equation (5), the RCLS was found to be 720 000 manhours during the planning horizon (1 year). But during the month of August, many more persons possessing construction skills joined the industry labour supply. Some of these new entrants may be high school and college students on summer vacation, and teachers from high schools or colleges. Because of these new entrants, the RCLS increased by 40%. Hence, the seasonal supply factor (SSF) is 1.40, and the RCLS of carpenters for the month of August is 84 000 manhours.

Manpower planning

The net manpower required is obtained from the forecasts of construction labour demand and supply as discussed above. Mathematically, the net manpower required is the difference between the demand and supply of labour at any given point in time. The net manpower required, therefore, can be either positive or negative. When it is positive there is a shortage of labour, and when it is negative there is a surplus of labour.

Shortage of labour

To eliminate shortages, several alternative courses of action are available to bring supply and demand into balance. These include training, improving labour mobility, the management of construction contract awards and modifying technology.

1. *Training.* Training programmes can be formal or informal and either on-the-job or off-the-job. Programmes may be offered by trade schools (such as government trade centres) or contractors in the form of on-the-job training. Training programmes usually seek to provide and upgrade employee skills, and thus increase the supply of skilled workers. The duration of training programmes may vary in length depending on the type. For example, the duration for persons in trade schools may be 3 years, while on-the-job may be 5 years.
2. *Improved labour movement.* An adjustment to the supply of labour can be made in terms of labour movement. The construction labour supply can be expanded by attracting workers from non-construction industries, from other occupations and from other geographical regions.
3. *Managing timing of construction contract awards.* The construction labour market is unique, because during certain periods each year, the need for workers rises significantly. This rise occurs because of an increase in the demand for construction projects. The resulting seasonality of employment in the industry is usually accompanied by a shortage of certain skills. It is, therefore, necessary that alternative contract award times be established so as to reduce the peaks in the demand for labour, and hence reduce the magnitude of shortages.
4. *Modifying technology.* Technology is a method of performing a task. A shortage of workers with a particular skill may be minimized or eliminated by changing the construction methods.

Surplus of labour

There is a surplus of labour when the forecasted regional construction labour demand is less than the forecasted regional labour supply at the planning horizon. To eliminate the surplus, several alternative actions can be taken, including retraining, stimulating worker movement, adjusting the seasonal supply of workers and changing the technology used.

1. *Retraining.* Because of the surplus of a particular skill, most of the workers who possess such skills may be unemployed. To minimize unemployment, such workers may be encouraged to join retraining programmes. These additional skills will make it possible for such workers to seek employment and the industry will also possess a diversified labour force. A worker may, therefore, possess two skills and can work, for example, both as a carpenter and a mason. Retraining may not be effective in the developing countries because there may not be employment even with retraining. This may not be the best approach.
2. *Stimulating worker movement.* In a situation where there is a surplus of labour, the surplus workers may be encouraged to move to other projects or regions where their skills can be used or are in demand. It is also necessarry that labour market information be adequate and available to workers who may consider moving. This labour market information may be in the form of bulletins which are published monthly or quarterly.
3. *Adjusting the seasonal supply of workers.* Some projects may be shut down during the winter months. However, both buyers of construction products and workers would benefit if projects are not shut down during certain months of the year. This would lead to reduced

unemployment in the industry, and the contractors would experience continuity of their work. Continuity may affect students or others who are only available during the summer months. They are not, however, primary workers, and hence it may not be a very serious employment problem within the industry.

4. *Changing technology*. Technology has been defined as a method of accomplishing a task. In a situation where there is a surplus of particular skills, labour-intensive techniques are appropriate. Labour-intensive techniques will ensure constant employment for many workers and should reduce unemployment. However, there may be a decrease in productivity and an increase in construction costs.

Summary and research needs

In developing countries, manpower planning in the construction industry is an unexplored field. The recognition of the role of manpower planning and the development of the skills required in the industry have made this area of study important. This paper has attempted to develop a manpower planning model for the construction industry and has been designed to illustrate those factors that can significantly affect labour in the industry. The paper has presented manpower planning as a flow of information to illustrate the importance of detailed information in assessing the supply of, and demand for, skilled construction personnel. The importance of good data in decision making and planning cannot be emphasized too stongly. Consequently, better and more readily available data on the demand for, and supply of, skilled construction personnel is very important for effective manpower planning in the industry.

Any type of research on construction manpower will be useful, because this area of study is not fully explored. There is need for research into the feasibility and cost of alternative mechanisms for improving employment stability in the industry, and the type of data relevant to planning construction manpower needs.

Considerable research into manpower flows in the industry is needed. Investigators might begin by assessing factors that influence labour mobility. Among the more important considerations are the composition of construction demand, the level of employment in non-construction industries (both among and within crafts), traditional patterns of labour mobility and the size of the labour pool possessing construction skills. Data on construction employment and unemployment by detailed craft are remarkably sparse. In the absence of these data, it is virtually impossible to obtain a quantitative assessment of the state and direction of the construction labour market.

Because of the importance of manpower data in the forecasting and planning for construction labour, research on the costs associated with data collection and the benefits of collecting such data is important. The research may focus on how to evaluate the costs and the benefits of collecting such data in the industry.

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