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Determinants of Construction Manpower Demand: A Review from Literature and Practitioners' Experience

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Abstract
Manpower forecast has become an important management tool for decision makers and policy makers to match and structure the skills of the workforce. National planners are also increasingly aware that the competitiveness and growth of the nation, as well as its social welfare, depend in no small degree on the full exploitation of the skills of its people. Although numerous potential variables can be found from the literature, there have been only a few studies to identify the factors affecting the employment level in the construction labour market. This paper probes a range of factors influencing construction manpower demand through a literature review at both project and industry levels. Semi-structured interviews were also carried out in both public and private sectors to grasp the factors from the practitioners' experience. The identified determinants are vital for the development of manpower demand forecasting models in construction. It is expected that the factors will be considered and involved in the forecasting models.

Keywords
Manpower forecasting, Labour Demand Determinants, Construction industry, Hong Kong

1. Introduction

In recent years, there has been an increasing emphasis on the importance of workforce planning for controlling and structuring the skills of the workforce (Harvey and Murthy, 1988). However, many researchers identify that the fluctuations in construction output, relative to most other sectors of the economy, tend to be enormously varied and the movements in skill demand can similarly be strong and rapid (e.g. Uwakweh and Maloney, 1991; Rosenfeld and Warsazwski, 1993). Human resource planning is needed to facilitate the construction programmes and to prevent the damage to the economy caused by attempts to undertake construction when and where the resources are not available (Briscoe and Wilson, 1993). In order to achieve equilibrium between the supply and demand for the various occupations in the construction labour market, it is required to develop a manpower planning model that will facilitate the development of industry designed to maintain the manpower equilibrium.

Clearly, a thorough investigation of the manpower demand determinants is a critical step for the efficient planning in the construction sector. Through a comprehensive literature search, the aim of this paper is to identify and group particular factors (variables), which are believed to be significant in affecting manpower occupational demand in the construction industry. These factors are derived firstly from the literature in general, and from an opinion survey in Hong Kong conducted through semi-structured

interviews in particular. They are grouped under the headings of project level and industry level. The semi-structured interviews were carried out with practitioners in both the public and private sectors.

2. Determinants at Project Level

2.1 Project type

The occupational labour demand for a construction project is apparently related to the *type of project* within a particular market sector (Chan *et al.*2002; Agapiou *et al.* 1995). For example, such trades as plasterering are closely associated with new housing work, whereas scaffolders have more employment opportunities from general repair and maintenance activities (Briscoe and Wilson, 1993). Different construction projects tend to have a different product mix, capital-labour ratio and fixed cost structure. Besides, when construction shifts from piling works to the construction of superstructure, the mix of skills changes significantly. Figure 1 depicts several samples of construction works, showing that different project types lie on different Resources-Labour (R-L) zones. Thus, it is important to identify the types of projects to be included in the project-based prediction model for an estimate of the basic output elements of the construction industry.

Figure 1: Construction resources used in final products (Source: Ganesan *et al*. 1996)

2.2. Volume of works

A number of literatures show that there was a strong relationship between the manpower demand and the volume of works (e.g. Uwakweh and Maloney, 1991; Grunbery, 1997) Chan *et al*. (2003) also develop a cost-labour demand relationship from 123 construction projects. In practice, the 'multiplier' forecasting model developed by Chan *et al*. (2002) exercises this relationship between construction cost and manpower requirement. They disaggregate the multipliers by project type not only because the mix of skills is different for different project types, but also due to the proportion of labour cost is varied as suggested by Apagiou *et al*. (1995). For example, health care project employs significantly more equipment than a residential building. Clearly, the size of a project within a particular market is another factor that dictates the extent to which specialized skills are practised in the construction industry.

2.3 Construction method

The construction method of an individual project also determines the number and mix of labour skills. For instance, the foundation contractor for the Bank of China project chose hand-dug caissons instead of other mechanized foundation techniques, which demand a number of additional labour forces (Fairweather, 1986). Apart from construction method, the demand for labour by trade would also depend upon the time schedule of the project (Tang *et al*. 1998). A large project such as an airport that is to be completed in 2 years will have very different labour requirements than one to be completed in 5 years, especially in each construction stage.

2.4 Design

The last apparent factor affecting labour demand at project level is the design or the complexity of the construction product (Ganesan *et al*. 1996). For example, the design of the Bank of China building

illustrates the contribution that structural design can make toward savings in resources. Simplified connections for the cross-braced steel truss allowed faster erection and savings in costs. Total steel requirements were about half that used for a typical building of the same height. The reduction in the use of steel translated into labour-savings in fixing and alignment of frames. Similarly, the design of modern sprinkler and hydrant systems minimizes wiring requirements and associated building services labour needs (Fairweather, 1986).

3. Determinants at Industry Level

3.1 Productivity rate

The productivity is considered as a fundamental determinant of manpower demand at industry level. It is generally recognized that improvement of labour productivity will lower the demand of manpower, and *vice versa*. A number of studies (e.g. Rosenfeld and Warszawski, 1993) indicate that technology change and management are the two broad categories of factors which have major influence on productivity.

3.1.1 Technology Change

Ganesan *et al*. (1996) affirm that Hong Kong has imported a substantial amount of modern construction plant and machinery during the last two decades resulting in the change of employment structure in the labour market. This technological change in the construction industry includes improvements in material specification, fixing and sealants, or in hand tools and equipment (IPRA, 1991). New technology tends to reduce the demand for labour as new inventions are often labour saving (McConnell *et al*., 2002). The increasing use of prefabricated components is an example showing how technology affects the manpower requirements. Prefabrication eliminates the need for traditional craft skills including bricklaying, plastering and carpentry (Agapiou *et al.*, 1995). Tam (2002) also demonstrates that the greater use of prefabricated components results in a substantial 43% reduction in the consumption of site labour.

Operatives need to update their knowledge of new products and process. A report to the CITB on technological change and construction skills in the 1990's identified and examined the principal technological changes likely to affect the building trades (CITB, 1991). In addition, robots have been implemented construction works in Japan, where about 50% of labour requirements have been replaced by the automation (Doyle, 1997). Agapiou *et al*. (1995) also state that the trends towards specialization in the construction industry, including the increased use of sophisticated systems in buildings and the repackaging of work into smaller portions to off-load risk, has a number of implications for future skill needs. Therefore, it is important to examine how technological alternatives will influence manpower requirements, in order that the forecasting could be based on the best possible information about the future requirement of the industry.

3.1.2 Management

Labour requirement can be affected by the management skills including planning, organizing, leading and controlling (Gould, 2002). Better co-ordination and utilization of plant and labour on sites leads to reduction in manpower requirement (Ganesan *et al*., 1996). Labour saving design can be achieved through enhanced management and interfacing between different trades such as electrical and mechanical trades. Better planning of site work can also ensure reduction in labour. For example, in laying pipes and conduits, last-minute changes in design often result in abortive labour and excessive final costs that exceed 15% to 20% of original estimates (Grunebery, 1997).

3.2 Construction output and economic state

Several recent studies focus on estimating labour demand by pursuing relationship between employment level and construction output (e.g. Chan *et al*., 2003; Ball and Wood, 1995). Briscoe and Wilson (1993) also identify that construction output is generally expected to have a positive effect on employment. Latham (1994) expresses the view that government is vital to construction, and her policies would directly affect construction workload through financing of public projects. The construction output, indeed,

includes the objectives and policies set by the private and public sectors that will be implemented and formulated in the planning horizon (Uwakweh and Maloney, 1991). These objectives will result in new construction contract award and demand for construction skills such as carpenters, concrete masons and asphalt concrete finishers. However the investment in construction in Hong Kong, to certain extent, depends on the economic state in general.

Given the close relationship between construction output and labour demand, it is vital to investigate the relationship between the construction sector and the aggregate economy when developing the forecasting model. At the first sight, construction output is an integral part of national output. It has been suggested that construction investment is a derived demand that is growth dependent. Some empirical studies of relationships between the construction sector and the aggregate economy show that GDP tends to lead the construction flow but not *vice versa* (Tse and Ganesan, 1997). In other words, it is the macroeconomic policy of government that affects outputs, and influences the construction activity, and not *vice versa*.

3.3 Other determinants

3.3.1 Economies of scale

Chan *et al*. (2003) illustrate that construction output increases the unit costs of production initially but then decreases due to economy of scale. Noticeably the construction industry is becoming more specialized. Agapiou *et al*. (1995) also hold the view that the pace of technological change in the construction industry combined with increased specialization would focus more attention on the pattern of future skills requirements. The existence of economies of scale would obviously affect the employment of a given amount of construction expenditure at the level of the industry as a whole (Ball and Wood, 1995).

3.3.2 Wage level

Another factor that may influence the demand of manpower in the labour market is the wage and non-wage labour cost. In an open economy, too high labour costs may cause lack of demand at the level of the firm (Ross and Zimmermann, 1993). Briscoe and Wilson (1993) also claim that an acceptable specification of a labour demand function should also include earnings level and come from a pragmatic viewpoint.

3.3.3 Factor price terms

Ncube and Heshmati (1998) believe that factor price terms including real wage and interest rate constitute the specification of employment function. The coefficient on interest rate is expected to be positive, given that firms substitute labour for capital as the price of capital rises. In construction, particular, interest rates might have a more general effect on the level of demand for the sector's output. The overall impact of changing interest rates will therefore depend on a more general macroeconomic view of the situation. This reflects the fact that as the cost of capital fall firms are encouraged to use less labour intensive construction methods. However, falling interest rates will have a positive effect on construction output (Briscoe and Wilson, 1993). This latter effect outweighs the direct impact of interest rates, so that overall lower interest rates may result in higher employment levels in construction.

3.3.4 Replacement Demand

In the construction labour market, mobility processes can be observed continuously. Many employees change occupations several times during their working lives. Willems and de Grip (1993) stress that replacement demand is an important component of the future demand for manpower but often neglected in manpower demand forecasts. It can be defined as the jobs resulting from the departures of workers that have to be filled by new workers. However, the data problem always poses as a constraint in the provision of reliable figures on replacement demand, especially by occupation at industry level (Agapiou, 1996).

3.3.5 Seasonality Parameters

Uwakweh and Maloney (1991) consider the construction industry in United States a seasonal industry. The seasonality may be a result of weather or pattern of contract awards. For example, during rainy seasons, the construction projects might be delayed due to the abominable weather conditions. 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, residential building construction can be underway throughout the year. Because of fluctuations in demand for certain skills due to seasonal changes, thus depending on the users' requirements, it might be necessary to develop seasonality parameters in the manpower demand forecasting model.

4. Summary of the Determinants

Table 1 shows a summary and a systematic critique of the existing literature related to the determinants of manpower demand. Figure 2 also illustrates a hierarchy of factors that can contribute to construction manpower demand. It must be emphasized that the factors identified are representative rather than comprehensive. Since the factors that may affect the demand of each occupation are numerous, it is therefore intended that this hierarchy be improved and expanded in the second phase of this study.

Figure 2: Factors affecting construction manpower demand

Note: unlabelled arrows indicate that other factors also contribute

* Cost/value is in turn affected by all other factors listed; whereas some other factors also interact to varying degrees

5. Conclusion

This paper identifies a range of factors affecting construction occupational demand, as derived firstly from the literature in general and from the survey in Hong Kong by semi-structured interviews in particular, at both project and industry levels. Construction manpower demand by occupation can be considered to be a function of all such primary, secondary and tertiary factors in the hierarchy, so manpower demand is a function of the factors (from the Figure 2 hierarchy). The identified determinants are vital for the development of manpower demand forecasting models in construction subsequently. It is anticipated that these factors will be considered and involved in the forecasting models.

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