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Factors facilitating construction industry development

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ABSTRACT

This paper reports on a study aimed at identifying the key factors associated with construction industry development worldwide, by using a grounded theory approach. This involved, firstly, the identification of 62 variables from earlier studies. A questionnaire survey was then used to elicit views of the current strength of each variable. The resulting data were factor analysed and a set of eight key factors obtained comprising: (1) Industry-led better practice and culture; (2) Financial resources and investor confidence; (3) Human skills and culture of transparency; (4) Government policies and strategies supporting construction business; (5) Research and Development for construction; (6) Self-reliant construction culture; (7) Institutional support; and (8) Supportive attitudes from Aid agencies. These appear to be relevant to both developed and developing countries.

KEYWORDS: construction industry development, factors, factor analysis, grounded theory, questionnaire survey.

INTRODUCTION

One of the earliest studies to identify the key factors influencing the development of the construction industry is by Bowley (1966) in her study of the British building industry covering an 80-year period prior to publication. This focussed on the factors helping or hindering change and associated problems. In particular, five fundamental problems were identified, namely:

- difficulties of prospective building owners of making an informed choice;
- lack of mechanisms to ensure innovation and technical progress;
- lack of integration of design and production;
- lack of economic rationale as input to design decision-making; and
- lack of efficiency and poor quality of house production.

Since Bowley, there has been a series of major studies concerned with the problems and issues concerning construction industries both nationally and internationally (e.g., IBRD 1973; World Bank 1984; Kirmani 1988; Miles and Neale 1991; United Nations Industrial Development Office 1991a, 1993; United Nations Centre for Human Settlements 1984; Dowall 1991; Ganesan 1991; Lu and Fox 2001; Simon 1944, Banwell 1964; Wells 1986; Al-Momani, 1995:87). These have been inhibited by a variety of complications including the wide range and type of data to collect (e.g., Momaya 1996:109); the large number of variables of possible relevance (e.g., Fox 1989; Al-Omari 1992; Flanagan *et al* 1999:27-29); and the large number of potential organisations and people from whom to collect data (e.g., Ofori 2000:258). Difficulties have also been experienced in

defining the construction industry and the basic concepts involved (e.g., Ofori, 2000) and this in turn has created significant conceptual differences between researchers.

Crucially, there has been an almost complete lack of theoretical development (Kafandaris, 1980:302; Manseau 1998:242). However, there are examples of research studies which have *ostensibly* achieved the fully mature stage of theory-building. This has, however, been achieved by borrowing theoretical frameworks from other domains, e.g., economic theory (Ofori 1980, Bon 1991), systems theory (Napier 1970, Fox 1989), statistical theory (Edmonds and Miles 1984), fuzzy set theory (Tay and Low 1994), transaction cost theory (Winch 1985), and catastrophe theory (Barton 1988).

As pointed out by Ofori (1993), no study of construction industry development has been wholly successful in solving the identified problems in a host of developing countries, in spite of the greater understanding achieved through research to date. The reason for this situation may be because a 'within-domain' theory has not yet been developed, that is, *a theory does not yet exist which stems from and arises out of the construction industry itself*. If the review of research studies is restricted to those which are ostensibly within-domain, it can be asserted that we are still no further forward in developing a within-domain theory. For research that is focussed on the construction industry as a whole, less than 20 relevant doctoral studies exist. Several of these are comprehensive studies of particular industries, or groups of construction industries. However, with the

exception of Kumaraswamy (1998) there are none that do so in a generic way. The research described in this paper aimed to rectify this by identifying the key concepts or contributing factors involved. It does so by adopting a grounded theory approach (Glaser & Strauss 1967), and it therefore assumes no existing theoretical framework. From a list of 62 variables identified in earlier studies, a questionnaire was developed and a survey was conducted. This elicited views from 76 respondents on the current strength of the variables in their local national industry. Factor Analysis (e.g. Rummel 1970) was then used to reduce the list of variables to a set of eight key factors. These were then considered in terms of the variables included in each factor and eventually labelled: (1) Industry-led better practice and culture; (2) Financial resources and investor confidence; (3) Human skills and culture of transparency; (4) Government policies and strategies supporting construction business; (5) Research and Development for construction; (6) Self-reliant construction culture; (7) Institutional support; and (8) Supportive attitudes from Aid agencies. All eight factors appear to be relevant to both developed and developing countries.

METHOD

The variable list

The earliest studies of the state of the construction industry date from the 1940s (e.g., Simon, 1944; Emmerson, 1962; Banwell, 1964; Great Britain, EDC for

Building, 1967; Wood, 1975), many with an economic emphasis (e.g., Bowley, 1966; Hillebrandt, 1974, 1984; Hillebrandt and Meikle, 1985). A number of these studies have produced lists of variables or factors, sometimes arranged into models. Some salient points concerning these are:

- The list of variables can be very long;
- There is no common method of classification of factors. This makes comparisons between studies extremely difficult as each can be interpreted differently.
- Many important factors differ between countries. While a broad classification can be made between developing and developed countries, there appear to be large differences even within these groups. The extent to which this is caused by differences in interpretation, however, is not known.
- Attempts have been made to identify the key factors intuitively. To date this has not been done empirically, by means of factor analysis for instance.
- In theory at least, some key factors should apply to all countries. Some similarity is expected in groups of countries with similar characteristics, for example developed country factors, developing country factors, and transition country factors, newly industrialised country factors.
- Those factors that *have* been identified are expressed in various ways. For example, "finance" is an important factor mentioned by Al-Omari (1992). However, "lack of finance" or "adequate finance", or "availability of finance" would all be more meaningful, simply because the noun is qualified, making it more specific. The lack of appropriate adjectives to accompany the noun of "finance", in this case, makes it difficult for the reader to evaluate the strength

of finance as a factor. This lack of qualification of the nouns is a problem encountered when reviewing previous studies and attempting to evaluate the current strength of many variables listed.

As a result of the difficulties encountered in identifying variables concerning construction industry from the literature, Fox *et al* (1999) conducted a series of interviews with 8 academic and industry practitioner "experts" to identify the important variables. This resulted in a list of 43 variables purporting to cover all the major issues involved. These were used to form the basis of our subsequent study. Comparing these with the studies reported in the literature, together with the activities of construction research institutes (such as the CII, CII Australia and ECI) revealed a number of outstanding themes of current research interest, including, for example, the use of "best practice" and "partnering".

For some of the original 43 variables, the wording was adjusted to make them more neutral. For example, barriers to the development of the construction industry included such things as a lack of materials, or lack of plant and equipment. These shortages may not apply in every country. The wording was therefore changed to "Availability of materials" and "Availability of plant and equipment" in order to allow respondents to rate these in terms of either too much or too little availability.

Other variables were re-phrased to discriminate more precisely between similar concepts. For example, one of the variables was institution building/institutional

development. This covers a wide variety of different types of organisation. The three institutions commonly found in the construction industry, namely "Trade Associations", "Professional Associations" and "Industry-wide association of stakeholders", therefore replaced this single variable. The intention was to distinguish between these institutions, as some of them might have more influence on construction industry development than others.

As a result of this process, the original list of variables were reworded and revised – the final list comprising 62 variables.

Questionnaire development and administration

The 62 variables were operationalised into questions in a web-based questionnaire for scoring by respondents on a scale of 1 to 5 for their current strength in the respondent's respective country. Also obtained was the respondent's number of years of experience of the construction industry; main area of experience (job role); number of countries the respondent has worked in (breadth of experience); and country type worked in (nature of experience).

76 useable returns were received, from members of CNBR and Mailbase (30); delegates of the CIB TG29 Conference 1999 (4) and AsiaConstruct Conference 2000 (19); China Mainland academics, practitioners and government officials (7); Hong Kong academics and practitioners (6); and personal contacts (6). Being

web-based, it is not possible to determine the rate of response but, with 76 returns, the sample size was considered to be adequate.

Factor analysis, principal component analysis and factor rotation

The Factor Analysis technique summarises correlations and interactions among variables into a small number of underlying factors (see e.g. Rummel 1970). As a result, it can uncover relationships among many variables. In the present context, this means identifying key variables or groups of variables associated with construction industry development.

There are different methods of extracting the factors from a set of data. The method chosen matters more when the sample is small, the variables are few, and/or the communality estimates of the variables differ. By far the most common form of factor analysis is Principal components analysis (PCA). PCA seeks a linear combination of variables such that the maximum variance is extracted from the variables. It then removes this variance and seeks a second linear combination which explains the maximum proportion of the remaining variance, and so on. This is called the principal axis method and results in orthogonal (uncorrelated) factors. PCA analyzes total (common and unique) variance. The PCA technique is appropriate where a limited *a priori* knowledge is available concerning the number of different cluster relationships that could be expected for the data sample (Hair et al., 1998). PCA also provides a deterministic method to group

elements into meaningful subdivisions in order to overcome multicollinearity problems in the project data.

In order to facilitate the interpretation of factors, factor analysis requires the rotation of axes. The rotation procedure does not affect the goodness-of-fit of the factor solutions but serves to make the output more understandable. Three rotation techniques are in general use: varimax, equimax and quartermax. Of these, the most popular is Kaiser's (1958) varimax algorithm, which is known to provide the best parsimonious analytical solution (Harman, 1967). This minimises the number of variables with high loadings on factors, thus causing the factor loadings of each variable to be more clearly differentiated.

An important decision is the determination of the number of factors to be extracted and several guidelines are available for this. One of the most common is the minimum eigenvalue criterion. This involves taking the principal components of all the variables, ranking their eigenvalues from highest to lowest, then the number of eigenvalue greater than one is selected as the criteria for the number of factors included in the analysis.

Several pre-tests are available to measure the sample characteristics necessary for successful factor analysis. One is the Kaiser Meyer Olkin's test (KMO) for sampling adequacy. KMO values vary from 0 to 1.0 and values closer to 1 are better. An overall KMO should be 0.60 or higher to develop successful factor analysis (Kaiser, 1974; Hutcheson and Sofroniou, 1999). Another test is the

Bartlett Test of Sphericity, which checks if the sample was randomly drawn from a population in which the correlation matrix was an identity matrix. This uses the determinant of the correlation matrix to tests the null hypothesis that the correlation matrix is an identity matrix using a chi-square approximation (Bartlett, 1947) and is particularly relevant when dealing with a relatively small sample of data (<100) and with a relatively large number of variables (>10). A further test is to examine the Anti-Image correlation matrix. The diagonals on the matrix should have an overall Measure of Sampling Adequacy (MSA) of 0.5 or above (Hair *et al* 1998:99-100). Individual variables can be considered for elimination from the analysis if they are low on this measure.

RESULTS

In the pretesting, the diagonals in the Anti-Image correlation matrix showed that there were 15 variables with an MSA value of below 0.4, and a further 18 with an MSA value of between 0.4 and 0.5. The 15 variables below 0.4 were eliminated first and the mean MSA was re-calculated as a value of 0.541, this being accepted as sufficiently high. The correlation matrix then identified 4 variables with low correlation values, i.e., less than 0.50. Two of these also had a low MSA value, and these were also eliminated from the factor analysis, making a total of 17 variables eliminated from further analysis. By eliminating those with low MSA and low correlation values, the smaller data set of 45 variables resulted in an adequate KMO value of 0.713. Bartlett's test of Sphericity, produced an

approximate χ^2=1090.354 (df=990, p=0.014), indicating that the population correlation matrix is unlikely to be an identity matrix. With a dataset of 76 cases and 45 remaining variables, the ratio between cases and variables was now approximately 1.7:1.

Several attempts were then made to produce a factor model using both orthogonal and oblique methods of rotation. These all resulted in twelve factors being abstracted, but there were difficulties in the interpretation, mainly because of overlaps between the various factors. The 45 variables were inspected and reconsidered with the view to eliminating those with a low MSA score (between 0.4 and 0.5). These were deleted leaving 28 variables.

A new factor model was created with the new set of 28 variables and this resulted in a much clearer picture in terms of the factor model generated. The statistical measures and tests also changed so that the KMO value increased to 0.792, and Bartlett's test of Sphericity produced an improved χ^2=680.601 (df=378, p=0.00). Using Varimax extraction with the conventional unity Eigenvalue criterion, 8 factors were generated as shown in Table 1. These were given the labels:

1 Industry-led better practice and culture

2 Financial resources and investor confidence

3 Human skills and culture of transparency

4 Government policies and strategies supporting construction business

5 Research and Development for construction

6 Self-reliant construction culture

7 Institutional support

8 Supportive attitudes from Aid agencies

These are described in more detail below. It is important to note, however, that the sequence of these is ranked by the factor analysis procedure and this is based on the strength of the association between the variables that load on the factors and may not coincide with the measure of association. Table 2 shows the original 62 variables, ranked in order of mean scores against the 8 factors identified and Table 3 summarises the means of these for each factor. This shows Factors 3 *Human capital and culture of transparency*, 2 *Financial resources and investor confidence* and 4 *Government policies and strategies supporting construction business* to be the most dominant, with Factor 5 *Research and development for construction* being the weakest.

1 Industry-led better practice and culture

As Table 1 indicates, nine variables load significantly on this factor (having a value of greater than 0.5). Three of these, namely *Use of E-Commerce*, *Use of Construction IT* and *Use of computing skills* clearly relate to developments in information technology (IT). However, the other variables loading on this factor appear to cross the boundary between the general business environment and the construction task environment, reflecting aspects of the information age in the adoption of knowledge, skills and culture from other areas in the form of *use of*

benchmarking, *performance measurement of the industry* and the *use of partnering*...

From a developed country perspective, these can be simply categorised as moves to better practice as urged in the recent major reports in the UK (Latham 1994; Egan 1998; Flanagan *et al* 1999:7), Singapore (Construction Manpower 21 1999) and Hong Kong (HK CIRC 2001) and Australia (Australia Industry Science Resources 1999; Hampson and Brandon 2004) and supported by construction industry institutes in the USA, Europe, and Australia. From a developing country point of view, there is also an interest in the adoption of western technology and an aspiration to do things better than has been normal practice in the past. Kumaraswamy (1998) also indicates that some previous studies have approached the needs of construction industry development in developing countries from a 'top down' perspective of overall strategies. In either case, however, whether developing or developed country, the attitudes and desires are similar, the main difference being the extent to which good practice or best practice has been achieved.

2 Financial resources and investors' confidence

The four variables - *Availability of finance, Availability of investment, Investor confidence in political environment stability and Investor confidence in economic environment stability* - fit together very neatly in that investors provide the finance

for the industry's needs. For investment to be successful and for the terms of finance to be attractive, the investors need confidence not only in the industry, but also in the wider business environment including political and economic dimensions.

In the developed countries, the construction industry has acquired new skills in the area of finance in the last two decades. There are a number of reasons for this, but the principle drivers have been the change in project procurement systems, which have been moving away from the traditional arrangement where design and construction processes are executed entirely separately by different organisations for the same project. Instead there has been a transition towards alternatives such as management contracting, design and construct build operate transfer (BOT) and similar arrangements. Many of these more recent procurement systems integrate the various stages in the whole development process, including the financial arrangements. Companies that have historically played their role as main contractors in a traditional procurement system have expanded their range of skills especially in the area of finance, in order to offer their new clients more choice. Recent developments in the UK with the Private Finance Initiative (PFI) have accelerated this transition, since the PFI contractors have to forecast the financing needed for periods of 20 years or more into the future. Requirements such as these from the clients demand a high level of financial expertise from the PFI contractors (Winch 2000).

In contrast, contractors in developing countries are mostly very dependent on other stakeholders such as their clients, or the banks that loan them their funds. Several of the Fox *et al*'s (1999) interview respondents said that these contractors' experienced chronic shortages of finance, either through a very high interest rate being charged from lenders, or from serious delays in receiving payment from clients. The same picture is painted a by a number of previous research studies (Asian Productivity Organisation 1983; Ganesan 1991b; Kumaraswamy 1994: 159; Wall 1993).

The second strand of this factor concerns investors who have a role to play in the industry. Given the highly-developed nature of current global investment markets, investors and potential investors have become very discerning in their choices of where to place their money at risk (European Commission 1994:ix). They are assisted by significant numbers of highly skilled and highly specialised investment analysts who are constantly looking at various industries and various companies within those industries in a comparative way (Chong 1988). The construction industry, even in the most advanced countries, is therefore competing with other sectors for investment, and is having difficulty in holding its own. There is growing evidence that senior management within the construction industry is aware of this competition and also of the construction industry's weakness in attracting investment (e.g., Egan 1998:10; UK CIPS 2002; Zylberstajn 1992).

3 Human skills and a culture of transparency

Four variables load on this factor - *Availability of management skill*, *Availability of technical knowledge*, *Government's concern for its image* and *Availability of information*. The first two of these have long been recognised as being important to the construction industry and form the core part of many educational programmes for construction students. The third and fourth variables indicate the associated role of government is to main responsibility for the development of human resources through its funding of the education system and the policies that need to be in place to ensure its educational thrust is targeted correctly. This is consistent with the recent move to New Public Management that promises more transparency (Hughes 1998:239). Thus, this factor has not only the flavour of availability of necessary skills for the development of the construction industry but also a motivation to use those skills for the benefit of individuals and society as a whole.

For developed countries, this theme is very familiar, ranging over the need for specialists to have co-operative attitudes (Rwelamila and Hall 1994; Walker 1995), generalist skills (Goleman 1996; Fox 1996, 2002) and be effectively co-ordinated (Lawrence and Lorsch 1967) and integrated (Banwell 1964; Tavistock 1966; Wood 1975; Latham 1994). For developing countries, the role of government in this seems to be more pronounced and sometimes detrimental – often through lack of transparency and accountability (United Nations, Dept. of Economic and Social Affairs 2000:22). One of the respondents in the survey, for

instance, provided examples from Thailand and the Philippines, where government prefers to use mechanisation in construction instead of labour-based methods, even though this was more expensive and an ample supply of labour available.

4 Government policies and strategies supporting construction business

This factor also comprises four variables - *Government intervention*, *Communication between Government and Contractors*, *Effective co-ordination between government departments* and *Government policy supporting private industry (contractor)* – and is closely connected with the previous one. Whereas with Factor 3 the government's role was more indirect, in this case, it is very explicit. Government policies are needed when considering the amount of support to be given to private industries and the degree of intervention necessary (ILO 1988; Ofori 1994; Wells 1996). In some countries such as Singapore, South Africa, Malaysia and People's Republic of China, the governments have quite clearly taken an interventionist stance. For policies towards the construction industry to be coherent and effective, good communication between government and the private sector is beneficial. For example, in Australia, the Construction Policy Steering Committee was set up overhaul the existing policies in order to fulfil a vision to make the construction industry internationally competitive (De Valence 1999:222; Australia DPWS 1993). In addition, effective coordination between government departments is helpful (Gt. Britain Cabinet Office 2000).

This is important particularly for construction industry, as the government is a major client of the industry and in any project, whether with a public or private sector client, many government departments are involved.

5 Research and Development for construction

Two variables load on this factor – *Research and development* and *Confidence in indigenous skills*. Research and development in the construction sector is neglected worldwide (Gann 2001:250) as indicated by mean values in Table 3 and comparisons are often made between the R and D in construction and R & D in other sectors. Many research studies have lamented the lack of development of indigenous materials and methods (e.g., Wells 1993). Developing countries are, however, gradually improving their research and development to make best use of indigenous materials

6 Self reliant construction culture

Factor 6 comprises both *Influence of contractors' perceptions/attitudes/culture* and *Confidence in indigenous skills* again – suggesting a connection between this and the previous factor. In developed countries, the construction industry has strength and power from the contracting sector. These have been shown to be very influential in the way the industry currently operates (Ball 1988, CII, USA

Construction Round Table). Confidence in indigenous skills is high in the developed world where a whole range of skills is fully developed.

Some writers argue that the major contractors in developed countries have been too strong and powerful for the good of the industry as a whole (Ball 1988; Cockerill 1993). For example, Ball argued that many of the industrial relations problems in the 1960s and 70s stemmed from a manipulation by main contractors in order to extract more money through claims from their clients. Likewise in Japan, evidence indicates that to the main contractors have been very influential on political leaders and political parties, such that the government has awarded construction contracts when they are not really justified. It has been suggested though, that through these methods, the Japanese construction industry has become the world leader in construction Research and Development (Seaden and Manseau 2001).

In a similar manner in Hong Kong, the construction industry main contractors pushed government to set up their own training organisation, the Construction Industry Training Authority, before government had even considered other industry sectors. This authority had become established, funded by a levy on all large construction projects, and established by statute, years before the government decided to introduce training institutions for a range of occupations more generally through the Vocational Training Council.

In the developing countries, people need to rely on themselves for all of their basic needs whether they are housing, water supply, food or clothing. Construction work may involve the whole family. Such work is widespread and constitutes the informal sector of the construction industry (Wells 1993). Many of Fox *et al*'s interviewees with experience in developing countries related their experiences of highway construction where most of the workers are unskilled and regarded construction work as a seasonal activity to earn some extra money. When there is no construction work, most of the people go back to their farms. Construction work offers an opportunity for unskilled of workers to earn some extra money over and above their subsistence-level farming activities.

In the People's Republic of China, for example, there is a constant flow of people from the rural country areas into the big cities, many of them finding work on construction projects. In this respect, China is the same as in many other developing countries. However, in China, there has been a positive aspect to this labour movement through the development of "labour bases" and "cradles of building craftsmen" (Lu and Fox 2001). Its benefits stem from co-operation of rural government with urban government, and through this mechanism, there has been a steady building up of the skills of the indigenous workforce. One of the strengths of China's long history and strong cultural influence is that the skills have been harnessed and passed on to others for the development of the industry as a whole. This appears to be a distinctive characteristic of the Chinese construction labour force.

7 Institutional support

Two variables load on this factor - *Intervention by a national construction industry development agency* and *Trade associations*. Some researchers have long advocated the need for intervention by a national construction industry development agency (Ofori 1994; Wells 1996), while the idea of support from associations and institutions has been established for more than 10 years (Miles and Neale 1991). Even if a government-funded agency is not established, some type of private-sector lead organisation is often considered desirable (e.g., UK's Construction Industry Board, Construction Industry Council, CII, USA Construction Round Table, and Hong Kong's Provisional Construction Industry Coordination Board PCICB). Many also have no doubt that in the developing countries, intervention is desirable so long as it is of appropriate nature.

The mean scores for this factor in Table 2, however, are around the lower quartile indicating that this factor is not strong in most countries.

8 Supportive attitudes of aid agencies

Only one variable loads on this factor at the level of 0.5 or above, but two other variables also load at slightly below 0.5 level, namely *organisational culture*, and *communication between government and contractors*. From a developed country

perspective of course, support from an aid agency does not usually apply. In the developing world, aid is still seen as vital to development for the nation as a whole and to the construction industry in particular. It is of interest to note that this factor lies almost at the bottom of the list as scored by respondents.

CONCLUSIONS

As noted earlier, the understanding of the 'big picture' of construction industry development is far from complete except for the rather overworked perspectives of productivity and efficiency. Previous comprehensive studies have been largely conducted in isolation from each other, making synthesis difficult if not impossible. In attempting to rectify this, the research described in this paper built on the results of Fox *et al*'s (1999) interviews with 'experts' from around the world, modified and extended to take into account what is to be found in the literature, and operationalised into a questionnaire that allows some quantitative analysis to take place. This grounded theory approach has resulted in a classification of the variables involved into eight categories or factors, some of which appear to be mutually exclusive and all of which have intuitive appeal for both developed and developing countries, representing their current strengths world-wide. These have been reported here along with some illustrative examples and connections found in publications and our own experience.

Of particular interest has been to contrast the state of affairs in developed and developing countries in terms of these eight factors. This has not been done in this way previously and is necessarily of a rather speculative nature. To do this quantitatively was outside the scope of the research reported in this paper – the aim of which was to identify the main factors involved in advance of more detailed international survey. Therefore it was the intervariable *correlations* that alone were of interest, rather than any differences in their mean strengths between countries. Having established the relevant factors, further research should now be able to make a quantitative comparison. Also, it is clear that to label countries as either developed or developing is likely to be regarded ultimately as a gross simplification and further research in providing a more detailed, perhaps multidimensional, characterisation will be beneficial. In fact, further research is needed to replicate our work in general – to examine the extent to which the eight factors are sufficiently robust to provide a basis for future theoretical development, whether a different set of factors may be more appropriate, or whether construction industry development can even be successfully factorised at all in this way.

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REFERENCES

Al-Momani, A. H. (1995) Construction practice: the gap between intent and performance, *Building Research and Information*, **23,** 2, 87-91

Al-Momani, A.H. (1995) Economic evaluation of the construction industry of Jordan, *Building Research and Information*, **23,** 2, 39-48

Al-Omari, J.A. (1992) *Critique of aspects of development theory using construction industry in a capital-surplus developing economy as an exemplar*, PhD thesis, U. of Reading

Asian Productivity Organisation (1983) *The construction industry in Asia*, Report and Recommendation of the APO Symposium on the Construction Industry 7th to 11th June 1982 Seoul, Korea. Tokyo: APO.

Australia, Department of Public Works and Services DPWS (1993) *Capital Project Procurement Manual*, NSW DPWS.

Australia, Industry Science Resources (1999) *Building for growth: An analysis of the Australian building and construction industries,* Commonwealth of Australia

Ball, M. (1988) *Rebuilding construction: economic change and the British construction industry*. London: Routledge

Banwell, H. (1964) see Great Britain, Ministry of Public Building and Works.

Bon 1991

Bowley, M. (1966) *The British Building Industry*, London: Cambridge University Press.

Chong C. (1988) *The construction industry in Hong Kong*, HK: James Capel Hong Kong Research, London/Hong Kong.

Cockerill, J.E. (1993) *The construction industry in Belfast 1800-1914*, unpublished PhD thesis, Department of Economic and Social History, The Queen's University in Belfast

Construction Manpower 21 Committee (Singapore) (1999) *Re-inventing construction*, Report of the Construction Manpower 21 Committee set up by the Ministry of Manpower and Ministry of National Development, National Government of Singapore published by Building and Construction Authority.

Crichton, C. (ed) (1966), *Interdependence and uncertainty: a study of the building industry*, London: Tavistock Publications Ltd. [see also The Tavistock Institute of Human Relations.]

De Valence, G. (1999) Australian construction policy and the industry response: promoting re-engineering through government policy, *Construction Process Re-engineering,* 219-30

Dowall, D.E. (1991) *From central planning to market systems: implications of economic reforms for the construction and building industries*, UNIDO, ID/WG.510/4, 19 September 1991

Egan, Sir John (1998) see Great Britain. Dept. of the Environment, Transport and the Regions (DETR)(1998).

Emmerson, H. (1962) see Great Britain. Ministry of Works.

European Commission (1994) *Strategies for the European construction sector: a programme for change*, final report of the Strategic Study on the

Construction Sector (the Secteur Study), by W. S. Atkins International Ltd. with Centre for Strategic Studies in Construction, University of Reading. Construction Europe, KHL Publishing: East Sussex.

Flanagan, R., Jewell, C., Cattell, K., (1999) *Lessons for UK Foresight from around the world for the Construction Associate Programme*, Department. of Construction Management and Engineering, The University of Reading.

Fox, P.W. (1989) *A Study of the Hong Kong construction industry using a systems approach*, unpublished MSc thesis, University of Salford.

Fox, P.W. (1996) Construction industry development - in search of a theory, *Proceedings of Twelfth Annual Conference 1996, Association of Researchers in Construction Management (ARCOM)* Sheffield Hallam University, U.K. 11th - 13th September 1996, 638-45.

Fox, P.W., Scott, D., Neale, R.H., (1999), Construction industry development and government: a grounded theory approach, *Proceedings of Second International Conference on Construction Industry Development and 1st Conference of CIB TG29 on Construction in Developing Countries*, Singapore, October 1999. V1, 25-34.

Fox, P.W. (2002) Training for quality in the construction industry: lessons from Hong Kong. In Ogunlana (ed) *Training for construction industry development,* CIB W107 Report, CIB Publication No. 282, ISBN 974-8208-52-4, pp 41-60.

Ganesan, S. (1991a) *Development of the domestic building materials industry: a case study of Sri Lanka* Colombo: ICTAD Publication in Association with the World Bank

Ganesan, S. (1991b) *Development of the national construction industry: a case study of Sri Lanka*, Colombo, Sri Lanka: Institute for Construction Training and Development in association with the World Bank.

Gann, D.M., (2001) How does innovation link to research? *Building Research and Information*, **29,** 3, 250-2.

Goleman, D. (1996) *Emotional intelligence*, Bloomsbury: London.

Great Britain, Cabinet Office (2000) Wiring *it up: Whitehall's management of crosscutting policies and services*, HMSO: London. ISBN 0-11-430160-3 [http://www.cabinet-office.gov.uk/innovation/2000/wiring/coiwire.pdf].

Great Britain, EDC for Building (1967*) Action on the Banwell Report,* (Chairman Potts, P. G.), NEDO, HMSO: London.

Great Britain, EDCs for Building and Civil Engineering (1975) *The public client and the construction industries* (Chairman: Sir Kenneth Wood), NEDO, HMSO: London (The Wood Report).

Great Britain, Ministry of Public Buildings and Works (1944) *The placing and management of building contracts: Report of the Central Council for Works and Buildings,* (Chairman: Lord Simon) HMSO: London. (The Simon Report).

Great Britain, Ministry of Works (1962) *Survey of problems before the construction industries*, A report prepared for the Ministry of Works by Sir Harold Emmerson, HMSO, London (The Emmerson Report).

Great Britain, Ministry of Public Building and Works (1964) *The placing and management of contracts for building and civil engineering work*, A report

of the Committee under the chairmanship of Sir Harold Banwell, HMSO, London (The Banwell Report).

Hair, J.F. Jr., Anderson, R.E., Tatham, R.E., Black, W.C (1998) *Multivariate data analysis with readings,* Macmillan Publishing: New York 5th edn.

Hampson, K D and Brandon, P S (2004) *Construction 2020: A vision for the property and construction industry*, Cooperative Research Centre for Construction Innovation, Brisbane: Icon.Net Pty Ltd, ISBN 0 9750977 2 5 [http://www.construction-innovation.info/ accessed 10 May 2006]

Harman, H. H. (1967) *Modern Factor Analysis,* University of Chicago Press, Chicago.

Hillebrandt P.M., (1974) *Economic theory and the construction industry,* MacMillan Publishers Ltd.: London.

Hillebrandt P.M., (1984), *Analysis of the British construction industry*, MacMillan Publishers Ltd.: London

Hillebrandt P.M. and Meikle, J.L. (1985) Resource planning for construction. *Construction Management and Economics,* **3**(3) 249-63. ISSN 0144-6193

Hong Kong (China), Construction Industry Review Committee (2001) *Construct for excellence: report of the Construction Industry Review Committee*, Report of the Construction Industry Report Committee under the chairmanship of Henry Tang, Hong Kong, China. Hong Kong SAR Government. (The Tang Report).

Hughes, O. (1998) *Public management and administration: an introduction*, 2nd ed. Macmillan Press Ltd.: Basingstoke

Hutcheson, G. and Sofroniou, N. (1999) *The multivariate social scientist: Introductory statistics using generalized linear models,* Sage Publications., Thousand Oaks, CA.

International Bank for Reconstruction and Development, (1973*) A framework for the promotion of construction industries in the developing countries*, Bank Staff Working Paper N168 IBRD.

International Labour Organization (1988) *Guidelines for the development of small-scale construction enterprises,* ILO: Geneva.

Kafandaris, S. (1980) The building industry in the context of development, *Habitat International,* **5,** 3/4, 289-322.

Kaiser, H. F. (1958) *Psychometrika,* **23,** 187-200.

Kaiser, H. F. (1974) *Educational Psychology Measurement,* **19,** 413-20.

Kirmani S.S. (1988) *The construction industry in development: issues and options,* World Bank Discussion Paper. World Bank: Washington D.C.

Kumaraswamy, M. M., (1994) Growth strategies for 'less developed' construction industries, *Proceedings of Tenth Annual Conference 1994, Association of Researchers in Construction Management (ARCOM)*, Loughborough University of Technology, U.K. 14th - 16th September 1994, Vol. 1 154-63.

Kumaraswamy, M. M., (1998) "Industry development through creative project packaging and integrated management" *Engineering, Construction and Architectural Management*, **5**, 3, 228-237, Oxford: Blackwell Scientific Publications, ISSN 0969-9988

Latham, Michael, Sir. (1994) *Constructing the team: final report*, July 1994: joint review of procurement and contractual arrangements in the United Kingdom construction industry, London: HMSO.

Lawrence, P.R., Lorsch, J.W., (1967) *Organization and environment, managing differentiation and integration*, Harvard University, Division of Research, Graduate School of Business Administration: Boston, Mass.

Lu, Y.J. and Fox, P.W. (2001) *The construction industry in the 21st Century: its image, employment prospects and skill requirements – A case study from China*, Sectoral Activities Programme, Working Paper WP180 for the ILO, Geneva. 50pp, ISBN 92-2-112858-X [http://www.ilo.org/public/english/dialogue/sector/papers/construction/wp180.pdf]

Manseau, A., (1998) Research information: who cares about overall industry innovativeness? *Building Research and Information,* **26**, 4, 241-5.

Miles, D., Neale, R.H., (1991) *Building for Tomorrow: International Experience in Construction Industry Development*, Geneva: International Labour Office.

Momaya, K.S. (1996) *International competitiveness of the Canadian construction industry: a comparison with Japan and the United States,* unpublished PhD thesis, Dept. of Civil Engineering, University of Toronto.

Office of Science and Technology (1995) *Technology foresight: progress through partnership 2: construction*, [see Great Britain, OST]

Ofori, G. (1994) Practice of construction industry development at the crossroads, *Habitat International* **18**(2) 41-56.

Ofori, G. (2000) Globalization and construction industry development: research opportunities, *Construction Management and Economics*, **18** 257-62.

Rummel, R.J. (1970) *Applied Factor Analysis,* Evanstone: Nothwestern University Press.

Rwelamila, P.D., Hall, K.A. (1994) An inadequate traditional procurement system? Where do we go from here? In Taylor, R G, (ed.) *CIB W92 'North meets South' Procurement Systems Symposium Proceedings,* Durban, 473-82.

Seaden, G., Manseau, A., (2001) Public policy and construction innovation, *Building Research and Information*, **29(**3) 182-96.

Simon (1944*)* see Great Britain, Ministry of Public Buildings and Works

The Tavistock Institute of Human Relations (1966) *Interdependence and Uncertainty: a Study of the Building Industry*, London: Tavistock Publications Ltd. [see Crichton, C.]

UK CIPS (2002) *How to develop an outsourcing strategy: the impact on business processes,* The Chartered Institute of Purchasing and Supply.

UNIDO (1991a) *Strategies and policies for the development of the building materials industry in the developing countries*, UNIDO, ID/WG. 510/1 11.

UNIDO (1993) *Prospects for the development of the construction industry in the developing countries*, UNIDO, ID/WG. 528/5 11.

United Nations Centre for Human Settlements (Habitat) (1984) *The construction industry in developing countries: Vol. 1 Contributions to socio-economic growth,* HS/32/84/E Nairobi.

United Nations Dept. of Economic and Social Affairs (2000) *Poverty amidst riches: the need for change*, Report of the Committee for Development

Policy on the second session (3-7 April 2000), United Nations: New York, ISBN 92-1-104497-9.

Walker, D. (1995) The influence of client and project team relationships upon construction time performance, *Journal of Construction Procurement*, **1**(1) 4-20.

Wall, D.M. (1993) Building maintenance in the context of developing countries, *Construction Management and Economics*, **11**, 186-93.

Wells, J. (1986) *The construction industry in developing countries: a strategy for development*, unpublished PhD thesis, University of Swansea.

Wells, J. (1993) Appropriate building technologies: an appraisal based on case studies of building projects in Senegal and Kenya, *Construction Management and Economics*, **11** 1206-216.

Wells, J. (1996b) The construction industry in developing countries (and in countries that are not developing) Unpublished draft of paper prepared in 1995.

Winch, G.M. (2000) Institutional reform in British construction: partnering and private finance, *Building Research and Information*, **28(**1) 141-55.

Wood (1975) *see* Great Britain, EDCs for Building and Civil Engineering, London: NEDO, HMSO.

World Bank (1984) *The construction industry, issues and strategies in developing countries,* Washington D.C.: World Bank.

Zylberstajn, Hélio, (1992) *The construction industry in Brazil: surviving the transition to a more competitive market*, Working Paper 52, Sectoral Activities Programme, International Labour Office.

	FACTOR							
VARIABLE	1	2	3	4	5	6	7	8
Use of E-Commerce	.886							
Use of construction IT	.837							
Use of benchmarking	.750							
Use of partnering	.750							
Attention to organisation culture	.728							
Use of computing skills	.688							
Attention to best practice	.679							
Performance measurement of the industry	.568							
Shared values amongst stakeholders	.532							
Availability of finance		.833						
Availability of investment		.763						
Investor confidence in political environment stability		.748						
Investor confidence in economic environment stability		.723						
Availability of management skill			.745					
Availability of technical knowledge			.726					
Government's concern for its image			.586					
Availability of information			.526					
Availability of craft and operative skills								
Government intervention				.804				
Communication between Government and Contractors				.598				
Effective co-ordination between government departments				.590				
Government policy supporting private industry (contractor)				.506				
Research and development					.817			
Influence of contractors perceptions/attitudes/culture						.744		
Confidence in indigenous skills					.521	.540		
Intervention by a national construction industry development agency							.728	
Trade associations							-.615	
Influence of aid agency perceptions/attitudes								.862
Eigenvalue	*9.748*	*2.615*	*1.898*	*1.571*	*1.445*	*1.229*	*1.114*	*1.040*
Percentage of Variance	*34.813*	*9.339*	*6.780*	*5.610*	*5.161*	*4.388*	*3.977*	*3.714*

Table 1: Rotated Factor Matrix (loading)

VARIABLES	MEAN	FACTOR
Competition between contractors	2.90	-
Availability of telecommunications infrastructure (telephones/internet)	2.86	-
Availability of power (electrical)	2.76	-
Political influence on government policy	2.48	-
Influence of business environment	2.43	-
Availability of materials	2.38	-
Availability of craft and operative skills	2.33	3
Professional associations	2.33	-
Influence of senior construction manager perceptions	2.33	-
Investor confidence in political environment stability	2.33	2
Availability of plant/machinery	2.29	-
Fluctuation of workload from boom to bust	2.29	-
Government's concern for its image	2.29	3
Availability of management skill	2.24	3
Government bureaucracy	2.24	-
Diversity of standards and specifications	2.19	-
Availability of entrepreneurial skills	2.19	-
Government intervention	2.19	4
Investor confidence in economic environment stability	2.19	2
Availability of technical knowledge	2.14	3
Availability of information	2.14	3
Availability of finance	2.10	2
Competition from overseas contractors	2.10	-
Confidence in indigenous skills	2.05	4
Availability of investment	2.00	2
Fragmentation of organisations and functions in the industry	2.00	-
Corruption	1.95	-
Communication between Government and Contractors	1.90	4
The mentor system (main contr/subcontr)	1.90	-
Government policy supporting private industry (contractor)	1.90	4
Appropriate production technology selected by contractors	1.90	-
Performance measurement of the industry	1.86	1
Influence of attitudes of overseas contracting staff	1.86	-
Training and education	1.86	-
Attention to supply-chain management	1.81	-
Industry-wide association of stakeholders	1.81	-
Encouragement for contractor's self-development through ladder of opportunity (main contr/subcontr)	1.81	-
Prefabrication and standardised production	1.76	-
Flexibility of Government attitudes in tailoring contract conditions	1.76	-
Trade associations	1.76	7
Influence of contractors perceptions/attitudes/culture	1.76	6
Use of computing skills	1.71	1
Ethical behaviour	1.71	-
Government's understanding of the construction industry	1.71	-
Effective co-ordination between government departments	1.67	4
Government promoting labour-intensive methods to create employment	1.67	-
Attention to best practice	1.52	1
Dependence on overseas aid	1.52	-
Flexibility of trade unions	1.48	-
Long term thinking of industry	1.48	-

Attention to organisation culture	1.48	1
Intervention by a national construction industry development agency	1.43	7
Tri-partite agreements (government/main contractor/trades union)	1.43	-
Shared values amongst stakeholders	1.33	1
Flexible aid agency procedures	1.33	-
Influence of aid agency perceptions/attitudes	1.33	8
Use of construction IT	1.33	1
Research and development	1.29	5
Confidence in intervention strategy	1.29	-
Use of benchmarking	1.19	1
Use of E-Commerce	1.19	1
Use of partnering	1.19	1

Table 2: Variables ranked by mean score and their association with the Factors

FACTOR	N	MEAN	Std.Dev.
3 Human skills and culture of transparency	5	2.23	0.09
2 Financial resources and investor confidence	4	2.16	0.14
4 Government policies and strategies supporting construction business	5	1.94	0.19
6 Self-reliant construction culture	1	1.76	-
7 Institutional support	2	1.60	0.23
1 Industry-led better practice and culture	9	1.42	0.24
8 Supportive attitudes from Aid agencies	1	1.33	-
5 Research and Development for construction	1	1.29	-
Total	*34*	*1.99*	*0.42*
All variables	*62*	*1.90*	*0.42*

Table 3: Mean strength of factors